1894

A Preliminary Introduction to the Study of Entomology

Lawrence Bruner
University of Nebraska

A

Preliminary Introduction

TO THE

Study of Entomology.

TOGETHER WITH A CHAPTER ON

REMEDIES, OR METHODS THAT CAN BE USED IN FIGHTING INJURIOUS INSECTS; INSECT ENEMIES OF THE APPLE TREE AND ITS FRUIT, AND THE INSECT ENEMIES OF SMALL GRAINS.

BY

LAWRENCE BRUNER,

Professor of Entomology in the University of Nebraska,
Acting State Entomologist, Experiment
Station Entomologist, Etc.

LINCOLN, NEBRASKA, 1894.

J. H.

Jacob North & Co., Printers.

PREFACE.

This book has been prepared for the purpose of partially supplying a demand that seems to exist here in the West for an elementary work on entomology such as can be used in the public schools and on the farm. It is not an original production, but comprises notes from many sources as they have been gathered by the writer and presented from time to time in talks to his classes in the University of Nebraska and before audiences at farmers' institutes throughout the state.

The chapters on remedies and on apple and small grain insects have been compiled and rearranged from the writings of such eminent economic entomoligists as Professors C. V. Riley, A. S. Forbes, L. O. Howard, J. H. Comstock, J. A. Lintner, Herbert Osborn, Otto Lugger, C. M. Weed, H. E. Weed, H. Garman, C. P. Gillett, F. M. Webster, Chancellor F. H. Snow, and a number of others. The illustrations also have, in most instances, been obtained from the same sources and are credited to their authors.

The first part of this book is practically the same as his report for 1893 as entomologist to the State Board of Agriculture. The appendix on the insect enemies of the apple tree and its fruit was printed in the Horticultural Society's report for the year 1894. The paper on insect enemies of small grains was contained in last year's Agricultural report, and is reproduced here so as to bring together under one cover accounts of as many of our common injurious insects as can conveniently be done at this time without adding anything to the cost of the book.

It is hoped by the writer that the work will meet with the approval of those for whom it was intended. If this proves true, he will feel amply repaid for the time spent in its preparation.

LAWRENCE BRUNER.

LINCOLN, NEB., June 1, 1894.

A
PRELIMINARY INTRODUCTION
TO THE
STUDY OF ENTOMOLOGY.

FOR USE IN SCHOOLS AND ON THE FARM.

The study of insects, or entomology, as the subject is more frequently called, is becoming more and more essential each succeeding year as the country grows older and the injuries caused by these creatures increase. The old-time feeling of contempt for all creeping things has gradually died away, so that at present it is seldom entertained by any but the most ignorant. So great has been the change in this respect that even the individual who "stoops so low" as to make a special study of "bugs" is allowed to mingle with "sane" people upon an equal footing. True, he must still frequently submit to a little good-natured jeering by those of higher ambitions with whom he may venture to associate. All this indicates a rapid advance for the science, as well as for its votaries, in the eyes of the public.

From the standpoint of the teacher, no other subject of natural history offers as great advantages for aiding the development of the powers of observation in children as does entomology. The vast amount and at the same time varied material that is always at hand in every region and clime renders the subject of great importance for this feature alone.

Although a very important study to the agriculturist at least, Entomology is still in its infancy as a distinct branch of natural history when compared with Botany or Ornithology. In fact it has been so little taught in our colleges even that we are practically without suitable text-books on the subject. It is true that a number of publications have appeared within the past ten or twelve years that in part fulfill the needs of the would-be student of insects. These, however, are the productions of systematists and not of teachers, and consequently contain such an array of technical or "scientific" names as to discourage at the outset most of the aspiring students in insect lore. The result is practically the opposite of what was intended when these books were prepared and presented to the student world.

While the writer of this paper may be a little self-reliant, he is not so presumptuous as to imagine that he can supply the deficiency at this time nor in the near future. He is willing, though, to at least try to present a short general outline of the subject for this occasion.

The study of entomology, like that of a number of other subjects, can be made interesting to the student from different standpoints. It can be taught as a mere science in which the systematic collecting and classifying of an indefinite number of widely distant forms are pinned and the technical or "Latin" names are attached. It can be made a study in which the transformations and growth of the creatures under consideration occupy the time of the pupil. Again, by choosing to follow the life-histories of various forms much interest may be aroused. In addition to the above, a careful study of the habits, both remarkable and interesting, of many of our most common species will reward the teacher as well as the scholar for the time thus spent. Add to these the application of preventives and remedies by which to check or lessen the ravages of injurious species, and we have a study which is both pleasing and profitable.

What is an insect, then, and in what respect does it differ from the many other "creeping things" that literally fill the world about us? This is a question, the answer to which many may desire to learn. Briefly, an insect is a representative of the class *Insecta* among the branch *Articulata* (or as more recent writers would have us say, the *Arthropopoda*) of the animal kingdom. As in all other articulates an insect's body is made up of rings or "joints," which are fastened one behind the other. Its legs and other appendages also partake of this same jointed nature. It is also provided with a system of air tubes or trachea that ramify the body and open to the air by means of little holes along its sides. These breathing pores are called *spiracles* or *stomata*, and represent the nostrils of higher animals. An insect proper has but six legs (three pairs), while spiders, mites, ticks, scorpions, etc., (class ARACHNIDA), are provided with eight, and the centipedes and millipedes (class MYRIAPODA) have more than fourteen. An insect differs further from all of these in having its body separated into three well-defined rigions, viz.: *head, thorax, and abdomen.* It is from this last mentioned characteristic that the name "INSECTA" is derived, the word meaning to cut into.

Insects also pass through successive transformations that are quite marked and characteristic of the group. These are: first, the *egg;* second, the *larva;* (which takes on different names in the various orders, as for example, "*maggots*" of flies, "*caterpillars*" of butterflies and moths, "*grubs*" of beetles, and "*nymphs*" of mayflies, grasshoppers, etc.); third, *pupa;* fourth, the *imago.* The first or "beginning" stage of an insect's life, in common with that of a great many other animal forms, is the egg. The second or larval stage of an insect's life may be called the "stage of growth," for it is during this period that most if not all of the growth is made—when the food is taken and assimilated that carries the creature through the next and frequently also through the last stage. The pupal, or third stage, should be called the "stage of rest" in an insect's life, although it is by no means entirely one of inactivity save with but comparatively few forms. The last or fourth stage is that of the imago or mature insect. During this stage the first and foremost object in its life is providing for the continuation of the species when it is dead and gone. It might therefore well be termed the "stage of reproduction." Aside from these different stages of existence an insect grows or increases in size by molts or successive sheddings of its skin. When one skin becomes too small to contain the rapidly growing larva it cracks open and the occupant wriggles out enveloped in a new and looser covering. This also in turn soon becomes too small and is likewise cast off, the operation being repeated four or more times during the growth of the larva after leaving the egg and before entering the resting (pupa) stage. In like manner the change from the pupa to the imago stage is made by a shedding process.

Some insects feed continuously while passing through the larval stage. "It is doubtful whether some ever sleep or rest except during molting periods or when disturbed. Some flesh-eating larvæ have been know to consume two hundred times their original weight in twenty-four hours, and there are caterpillars which, during their progress to maturity, increase in size ten thousand times inside of thirty days." Imagine, then, the amount of food that must be consumed by an insect in order that it can increase so greatly in weight.

Right here considerable time might profitably be spent in studying the great variety of conditions under which these four stages occur among different insects; and to learn something of the senses as they are exhibited by these creatures—how instinct, or perhaps reason, directs their movements when selecting the proper means for insuring the safety of future generations of their kind. Some time might also be given to following the gaudy butterfly as it flits over the greensward in quest of the proper food-plant upon which to leave its eggs so that the larvæ when hatched would not find the food distasteful and die of starvation. Later, we might spend a little time in watching the caterpillar carefully creeping to some secluded spot wherein to rest as a pupa or "chrysalis." Truly, "the first law of nature is self preservation" as exhibited in all life, both animal and vegetable.

Insects occur in all countries, at all times of the year, and under nearly every condition. They infest our homes, fields, woods, and prairies; they occur upon and within the bodies of domestic and wild animals, as well as in the air, water, and earth. No region is without one or more forms of these creatures. They enter into and affect our daily lives more or less prominently everywhere and under nearly every condition. We are more or less dependent upon them, or at least utilize many of them or their products in our food, clothing, and the arts almost every day of our existence. In fact, among the insect world we find both friend and foe, be our calling in life what it may. They come across our pathway as enemies to all kinds of useful vegetation, as parasites that attack and infest useful animals. We may meet them on the other hand as friends that assist in the fertilization of, and in gathering honey from flowers, make wax, spin silk, act as scavengers by removing decaying animal and vegetable substances, or in the form of parasites upon and within the bodies of the enemies mentioned above.

If the distinct species or kinds of other animals are numerous, those of the class Insecta are very much more numerous. Various estimates by competent authorities have placed their numbers as high as from two to ten millions of species. In comparison it is estimated that all the other animal forms which probably occur upon the globe will scarcely reach one million species. No wonder, then, that the entomologist is often credited with being "crazy." It is quite enough to make him so if he only keeps track of one-fourth or at most one-third of these in all their changes, food habits, haunts, names, relationships, etc., without being obliged also to "keep posted" in reference to such other "creeping things" as the MYRIAPODA, ARACHNIDA, some of the CRUSTACEA along with the VERMES, and a few of the other forms to the number of about a half million species, or fully one-half of the remaining forms of animal life.

Since there are so very many distinct species or kinds of these creatures with which we must deal, it is quite necessary that something should be known of their relationships one to another in order to make their study at all possible from the economic or any other standpoint. To do this the most readily they have been arranged or classified into major and minor groups. These groups have been established or based upon the structure of the various forms of which they are made up. Other classifications of the class Insecta can and have been suggested, taking for their basis food-habits, haunts, and the presence or absence of wings. The former classification is a more or less natural one, and actually exists in nature, the latter are altogether artificial and are used chiefly for convenience, by those who sometimes have occasion to employ them.

While it is not absolutely essential for one to know the systematic relations of an insect that may come under his or her notice, it certainly facilitates matters if references are to be made to books with a view of learning what has been published about the species. By knowing the order to which your insect belongs you are one step closer towards the information sought. With a knowledge of the order in mind to which your specimen belongs, you can at once refer to the literature treating of that group; and then by the aid of analytical keys there is but little difficulty experienced in "running your insect down" to the family, genus, and possibly even to the species. Now, with the name of the specimen at hand, it is easier to find a record of its life history, provided this is known and has been recorded, than would be the case without this knowledge. It is, therefore, quite evident that even the work of the systematist must be acknowledged as of some value to the ordinary student of "bugs" and "bug lore" if pursued entirely from the economic standpoint.

Originally insects were separated into seven orders by Linnæus, which arrangement, with but slight modifications, has been in use for many years. These orders as generally accepted were as follows, commencing with the most simple in structure and proceeding towards the highest or most complex in structure: 1.—Neuroptera; 2.—Orthoptera; 3.—Diptera; 4.—Hemiptera; 5.—Lepidoptera; 6.—Coleoptera; 7.—Hymenoptera. If, however, we are to begin with the highest and proceed to the simplest, the numbering of the orders should be reversed. More recently Friederich Brauer has remodeled or reconstructed this classification upon the basis of sixteen instead of seven orders. This change was decided upon only after very much careful study of insect structure and development from the egg to maturity. The following, with some modifications, is Brauer's classification as given by Hyatt and Arms in their admirable little book entitled "Insecta:"

I. Thysanura. (Spring-tails, Fish-moths, Snow-fleas, etc.)
II. Ephemeroptera. (May-flies, Day-flies.)
III. Odonata. (Dragon-flies, Darning-needles.)
IV. Plecoptera. (Stone-flies.)
V. Platyptera. (Biting-lice, Book-lice, White ants or Termites.)
VI. Dermaptera. (Earwigs.)
VII. Orthoptera. (Cockroaches, Mantides, Walking-sticks, Grass-hoppers, Locusts, Katydids, and Crickets.)
VIII. Thysanoptera. (Thrips or Fringe-wings.)
IX. Hemiptera. (Tree-bugs, Tree-hoppers, Plant-lice, etc.)
X. Coleoptera. (Beetles.)
XI. Neuroptera. (Lace-wings, Ant-lions, Shad-flies, etc.)
XII. Mecoptera. (Scorpion-flies.)
XIII. Trichoptera. (Caddis-flies.)
XIV. Lepidoptera. (Butterflies, Moths.)
XV. Hymenoptera. (Saw-flies, Ants, Bees, Wasps.)
XVI. Diptera. (Mosquitos, Flies, Fleas.)

This arrangement also proceeds from the simpler to the more complex or specialized forms, as will readily be seen by any one who knows just a little about our common insects and is acquainted with the popular names of these creatures. The appended arrangement will also show at a glance the changes that have been made and the relations which the two classifications bear to each other:

1. Hymenoptera.—Hymenoptera, XV.
2. Coleoptera.—Coleoptera, X.
3. Lepidoptera.—Lepidoptera, XIV.
4. Hemiptera.— { Hemiptera, XI. – { Homoptera. / Heteroptera. } ; Thysanoptera, VIII. }
5. Diptera.—Diptera, XVI.— { Including Aphaniptera, or Siphonaptera of some authors. }
6. Orthoptera.— { Orthoptera, VII. ; Dermaptera, VI. }
7. Neuroptera.— { Trichoptera, XIII. ; Mecoptera, XII. ; Neuroptera, XI. } Neuroptera. { Platyptera, V. ; Plecoptera, IV. ; Odonata, III. ; Ephemeroptera, II. ; Thysanura, I. } Pseudoneuroptera.

By referring to the above chart it will be seen that the changes are not so great after all as one would naturally suppose them to be. The orders Diptera, Lepidoptera, and Coleoptera remain unchanged. From the Hemiptera have been separated a small group of diminutive forms as a distinct order, viz., the Thysanoptera. The old order Orthoptera included also the forms that are now set aside under the name Dermaptera. From the old Neuroptera, however, we notice a great change. Here we find six new orders made from what before were considered only families belonging to the one order. These changes, instead of adding confusion to the classification, greatly simplify matters. We are no longer compelled to mass into one group forms with a diversity of structure, metamorphosis, and habits as belong to the various creatures that

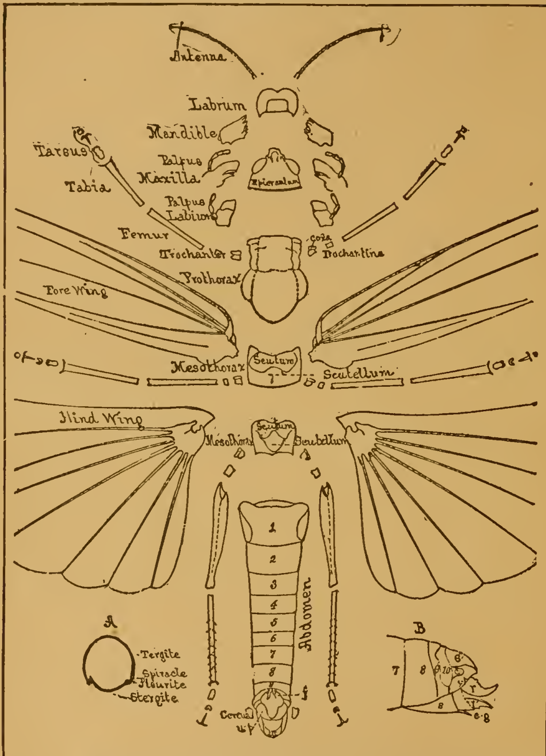


FIG. 1.—*Melanoplus spretus* (Rocky Mountain Locust), dissected so as to show the different parts—from above. [After Kingsley.)

were thrown together into the one order NEUROPTERA simply because they would not fit into any of the other six recognized divisions. Some of these insects have a very complete metamorphosis, as the Caddis-flies, (TRICHOPTERA) for example; others have scarcely any indication of change in form from the time of leaving the egg until arriving at maturity, as is the case in the members of the order THYSANURA. In still others we find greatly different degrees of metamorphosis. These differences can best be presented to the student by taking up the orders into which the class Insecta is divided and describing them one by one.

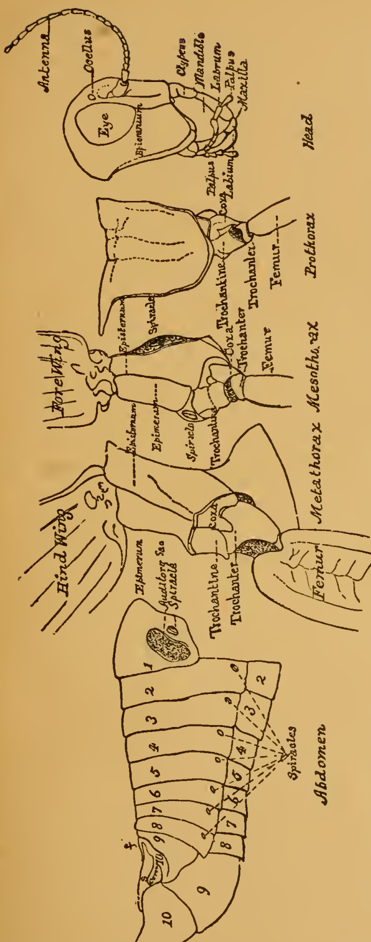


Fig. 2.—Rocky Mountain Locust—side view showing anatomy of outside. [After Kingsley.]

The Coarse Anatomy of Insects.—A reference to the accompanying outline figures of the Rocky Mountain Locust will give the student some idea of the structure of an insect. The various parts of this insect have the same names as like parts in other insects, hence if they are learned for this one, the names will apply equally well to all others. In glancing the names over carefully it will be seen that they are very similar to those used for like parts in other animals. In addition to the terms in use for the various parts of the human body there are, of course some special names that are used in connection with insects alone. This is likewise true of all other special branches of natural history, and therefore the would-be student of Entomology should not be discouraged on account of this array of new and special names that accompany the subject.

If we take any grown grasshopper, or, more properly speaking, locust, and examine it, we will find that it is made up of a number of rings attached one behind the other. These rings are grouped into three well-marked regions which have already been mentioned as *head*, *thorax*, and *abdomen*. The head is provided with a number of attachments as for example the *antennæ*, *labrum*, *mandibles*, *maxillæ*, *labium*, and *eyes*

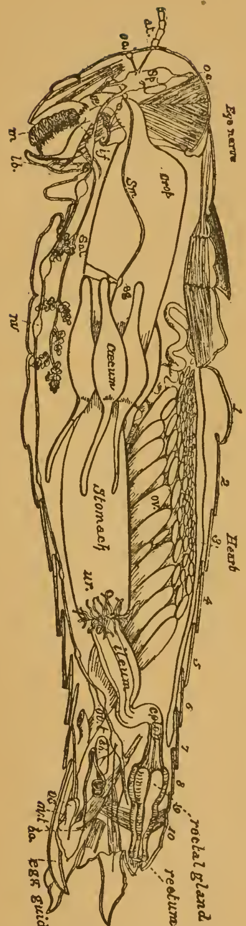


FIG. 8.—Section through body of female Rocky Mountain Locust, showing internal anatomy. [After Burgess].

Some of these also bear additional parts, which add to the seeming complexity of the region. To the *thorax* we find attached the organs for locomotion, viz., the legs and wings. The abdomen is the region devoted to digestion, assimilation, and is the location of the organs of reproduction.

Examining the insect again, we find that the outside is composed of hardened walls so as to form a sort of protection for the softer internal parts. In other words, the insect's skeleton is on the outside and the muscles and other tissues on the inside. The muscles are attached to the inner surface of the skeleton-like rings of which the outside is composed. In this way a much greater strength is developed in an animal of correspondingly smaller size.

By examining the anatomy of an insect a little more fully, we find the following conditions: HEAD. — *Antennæ*, the two many-jointed, thread-like attachments that project forwards from the face in front of and between the eyes. These are called feelers, and possibly serve the purpose of some special sense that we know nothing about. The *labrum* or upper lip is a sort of curtain that hangs in front of the *mandibles* or true jaws, which are used for biting and chewing the food. Behind these latter are located a secondary pair of jaws, the *maxillæ*, which also assist in the mastication of food, and to each of which is attached a five-jointed appendage known as *palpæ* or feelers. Still back of these accessory jaws is the *labium* or lower lip, which also is composed of two parts, to each of which is attached still another of these jointed appendages similar to the ones connected with the *maxillæ*. THORAX.—The thorax is composed of three joints, which are commonly called the *pro-thorax*, *meso-thorax*, and *meta-thorax* respectively. Each of these joints bears a pair of legs, and the *meso-* and *meta-thorax* also bear a pair of wings each. The pro-thorax is moderately free

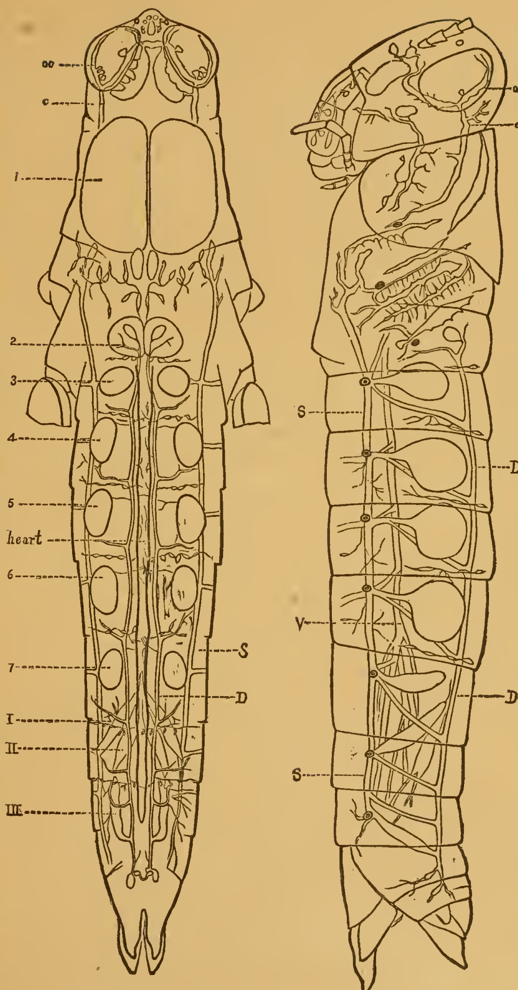


FIG. 4.—Figures of female Rocky Mountain Locust showing distribution of air sacks and tracheæ also the dorsal vessel or heart—side and top views.

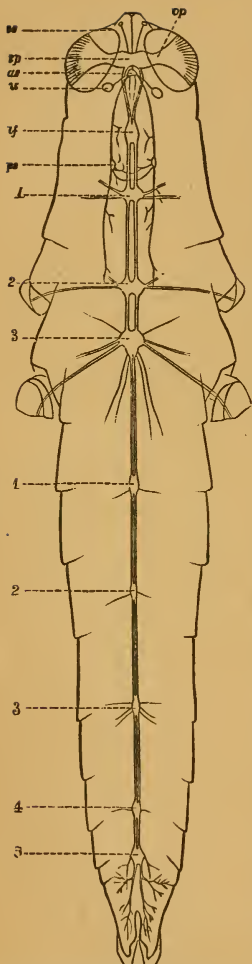


FIG. 5.—Female R. M. Locust from above, showing distribution of nerve centers.—[After Emerton.]

from the other two joints as well as from the head. Each of the six legs that an insect possesses is also made up of a number of joints that have special names applied to them. Beginning at the body we first have the *coxa*, or the movable, ball-like joint that works in a socket within the body. Next in rotation is a small joint called the *trochanter*, after which follows the *femur* or thigh, and then the *tibia* and *tarsus* respectively. The wings are called by different names, and are more or less divided into regions by principal veins that bear special names and that often are brought into use by the systematist as a basis for classifying the different genera and species. The front pair, called *tegmina* in the present insect and its allies, are used partly for flight and partly as a protection to the hind pair, which are more delicate, and that are folded lengthwise like a fan, as can be seen by examining first figure given on page 284.

ABDOMEN.—The abdomen of a locust is composed of ten segments or joints, and contains the intestines, ovaries, etc., and ends in the ovipostor or male claspers accordingly as the specimen is male or female. The *ovipositor* is composed of four horny plates that are pointed and curved so that the insect can dig into the ground for the deposition of her eggs. (See Fig. 1, B, *r* at right hand lower corner).

As the external anatomy of an insect differs greatly from that of higher animals, so does also its internal structure differ much from that of them. The circulatory apparatus is composed of a long tube-like sac that is located along the upper side of the body and which is provided with a number of valves. This vessel which is shown in Fig. 3 at *3*, beats in a similar manner to the heart of higher animals. The nervous system is not nearly so complicated nor so centralized in its location as we find it in mammals, etc. It is confined near the lower surface, and instead of being centralized in the head it has a number of enlargements along its course as can be seen by reference to the illustra tion, Fig. 5. The breathing arrangement of insects can be seen in figure 4 and differs materially from what we are accustomed to see in other and higher animals. Imagine a number of holes along both sides of the body through which air is obtained directly into tubes which follow the courses of the principal blood vessels, and you have a pretty fair idea of what the breathing apparatus of an insect is like.

ORDER I. THYSANURA.—(*Tassel Tails.*)

That the many different forms of insect life may be presented to the reader, it will be best to take for our first example a few of those belonging to the order Thysanura mentioned in a former paper. As stated there these insects are all very simple in their structure, are rather small as compared with many others, are all without wings, and are the same form when leaving the egg as when mature. Many of the Thysanura are nearly or quite blind, living as they do in the earth and under stones away from the light. Not only do the members of this group of insects represent creatures of comparatively simple structure, but they also exhibit much variation among themselves as will be seen by a reference to the six accompanying illustrations. In the order are found forms that show close relationship to the Myriapoda or "thousand legs." The different species of *Scolopendrella*, which name is the diminutive of *Scolopendra*, the Centipede, and which are considered by many systematists as the very lowest representatives of the class Insecta, are provided with accessory abdominal legs like the Myriapods; but differ from the latter by having the legs five-jointed and ending in two claws instead of a single one. Their bodies also resemble those of the next group (see Fig. 6) more than they do those of the Myriapods.

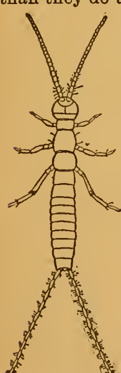


FIG. 6.—*Campodea.*

So greatly do these simple, minute creatures differ among themselves that they have been separated into three suborders, viz.: *Symphyla*, *Cinura*, and *Collembola.* Of the first suborder we have no illustration for an example, but refer the reader to the description of *Scolopendrella* above. In the next suborder we meet with creatures that also bear the jointed abdominal appendages upon the seven basal segments at least. These, however, are quite short and are not used in walking. Like the others these live in dark localities. The thread-like, jointed, anal appendages are very similar to those on the head end, and possibly serve similar purposes in the economy of their possessors—in the absence of the eyes very likely acting as guides for feeling the insect's way and in notifying it of the approach of an enemy from behind.

Another type of this order is shown in Fig. 7, and is known as *Japyx.* These insects are also blind and live in dark, damp places. The one illustrated herewith is one-half inch or more in length, and occurs in Mexico where it is not at all rare in the vicinity of Orizaba and Cordova. In the United States a smaller species occurs where it inhabits caverns and like localities. These insects are characterized by their caudal appendages, which resemble those of the earwigs and form a pair of horny forceps or pincers.

A third type of Thysanuran insect belonging to this suborder is shown in Fig. 8. This latter is known as *Lepisma* to the entomologist, and as Fish-moth to the average mortal. It is a common household pest, and often does considerable injury by feeding upon the paste used in the binding of books. Its form is quite similar to the Campodea, but the appendages and scales with which it is provided change its appearance not a little. It also has eyes, and in length exceeds one-quarter of an inch. These three insects are types of the families that comprise the suborder Cinura.

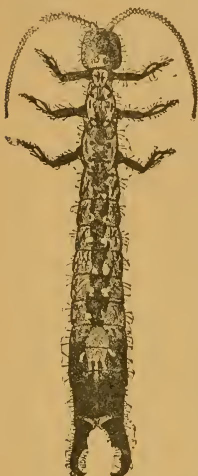


FIG. 7.—*Japyx.*

By far the largest number of species among the order belong to the family Poduridæ or Springtails of the suborder Collembola. The latter are usually very small—often not more than one-tenth of an inch or less in length—and like most of the other representatives of the order are found in damp places where they occur in large numbers. Three of these "spring-tails" are shown in Figs. 9, 10, and 11. Several species of these are often seen jumping about upon snow during early spring, even when the temperature of the air is below the freezing point, hence the name "Snow-fleas" that is sometimes applied to them.

Generally speaking, the Thysanurans are to be classed among the non-injurious insects, since their food consists for the most part of decaying vegetation, as of various molds and other microscopic vegetable forms. A few of them are, however, directly injurious, as for example the Fish-moth and one or two allied genera.

Aside from their being interesting as the simplest types among insects, these little creatures in themselves present a rich field for study to the student who cares to examine little things. They are admirable subjects for testing the use and possibilities of the microscope. Taking the world over there are very many genera and species of Thysanuran insects.

FIG. 8.—*Lepisma.*

FIG. 9.—*Tomocerus.*

FIG. 10.—*Degeeria.*

FIG. 11.—*Smynthurus.*

ORDER II. EPHEMEROPTERA—(*May-flies, Day flies.*)

If the Thysanarans are the lowest or most primitive among insects, as is now generally acceded by the students of natural history, the May-flies must certainly be placed next in order. Their simple structure and but slight change in form from the time of leaving the egg until attaining wings and maturity alike indicate a low position in the scale of advancement towards the very complex insect as found among the Hymenoptera and Diptera.

FIG. 12.—May-fly and larva.

A reference to the illustration given in figure 12 will indicate at once to the reader what the insects are like which are placed in this order. Although there are many species of May-flies to be met with in the United States, they are very much more numerous both in species and individuals about large bodies of water than in other localities. Of course this is quite evident to anyone when he has learned that they live in water during their growing or larval and pupal stages. While the various species differ considerably one from the other in size and appearance, they all have in common certain characteristics which at once distinguish them from all other insects. They are very delicate and fragil, with large, many-veined front wings that are usually carried folded with their upper surfaces together and held at right angles with the body when at rest. The hind wings are rather small or entirely absent in some forms; and the abdomen ends in either two or three long, many-jointed thread-like appendages, as is shown in the figure. Unlike some of the Thysanura their bodies are smooth, *i. e.*, they are not clothed with scales or hairs. The head is free and provided with rather large, compound eyes. The antennæ are short and inconspicuous, and the mouth-parts but poorly developed or atrophied. This condition being due to the fact that no food is taken by the insects during their existence as imagoes. Other characteristics might be mentioned as belonging to these insects exclusively, but will be left for some future time or some other writer to describe.

Aside from the scientific interest which attaches to these creatures, May-flies have received much attention from non-scientific writers on account of their short-lived existence as adult insects. In fact, their name signifies "of short life." While these popular notions as to the lives of the different representatives of the order are not very clear, they have some foundation. Taking the entire life cycle of any particular May-fly into consideration, these insects are rather long-lived than otherwise. Some species appear twice each year—in spring and autumn ; but others require one, two, or even three years for a generation. When we take into consideration the fact that the greater part of this time is spent under water, the time in the air certainly is short. "With many species the individuals leave the water, undergo two transformations, mate, lay their eggs, and die in the course of an evening or early morning." (Comstock.)

The immature stages of most May-flies resemble in body somewhat that of their parents. With these insects the skin is cast or shed quite often during the growth, being changed a dozen or more times ; and in some instances as often as twenty-one of such molts take place during their growth from the egg to the imago. At first these little nymphs breathe directly through the skin of the body at large, but after the first few molts rudiments of tracheal gills appear at the outer rear edges of the abdominal segments. These gill-like appendages become much modified during the growth of the larva and in different genera ; and in some forms are also attached to the front legs, head, and tip of abdomen. These appendages, which are used for breathing purposes, may be either thread-like, tufted, or plate-like in their form. In Fig. 12 one of these May-flies, or, rather, May-fly nymphs, is illustrated, in which the tufts at the side of the body represent the gills by means of which the insect extracts the oxygen from the water.

May-fly nymphs, according to Eaton, "feed upon either mud or minute aquatic vegetation, such as cover stones and the larger water plants" under water. If, however, we are to judge from the structure of the well developed mandibles and maxillæ with which some of them are provided, certain species are very probably predaceous in their food-habits. In the imago stage no food is taken as has been stated above, hence the mouth-parts are rudimentary in their structure ; and in fact the short duration of this stage renders it unnecessary that food should be taken by them.

The Ephemeroptera often appear suddenly in very large numbers, when they are attracted to lights by the millions—sometimes to such an extent that they have been known at such times to extinguish the flames of a gas light with their numbers. So regular is their appearance that each year in a given locality the corresponding date will usually herald their appearance and disappearance. All the individuals of a given species also mature nearly simultaneously, hence it is seldom more than a few days during each year that any single species can be taken by the collector.

While these insects might be made the basis for much interesting study by any one who would care to take them up for this purpose, they still remain but poorly worked so far as this country is concerned. Still, Eaton in his monograph of these insects enumerates nearly one hundred species, which he separates into more than twenty genera. In the classification of these insects the wing venation is much used.

Aside from the interest which attaches to the May-flies on account of their ephemeral existence as adults, they are of much economic value as food for many of our fishes—furnishing, as some of our authorities would have us believe, fully one-half of their food supply.

ORDER III. ODONATA.—(*Dragon-flies, Darning-needles, Snake-feeders, Snake-doctors, etc.*)

Following the Ephemeroptera in the order of their ancientness or time of appearance upon the earth, as well as in their structure, are the insects which are known by the above mentioned popular names. All of the representatives of the order are rather large in size when compared with many other insects, but small in comparison with some of the ancient giants of the order that are said to have reached nearly two feet in their wing expanse.

As will be seen by a reference to Figs. 13 and 14, the members of this order have a very characteristic form. The body is long and spindle-shaped, the four wings are long, narrow, powerful, and supplied with a network of veins. The two pairs of these organs are about equal in size and form. The head is large, broad, and often semi-globose in form, with the hind part concave. It is taken up for the most part by the very large compound eyes and is attached to the prothorax by a slender neck upon which it moves quite freely. The antennæ are small and bristle-like, and barely visible unless especially looked for. The mouth-parts are very well developed; both the mandibles and maxillæ are strongly toothed, while the labrum and labium, or lips, nearly inclose the jaws while at rest. The thorax is large, as must necessarily be the case in order to contain the necessary muscles to move the powerful wings with which the insects are provided, and which they know so well how to use. The abdomen is long and slender and is provided at the extremity with a pair of claspers or cerci. The venation of the wings, which appears to be very complicated, is the chief basis for classification in the order.

Like the Ephemeroptera the members of the Odonata spend their earlier existence in the water, where they dwell as nymphs that occupy much of their time in capturing and devouring such various kinds of animal life as they can capture and overcome. It is needless to state that the "bill of fare" of these insects includes not only the various aquatic insects that occupy the same waters with them, but also many young fishes, worms, and crustaceans fall before them and go to satisfy their ravenous appetites. If we were to see these nymphs for the first time moving about on the bottoms of aquaria or in their native haunts in their characteristic sluggish manner little would we think that they were such ferocious creatures. Although the nymphs or larvæ of these insects vary considerably among themselves in form, their general appearance is quite characteristic. While some of them are very slender, others are nearly as broad as long. Still the structure of the mouth-parts will readily distinguish them from all other insects. They are provided with well-developed maxillæ and mandibles, all of which are armed with sharp, strong teeth. By a peculiar arrangement of the lips none of these are visible when the insect is at rest and not feeding. The lower lip or labium is greatly enlarged and so formed as to cover all of the other mouth-parts like a mask. In fact, when we look at one of these creatures from the side we cannot help but think of the "knights of old" as we remember them in our picture books. In addition to covering the other mouth-parts this lip is used both as a weapon of defense and for seizing and holding the prey.

If the mouth-parts of the young Odonata are peculiar when compared to those of other insects, their breathing apparatus is even more queer. Imagine, if you can, the organs of respiration to be formed by a modification of the rectum at the tail end of the body. This is somewhat enlarged and the walls well supplied with tracheal tubes. By the water being alternately taken in and forced out through the anal opening the air in the trachea becomes purified. This arrangement for "breathing" is also made use of by the nymphs as an organ for locomotion. By gradually drawing water into the organ mentioned and expelling it forcibly the insect is enabled to move forward quite rapidly. It is thus provided with a hydraulic motor of no mean design.

When fully grown and ready to transform these nymphs leave the water, and climbing to some object where they cling, they crack open along the back of the thorax and head to disclose the perfect insect. Now that the insect has finally obtained its powerful wings and knows how to use them, it is a dread enemy to weaker insects of many kinds. It is especially inclined to search for and devour flies, gnats, and mosquitos, hence the popular name "Mosquito-haw," that is so often bestowed upon it. It is, therefore, more or less due to the abundance or scarcity of these Odonata in certain localities as to whether or not mosquitos are troublesome.

Dragon-flies or "mosquito-hawks" are divided into several well-marked families; but for ordinary purposes they can be separated into two groups, the one in which the wings are all alike and folded vertically in repose, and the other where the wings are somewhat unlike and carried horizontally when in repose. The former type is shown in Fig 13, while the latter is presented by the illustration at 14.

Dragon-flies usually require one year for each generation. Some species appear very early in spring; and unlike the Ephemeroptera, many of them live several weeks or even months before dying of old age. The eggs of these insects are laid in the water, sometimes singly, sometimes in masses. Some of the species deposit their eggs on the under side of the abdomen, where they are carried until the insect chances to come to a suitable body of water, when they are soaked loose and allowed to settle to the bottom upon the mud, where they remain until hatched. This arrangement enables the insects to wander far away from the bodies and streams of water in search of food.

Several species of these insects have often been known to gather in large numbers or swarms and then to migrate like birds. In the wake of such flights of dragon-flies it has been noticed that mosquitoes and other small, soft-bodied insects are always scarce for several days.

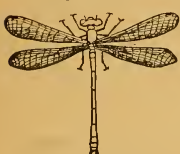


FIG. 13.—*Agrion.*

Before leaving the order Odonata for good, it might be well to state that many other interesting features in connection with their anatomy and habits might be mentioned; but these can best be learned by reference to a more systematic treatise on the order.

FIG. 14.—*Libellula.*—[After Packard].

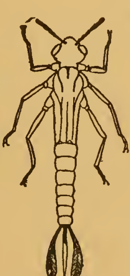


FIG. 15.—*Agrion* larva.

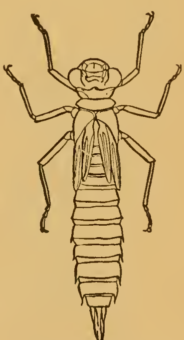


FIG. 16.—Larva of *Æschna.* —[After Packard].

ORDER IV. PLECOPTERA.—(*Stone-flies*).

A reference to Fig. 17 will show the reader at a glance the type of a fourth order of hexapod insects. As will be seen the illustration pictures a quite different creature from any of those mentioned as belonging to either of the preceding orders. As indicated above, the members of this group have received the popular name of "stone-flies." This name is derived from the habits of the insects both as nymphs and imagoes, since they are, for the most part, found about stones and in stony places along streams. The larvæ or nymphs are found most numerously in swift running streams with stone bottoms. As indicated by the figure of the nymph at the right in the illustration, they have flattened bodies fitted for living under stones or other flat-lying objects. These nymphs are to be recognized, then, by their very flattened bodies from which radiate the limbs, antennæ, and anal setæ. The latter are as long or longer than the antennæ, many-jointed, and are retained in most of the forms in their imago stage. The legs and thoracic segments of many of them are provided with fringes or tufts of hair-like gills by means of which they "breathe" from the water such air as is required by them. In a few of the forms it is said that these gill-like appendages are retained by the imagoes throughout life.

Like other aquatic insects these stone-fly nymphs leave the water when about to transform to the perfect stage. Climbing upon some object they cling fast by means of their hooked feet and crack open along the back of the thorax and head as described above in connection with the nymph of the dragon-fly, and disclose the imago.

The food of these creatures is supposed to be chiefly of a vegetable nature; and in turn they form quite an important item in the food supply of fishes.

FIG. 17.—Stone-fly, wings, and nymph.—[H. G. Barber.]

In the perfect insects we find the body somewhat flattened, elongate, with the sides nearly parallel. There are four wings, the hind pair much larger than the front ones, and folded upon themselves once. When at rest the wings are folded upon the body one over the other in a plaited manner, hence the name Plecoptera, meaning "plaited wings." The tarsi are three-jointed; and, as stated before, in most species the anal setæ are retained during the imago existence.

The order comprises but a single family, viz., Perlidæ; and most of our species are placed in the genus *Perla* by systematists. Some of these insects transform to the perfect stage very early in the spring, so early in fact, that they can often be seen crawling upon snow. They vary in size from less than one-fifth to over an inch in length exclusive of the wings; and a few of them have abbreviated wings. Like some of the members of the previous order, these insects carry their eggs about with them attached in a mass to the end of the body until they are finally dropped into the water. Some of these stone-flies are considered excellent fish-bait. On account of their economic importance in connection with the fish industry of the country these insects deserve to be better known than they are at present. Should any of my readers become interested in them they will find some valuable aids by which they will be enabled to carry on their investigations.

ORDER V. PLATYPTERA.—(*Termites*, or *White Ants*, *Book-Lice*, and *Biting-Lice*.)

Very similar to the imagoes of the last order are certain small insects that are known as Termites or White Ants, since they bear a slight resemblance to the *true* ants that will be described among the Hymenoptera near the end of this paper. These Termites, on account of their social habits, occur in many special forms within a single colony. The great injury which they commit, along with their modes of life, have made them noted among insects. The accompanying figure represents our common species in this region—*Termes flavipes* or the Yellow-Footed Termite. As most of these Termites have similar habits, a short sketch of our common species will answer for all of them. In presenting this sketch of its life history, permit us to quote from Hyatt and Arms' little work entitled "Insecta," which, by the way, is one of the very best elementary works on entomology extant.

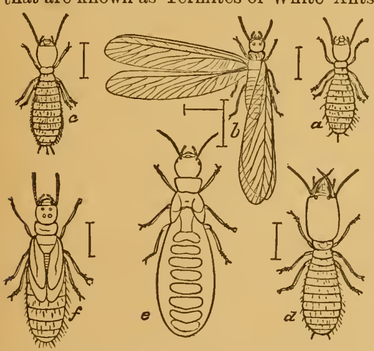


Fig. 18. *Termes flavipes*; *a*, larva; *b*, male; *c*, worker; *d*, soldier; *e*, queen; *f*, pupa—enlarged.—[After Riley.]

"The Termites have become well known in Massachusetts of late years from their depredations * * * at the state house. A colony of these insects illustrates the fact that social habits tend to the production of different kinds of individuals fitted to perform different kinds of work. The worker of our common species *Termes flavipes* (Fig. 18, *c*) has a light-colored body and a brown head of medium size. The color of the head shows that the insect performs the hardest work with this part of the body. The thorax and abdomen are broadly connected, while in the Hymenopterous ants the abdomen has a slender stem or peduncle.

"The mandibles are not large, but are strong and horny, while in the soldiers (Fig. 18, *d*), which perform greater labors for the protection of the colony, the head and mandibles are greatly developed, and the latter deeply colored. The difference in structure between these two individuals is, in fact, exactly proportioned to the amount and kind of work they perform. It is also interesting to note that the worker obliged to work below has its head turned downward at right angles with the body, while the soldier, using his mandibles in fighting in narrow places, has its head extending forward or in a line with the body. Both workers and soldiers may be of either sex, but the reproductive organs are (only) slightly developed. They are blind, the eyes being absent, and they never have wings, the name *Platyptera* referring to the wings of the male and female. They are in reality larvæ which never pass through the pupal stage, but are arrested in development, and in the soldier the head is abnormally developed to accomplish the special work of attack and defense. The larvæ proper, or young Termite, is white; even the tips of the mandibles are only slightly tinted, while the hooks of the feet are entirely colorless. * * * The larval Termites are nursed by the workers who prepare their food and tend them with great care. The resemblance of these larvæ to the Thysanuran insects is seen in the shape of the body and the distinct thoracic rings. Those forms that are destined to develop into males and females are kept longer under the care of the workers, and pass through the pupa stage. The pupæ are colorless like the larvæ, but have eyes and wing-pads fringed with hairs. They are active, and therefore the metamorphosis of Termites is direct.

"There are two castes of males and females. The complemental males and females, as they are called, are supposed never to leave the nest. They are of light color, like the workers. In case of need several of these females are substituted for a true, prolific queen. They can produce but few eggs, however, and do not enlarge as does the queen. The king and queen caste arises in the spring. They fly out in clouds from the nests for their marriage flight. They then alight on the ground and loose their wings. The workers select from these a pair for each nest, and the rest soon die. The royal pair are housed in a special apartment. In *Termes flavipes* this caste is dark chestnut or black, but the royal pair have never yet been found in any nest.

"The colorlessness of the Termites is interesting, since it correlates with their habits. They are more exclusively confined to their nests than the ants, and, like cave animals, being protected from the action of the atmosphere and light, they are colorless or only slightly colored. The exceptional coloring of the jaws in larvæ before they begin to feed is probably due to inheritance, the vestiges of a time when they lived an open and freer existence, and had not yet arrived at the remarkable stage of specialization which they now exhibit."

The number of eggs that are laid by a single Termite are simply wonderful, since as many as sixty eggs per minute have been counted, or upwards of eighty thousand per day, if that rate were kept up continuously.

Termites are exceedingly numerous in the warmer regions of the earth and in these localities do much injury to property. They work into wood of all kinds, and by eating out the interior of the boards and timbers and leaving the outside untouched, buildings often collapse suddenly when they are apparently sound from outward appearance.

In Mexico where the writer had an opportunity to study these insects much injury was observed in the city of Orizaba, where great beams in a building had become so weakened by their attacks as to require propping or renewing in a very few years. Railroad ties of wood are soon destroyed by them, and are now substituted by ties of iron upon the roads running through the "tierra calientes" or hot country. When a large forest tree falls these insects immediately attack it, and along with others and the action of fungi of various kinds, soon reduce it to vegetable mold. Still further south Termites are said to be much more numerous and also correspondingly more destructive to everything wooden. Even articles of furniture left standing in darkened or poorly lighted rooms for several months at a time have been known to receive their attention and collapsed when used for the first time after such a rest. One species of African Termite constructs for itself hillocks of clay from ten to twelve feet in height. "In the center of these and near the surface of the ground is the royal chamber occupied by the king and queen. Extending a foot or more around this chamber on all sides are the apartments of the workers and soldiers, and beyond these the storehouses. It is a significant fact that while all other chambers are built of clay, the nurseries are 'totally different,' being made of wooden materials, apparently cemented together with gum." In the Mexican species that came under our notice the nest appeared to be made entirely of this wood fibre mixed with saliva or some insoluble gum-like substance that made the nest very strong and at the same time very light.

Psocidæ.

The insect shown in Fig. 19 is known as a "Book-louse." It is sufficiently similar in its structure to the Termites to be placed along with them in the same order. As will be seen by studying the illustration, these Psocids are small and remind one of the plant-lice, as will be seen by reference to those insects further on in the paper. Their head is large in comparison to the size of the body; and the wings when present are ample and reach beyond the tip of the abdomen. The compound eyes are small though prominent, and when examined under a high power lens appear like a blackberry. The antennæ are long and slender. The mouth-parts are for biting. The food of these insects is somewhat variable, being either vegetable or animal, according to the species under consideration. Those that live out-of-doors feed for the most part upon lichens and other dry vegetation, while some of the indoor forms are museum pests by infesting and feeding upon botanical and entomological specimens. They also infest books, hence the name "book-lice."

FIG. 19.—Psocid.—[After Packard.]

These insects are very active and run either backward or forward seemingly with equal facility. Their small size and light colors render them protection where large insects would be detected and destroyed or routed. They can be kept out of collections of plants and insects by the use of napthalin crystals if these are strewn about the cabinets.

MALLOPHAGIDÆ.

Still others of the six-footed insects are classed in the order Platyptera, as will be seen by reference to the accompanying nine cuts which represent certain parasitic animals known as biting lice. Most of these

FIG. 20.—The Chicken Goniodes. *Goniodes dissimilis* Nitzsch.—[After Denny.]

FIG. 21. —Pigeon Goniodes. *Goniodes damicornis* Nitzsch. —[After Osborn.]

FIG. 22.—Peacock Goniodes.—*Goniodes falcicornis* Nitzsch.—[After Denny.]

are parasites of birds, though a considerable number of them are also known to infest mammals. Some species of birds are known to harbor more than a half dozen kinds of these biting lice, and most kinds have

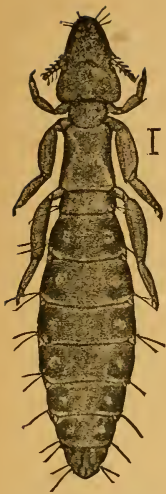


FIG. 23.—Squalid Duck louse. *Lipiurus squalidus* Nitzsch.—[After Osborn.]

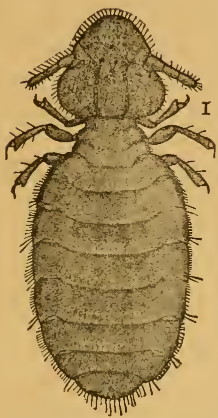


FIG. 24.—Biting louse of cattle. *Trichodectes scalaris* Nitzsch. —[After Osborn.]

FIG. 25.—Biting louse of ass. *Trichodectes pilosus* Giebel. [After Piaget.]

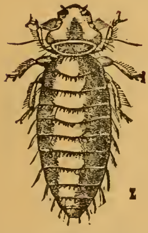


FIG. 26.—Common Hen Louse. *Menopon pallidum*, Nitzsch.—[After Denny.]

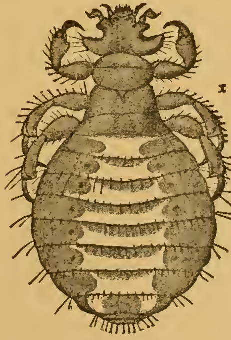


FIG. 27.—Guinea-Pig Louse. *Gyropus ovalis*, Nitzsch.—[After Denny.]

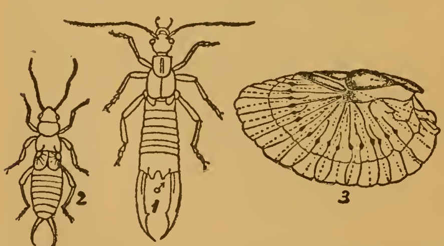
FIG. 28.—Variable Chicken Louse. *Lipeurus variablis*, Nitzsch.—[After Denny.]

at least one species that is characteristic to it alone. Unlike the Termitidæ and Psocidæ, which are terrestrial the Mallophagidæ are wholly parasitic, "and possess the usual specializations noticeable in such groups." They are all wingless, and possess biting mouth-parts in contradistinction to the sucking mouth-parts of the "true" lice. Instead of living upon the blood of their hosts these lice feed upon dandruff, feathers, etc.

These lice can be killed by using grease upon the animals which they infest. The kerosene emulsion which is described in the chapter devoted to "remedies" is one of the very best remedies that can be used against these and other lice. The plan upon which grease works in the destruction of these animals is that of suffocation; it chokes up the breathing pores.

ORDER VI. DERMAPTERA.—(*Earwigs*).

In this order we find a repetition of the form of the Thysanuran known as *Japyx* which is mentioned and figured in connection with that order. (See Fig. 7.) It will be seen by a reference to the accompanying Figs. 29 and 30, that these insects possess at the tips of their bodies a pair of forceps or pincers. It is this character which gives them the family name FORFICULIDÆ, the word "forficula" signifying scissors. The name "earwig" is harder to trace to its origin, although there is a superstitious notion extant that these insects enter the ears of sleeping persons and cause injury to those organs. It is needless to state that such a notion as this in connection with the representatives of the order under consideration has no foundation whatever. A much better interpretation of the origin of this name might be suggested by the supposition that the name as originally written was "ear-wing" on account of the resemblance of their unfolded hind wing to the human ear. A reference to the illustration will at once indicate why this suggestion is offered as a solution of the name "ear-wing" which could very easily be rendered "ear-wig" by abbreviation.



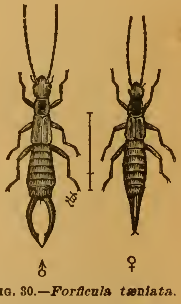


FIG. 29.—Earwig: 1, mature male; 2, nymph; 3, wing unfolded. FIG. 30.—*Forficula tæniata*.

The members of the order are all terrestrial in their haunts. In form they are elongate, with the bodies more or less flattened, and the legs adapted for running. The first or front pair of wings is leathery, and when folded form a protection to the second and very delicate flying wings. These latter, as would be imagined both from their appearance and from the fact of their being so snugly tucked away underneath the small front pair, must be much folded. A second and more careful examination of the figure will give the reader some sort of an idea as to how this folding is done. They are first folded like a fan and then laid back upon themselves in the middle before being tucked away beneath the leathery pair. It is thought that for this purpose the anal forceps are used to some extent.

The food-habits of these insects, as far as known, are entirely of a vegetable nature. The mass of the species are confined to the warmer parts of the earth where they often do much injury to showy plants by gnawing their blossoms full of unsightly holes. They are nocturnal in their habits, and during daytime remain hidden away from view in all kinds of nooks and crannies. In this state there are but three of the earwigs known, and these are very rare and seldom seen by anyone except the entomologist who knows where and how to look for them.

The female Dermaptera lays but few eggs and then watches or broods over them until they are hatched, after which she sometimes cares for the young as an old hen does for her brood of chicks. Such a sight as this is of very common occurrence in the southern part of our country if the individual takes the trouble to lift the loose bark from fallen trees.

Less than five hundred species of these insects have been described from the entire world; and some of them show much variation in their form from the typical earwig as shown in the illustration (Fig. 29). Many of them are wingless throughout their lives. One of our Nebraska species is shown in Fig. 30.

ORDER VII. ORTHOPTERA.—(*Straight-winged Insects.*)

The insects which comprise this order are among some of our commonest and best known forms. They are such as the Cockroaches, Crickets, Walking-sticks, Grasshoppers, Locusts, and Katydids. All of these insects, it will be seen, are quite readily separated from other forms, such as we have already noticed, as well as from such others as will be described in the succeeding pages.

In writing of the members of this order Comstock says: "Although the song of the katydid and chirp of the cricket are most often associated with recollections of pleasant evenings spent in the country, we cannot forget that to the members of this order are due some of the most terrible insect scourges man has known. The devastations caused by great swarms of migratory locusts are not only matters of historical record, but are too painfully known to many of our own generation in the western states." Certainly many of us here in Nebraska have had occasion to know what a "grasshopper" plague signifies.

As a rule the food-habits of these insects are such as to make them directly injurious to man. They are vegetable eating, or as it is more commonly called, herbivorous, and many of them are so numerous as to become of great economic importance. If, therefore, rather more space is given here to their treatment than to that of a few of the less injurious orders, it is for the purpose of becoming better acquainted with them.

These insects are provided with four wings, the two pairs being quite different in structure. The front pair is leathery in texture and serves as a protection to the more delicate hind pair. They have received the special name *tegmina* for the order in distinction to that of *elytra* of beetles and bugs, and *primaries* of the butterflies and moths. In most of the representatives of the order the tegnina are thickly reticulated with a net-work of veins. Their structure and position differ considerably in the different families and afford excellent characters for separating them. The hind wings are also quite thickly netted with veins, the principal ones being arranged somewhat like the ribs or bars of a folding fan, and like a fan they are similarly folded when not in use. In fact, the name "Orthoptera" has its origin from this manner of folding the wings.

A number of different characters are used in the classification of the Orthoptera by systematists who have made the group a special study. Some of these are variations in the form and position of the eyes and antennæ, structure of the vertex of the head, form of the pronotum or upper part of the front ring of the thorax, the form and venation of the tegmina, the number and arrangement of the spines on the hind tibiæ, form of terminal segment of the abdomen, and in the presence or absence of a spine between the bases of the front pair of legs. In some groups one, and in others other of these characters are employed for separating the genera and species.

Like the members of all the preceding orders that have thus far been characterized, the Orthoptera have an incomplete metamorphosis. Hence the young grasshopper, cockroach, or cricket, is of much the same form when it first leaves the egg as are its parents. It also remains active and feeds throughout most of its growing stage. Some forms are without wings throughout their lives, but others begin to show signs of these appendages after the third moult. The *nymphs*, as the young of these insects are usually called, can at once be recognized from the imagoes by the structure of these appendages, even in such species as have rudimentary wings in maturity. In the immature insects the wing-pads are inverted, as "shown by the curving down of the extremities of the wing-veins instead of up, as with the adults; and the rudimentary wings are outside of the wing-covers, instead of beneath them. There is also the distinction that these rudiments of the second pair of wings are triangular in outline, and are flat, not folded; while the wings of the adults are more or less folded, even when too small to be of use as organs of flight."

It is in the order Orthoptera also that we find nearly all of the insects which are said to be provided with a "voice." Many of the representatives of the three higher families Acrididæ, Locustidæ, and Gryllidæ are very characteristic musicians; and one fairly well acquainted with these insects can readily recognize the different species by their song. Queerly enough is the fact that in these three families we also find what are supposed to be well-developed ears. In the Acrididæ these ears are located on the sides of the body at the base of the abdomen; and in the katydids and crickets—representative forms of the two other families referred to above—these organs are located near the upper extremities of the front tibiæ. If these are ears, as they certainly appear to be, would not this suggest the thought that each form of life is created for itself alone? Otherwise why not have ears to hear the voices of birds, of man and other forms of life? Each seems to struggle for itself alone at the expense of all others.

The order is separated into six super-families, which in turn are divided into smaller groups. For convenience these insects have been grouped as follows with reference to certain leading characteristics belonging to them:

I. CURSORIA, or Runners, which includes the Blattidæ or Cockroaches.
II. RAPTORIA, or Graspers, which includes the Mantidæ or Rearhorses.
III. AMBULATORIA or Walkers, which includes the Phasmidæ or Walking-sticks.
IV. SALTATORIA or Jumpers, which include the Acrididæ or Locusts or short-horned Grasshoppers, the Locustidæ or long-horned Grasshoppers and Katydids, and the Gryllidæ or Crickets.

FAMILY 1. BLATTIDÆ.—(*Cockroaches.*)

Nearly everybody will recognize the insects that are shown in Figures 31 and 32 as old acquaintances, even if they do not know the names by which they are known to entomologists. Cockroaches are flat-bodied, spiny-legged, quick-running creatures that love darkness rather than light; and which are almost omnivorous in food-habits. The two forms shown here frequent houses in this part of the country where they make themselve at home in the kitchens and pantries. They are also very numerous about basements and in bakeries, in which places they gather in warm, damp nooks. The holds of ships are also very much infested by these and several other species which have become almost cosmopolitan in their distribution by means of commerce. If these few species of comparatively small cockroaches are such a nuisance to housekeepers in the temperate regions of the earth, what must be true of the many species that swarm in the tropics? In those countries these insects are much

FIG. 31—The German Cockroach, *Ectobia germanica*.—[After Riley.]

larger, and are to be found everywhere both indoors and out. Some of the species are two inches or more in length, and half as wide. More than five hundred distinct species have been described by entomologists.

As above stated, these insects are flat-bodied, swift running creatures, with the head nearly or quite hidden beneath the front edge of the large, shield-like pronotum. The head is so bent backwards as to be nearly horizontal, with the mouth parts to the rear. The antennæ are long and thread-like, and the apex of the abdomen terminates with a pair of jointed appendages called *cerci*.

A very curious fact in connection with the life-history of cockroaches is that the female lays all her eggs at once, they being enclosed in a purse-like pod one of which is shown in figure 31 at *g*. This pod or "*oötheca*" as it is called, varies somewhat in form for the different genera and species, but is sufficiently characteristic of each to be used in the classification of the insects themselves. These egg-pods are double, *i. e.*, they contain a division through the middle separating the two series or rows of chambers in which the eggs are placed. Most species carry these pods about them until the eggs hatch, when the empty cases are dropped upon the ground or wherever they chance to fall never to be used again. One tropical species of Cockroach (*Panchlora viridis*) that is of a beautiful light green color has been known to give birth to living young. Whether that is the regular method of reproduction with the species is not known.

FIG. 32.—*Perplaneta orientalis.*—[Flint.]

In many of these creatures we find the two sexes quite different in appearance, the one being well equipped for flight and the other entirely without wings or apterous. In others the wings may be unequally developed. When this is the case, the male is the one that has the complete wings.

The one shown in figure 31 is called the German Cockroach and also "Croton-bug." It is by far the most common species in cities and towns in the United States. It has been introduced from Europe, as has also the one which is shown in the illustration at Fig. 32. This latter insect is sometimes called the Oriental Cockroach as well as "Black Beetle." The figure represents the male insect, the female having much shorter wings.

Quite a number of species of cockroaches occur within the limits of the United States, where most of them are confined to the fields, woods, and swampy regions.

FAMILY 2. MANTIDÆ.—(*Rear-horses, Preying Insects, etc.*)

Among the Orthoptera we find a group of very interesting insects that have been separated from all others and placed in a family themselves under the name MANTIDÆ. These insects are characterized by their triangular heads, the very long prothorax, and the peculiar structure of the front pair of legs which is very strong and constructed for grasping and holding fast other insects upon which the Mantids feed. Their wings, too, are quite frequently imitative in their structure and appearance, resembling leaves of plants of different kinds. Their bodies are long and stick-like, or broad and more or less flattened. This structure, along with their brown and green colors, it is needless to state, is a protection to them by causing them to be mistaken for parts of the plants

FIG. 33.—The Carolina Mantis, female.—[Riley.]

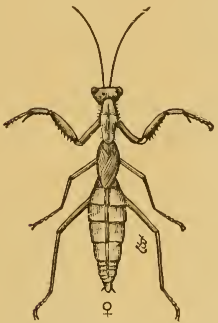


FIG. 34.—*Stagmomantis Minor.* —[Original.]

FIG. 35.—Eggs of Carolina Mantis.—[After Riley.]

upon which they may be resting. Unlike the members of the preceding family, which are very active, the Mantidæ are slow in their motions and have the habit of waiting for their prey to come within reach. The position assumed by these insects while waiting for their prey is shown in Fig. 33. Like the Blattidæ, the female Mantis lays her eggs in clusters which are attached to twigs, stone walls, and the bark of trees. (See Fig. 35.)

The development of these creatures is direct, *i. e.*, there is no quiet pupa stage intervening between the larva and imago. These insects are also much more abundant both in individuals and species in tropical countries than they are elsewhere. Over five hundred distinct species of them have been described for the entire world.

FAMILY 3. PHASMIDÆ.—(*Walking-sticks*, *Leaf-insects*, *Spectres*, *etc.*)

Perhaps the oddest and most grotesque of all insects are the "Walking-sticks" or "Leaf Insects" among the Orthoptera. As the popular names signify, these creatures resemble sticks and leaves; and, since they frequent plants, these resemblances are very useful to them as a means of affording protection from birds, reptiles, and like predaceous animals.

FIG. 36.—*Diapheromera femorata: a, b,* the egg; *c,* eggs and young; *d,* male; *e,* female insect.—(After Riley.)

These insects are long and linear, with long legs and antennæ. The three pairs of legs are very similar in form, and the wings when present are either folded longitudinally upon the body or they are broad and leaf-like. With them the front pair is very small, and hence the front edge of the hind pair is transformed so as to afford the necessary protection for the more delicate hind portion. While the family is chiefly a tropical one, a few of the species occur within the more temperate regions. In Nebraska four or five distinct forms are occasionally met with. The one figured herewith (Fig. 36) is known as *Diapheromera femorata*, and sometimes becomes sufficiently numerous to cause much destruction to forest trees. Other species of the same genus occur upon the prairies.

The eggs of the Phasmidæ, or "*Spectres*" as the family name signifies, are laid singly, and allowed by the female to fall upon the ground at random, where they lie until the following spring. These are hard and of the form shown in the illustration at *a* and *b*.

One of these insects in parts of Texas and Indian Territory has received the popular name of "Mule Killer" through some superstitious notion for which I am unable to account.

FAMILY 4. ACRIDIIDÆ.—(*Locusts* or *Short-horned Grasshoppers.*)

The representatives of this family of the order Orthoptera are perhaps by far the most important of all insects if we look at them from the side of the agriculturist. They are also of interest to us for other reasons. The exact meaning of the word "locust" is very vaguely impressed upon the minds of the general reader, since but few persons seem to know definitely what insect is meant by it. Even the earlier naturalists were more or less confused in the matter, since the family name Locustidæ has been given to the long-horned grasshoppers instead of to the short-horned ones or the "locusts" of scriptural times, as it should have properly been done, in order to remove the confusion that exists.

In a recent report to the United States entomologist, the writer made a statement that "If one were to describe or even mention all of the locusts that are injurious to vegetation in this country every species would have to be included in such a list. Taken as a group there are no exceptions to the rule in this particular case. Every member of the family is a vegetable feeder, hence is to be considered as harmful from the agricultural standpoint. * * *

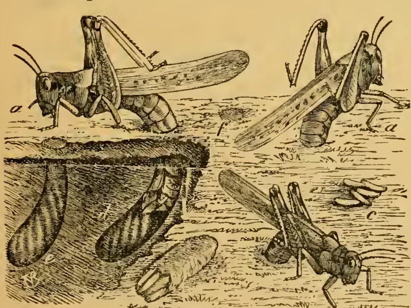


FIG. 37.—*Melanoplus spretus*, laying eggs.—[After Riley].

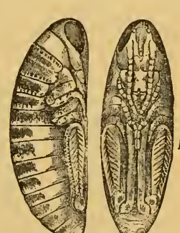


FIG. 38.—Young locust just before hatching.—[After Riley].

"Every warm or temperate country of any extent of which a considerable portion is arid or semidesert, or where the climate is liable to variation, has its locust swarms. Of all insect pests these swarms of locusts are generally most dreaded, because of their manner of attack, and the rapidity with which they can and do lay waste a country or district. Other insect enemies may do an equal amount of injury during the year; but, as it is not done 'right before our very eyes,' we do not think so much of it.

"These destructive locusts may be divided into two classes with respect to their habits, viz., they are either migratory or they are non-migratory. When the former, they move about over the country from one region to another and drop upon us without much warning. When the latter, they simply multiply, do their injury, and remain where they are."

While the family is divided into a number (nine) of subfamilies, the most important of them belong to four such subfamilies here in the United States, *Tettiginæ*, *Tryxalinæ*, *Oedipodinæ*, and *Acridiinæ*. The members of the Tettiginæ are small insects that are readily distinguishable from the others by having the pronotum extending backwards so as to cover the entire body; and the tegmina are greatly abbreviated and in the form of little lobes at the side of the body. These little locusts also differ from the other locusts in the cushions of the feet being entirely absent. The members of the Oedipodinæ are recognizable by their colored hind wings, the unarmed prosterum of the thorax, and in having the cushions between the claws of the feet very small. The Tryxalinæ can be distinguished by having their head advanced forward at the apex

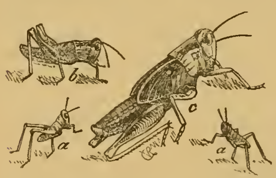


FIG. 39.—Rocky Mountain Locust—different stages of young.—[After Riley].

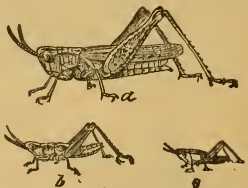


FIG. 40.—*Stenobothous maculipennis*.—[After Riley].

FIG. 41.—Rocky Mountain Locust, illustrating molt of the pupa.—[After Riley].

somewhat in the form of a cone. They also possess other characters that will be learned by reference to some of the special publications devoted to these insects. On the other hand the Acridiinæ are characterized by the strong spine upon the breast between the front pair of legs, the large cushions between the claws of the feet, etc.

The operation of egg-laying as performed by these insects is illustrated in Fig. 37, where several Rocky Mountain or migratory locusts are exhibited as they appear when engaged in this necessary feature in their life cycle. At Fig. 38 is shown the developed embryo just before it hatches. The various stages of growth in the young of this same species can be seen by a reference to the illustration at 39. The life-history of this locust is practically the same as that of all others of our locusts. Although this life-history has been but very briefly given here, it need not be entered into more fully at present. Usually but a single generation of locusts is raised each year—some of the species, however, appearing at different seasons of the year. Occasionally it is seen that this rule is forsaken and two generations are hatched and grow to maturity.

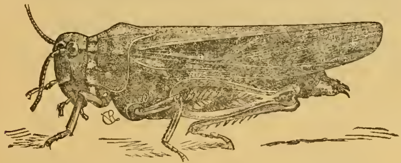


FIG. 42.—*Hippicus discoideus*, female.—[After Riley].

FIG. 43.—*Tettigidea late ralis*

Some typical species belonging to the several subfamilies of our locusts are shown in Figs. 37 to 48. These represent some of our common Nebraska species. The *Tettigidea lateralis*, Say, which is shown in Fig. 43, is a very fair example of what are termed "Grouse locusts." These small 'hoppers usually live over winter in the mature stage, and are found in sheltered places in wooded regions and along the margins of streams where they conceal themselves beneath leaves, dead grasses, etc. These locusts love to frequent muddy localities, and in some of the tropical forms we find an almost aquatic habit. Several hundreds of these peculiar little insects have been described. The subfamily Oedipodinæ is represented by three distinct species which are shown in Figs. 42, 44, and 46. *Chimarocephala viridifasciata*, DeG., is one of our earliest spring locusts, and occurs in similarly sheltered localities to those frequented by the "grouse locusts." It occurs in two color variations, brown and green. It lives over winter in the larval and pupal stages. The large, mottled *Hippiscus discoideus*, which is figured at 42, is also one of these wintering species. At Fig. 44 is shown the insect known as the Long-winged Locust of the plains (*Dissosteira longipennis*, Thos.) which a few years ago suddenly appeared as a destructive species in parts of Colorado, western Kansas, and northern New Mexico. It is rather closely related to our common "Dusty Road Locust" (*Dissosteira carolina*, Linn.), which is common over the entire United States, and has become almost a part of the childhood days of every one. In Fig. 45 is shown one of the very characteristic locusts of the middle and western portions of this state. In fact, it is the characteristic species for the region mentioned. It is known by a number of popular names, but the most appropriate of these are the "Lubber Grasshopper" and "Buffalo Grasshopper." Scientifically it is *Brachystola magna*, Girard. This in-

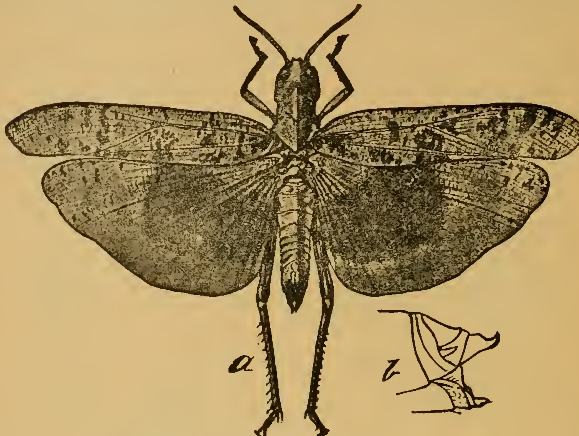


FIG. 44.—The Long-winged Locust. *Dissosteira longipennis.*

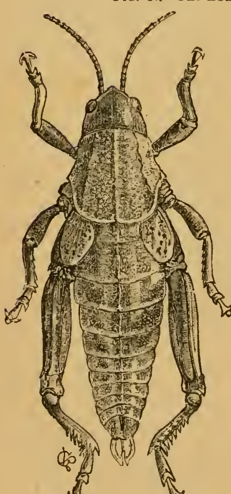


FIG. 45.—*Brachystola magna.* —[After Riley.]

FIG. 46.—*Chimarocephala viridifasciata.*—[After Riley.]

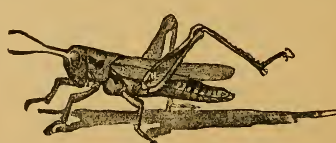


FIG. 47.—*Melanoplus angustipennis*

FIG. 48.—*Acridium frontalis.*

sect exhibits some of the shrewdness belonging to man himself, for on hot, sunshiny days these lubber 'hoppers seek the shade where they appear to enjoy themselves. They also know enough to shift as the sun moves around. In the illustration numbered 40 the reader will find depicted one of the Tryxalinæ. It is known in this country as *Stenobothrus maculipennis*, Scudd., but, perhaps, should be placed in the genus *Orphula* instead of *Stenobothrus*. Lastly two additional species of the subfamily Acridiinæ are shown in figures 47 and 48. Both of these latter insects are common in Nebraska.

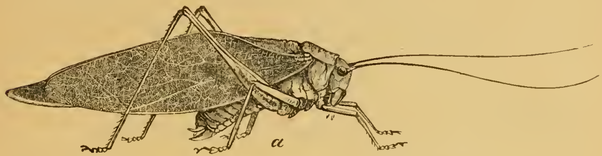


FIG. 49.—*Microcentrum retinervis*, male.—[After Riley.]

FIG. 50.—Angular winged Katydid—female laying eggs. —[After Riley.]

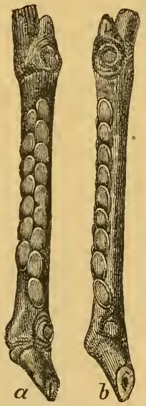


FIG. 51.—Eggs of Angular winged Katydid.—[After Riley.]

FAMILY V. LOCUSTIDÆ.—(*Katydids, Long-horned Grasshopper, Stone-crickets, etc.*)

The members of this family differ from the Locusts or "Short-horned Grasshoppers" in having their antennæ very long and thread like. They also differ in having the ovipositor of the females compressed and swordshaped; and in the tarsi being four instead of three-jointed. In the males the wing covers or tegmina are provided with a musical apparatus which is located near their base so that when these are closed it occupies a position just back of the pronotum. The tegmina when at rest are held with their inner sides approximating.

As in the preceding family, this one is also subdivided by systematists into a number (15) subfamilies. Of these the first to be mentioned is the *Phaneropterinæ* which is made up of the true katydids.

FIG. 52.—*Scudderia pistillata*.—[Original.]

FIG. 53.—*Cyrtophyllus concavus*.—[After Riley.

Several of these insects are shown in Figs. 49 to 52. This is a very extensive family if we take into consideration all the varied forms that occur in the different countries on the globe. The angular-winged katydid is shown in Figs. 49 and 50. In the former the male is shown in one of its characteristic positions during the daytime, while the female is shown in 50 in the act of laying her eggs which, as will be seen, are glued to a twig in two overlapping rows. This insect is more of a southern insect than the one which is shown as *Scudderia pistillata*, Bruner, and which is shown in Fig. 52. The one figured at 53 belongs to a different subfamily (*Pseudophyllinæ*) from the other katydids that have just been mentioned, but nevertheless is the true katydid if we are to class them by the noise they produce. This last mentioned species is also more abundant at the south than here in Nebraska, where it is rather a rare insect.

The Cone-headed Grasshoppers, one of which is figured at 54, belong to the subfamily *Conocephalinæ*. Many of these latter are the characteristic slender meadow grasshoppers so familiar to all of us. The one which is figured is called the *Conocephalus crepitans*, Scudd. This is also a very extensive group of Orthoptera. These insects, feeding in company as they do the summer through, commit a great deal of damage to our meadows and even to fields of grain. Many of them could be destroyed by dragging over the meadow once or twice during the summer with the "hopper dozer," described in connection with the destructive locusts in the Horticultural Report for 1894.

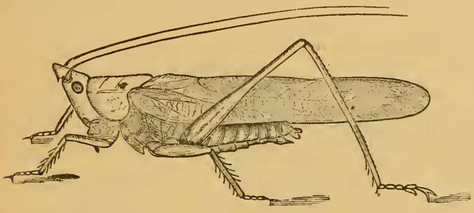


Fig. 54.—Cone-headed Grasshopper.

In the figure 55 is shown a "wingless cricket," of the subfamily *Decticinæ* of authors. This group contains many very queer looking creatures, and also some that occasionally increase in such numbers as to become pests. Our large "Mormon cricket," the one shown in the illustration, is an example of the latter kind.

Fig. 55.—*Anabrus simplex*.—[After Riley.]

Still another subfamily of the *Locustidæ* is shown by the figure 56, which is a type of those called *Stenopelmatinæ*. While many of this last group are provided with wings, many others are wingless and live in burrows in the ground, under stones, in dark, damp places, as caverns, etc. These wingless creatures belonging here are sometimes called "Camel-crickets" on account of the upward curve of their backs. They also frequently receive the names of "Stone-crickets" and "Cave-crickets."

Fig. 56.—Camel Cricket.—[Flint.]

Family 6. Gryllidæ.—(*Crickets.*)

The last family of the order Orthoptera, like the two preceding, is quite extensive, and is composed of jumping insects. If we include the four quarters of the globe there are many distinct forms and even subfamilies of these insects; but if we confine ourselves to the United States or Nebraska we will find but few true crickets as compared with either the short or long-horned grasshoppers.

The GRYLLIDÆ are to be distinguished from the Locustidæ, which they resemble by having long antennæ, by their three-jointed tarsi, in the music organs of the males which occupy the greater part of the tegmina, also in their food habits being omnivorous rather than herbivorous.

FIG. 57.—Mole Cricket—*Goyllotalpa vulgaris.*

Most of the Gryllidæ are nocturnal in their habits, hiding away in the earth or dark nooks during daytime and venturing forth only after nightfall to seek their food and mates. Some of them always live hidden away in burrows which they construct for themselves, or else they live as guests in the nests of ants. One of these latter is shown in Fig. 62. The Mole-crickets are odd looking creatures as will be seen by reference to the illustration (see Fig. 57). Again our common field crickets are shown by the figure of a female of *Gryllus abbreviatus* which has the tegmina and wings abbreviated (Fig. 63). The Tree-crickets differ from other crickets in their mode of life. While field crickets and their allies, most of which are dull brown, or black in color, live upon and in the ground, tree-crickets, as their name implies, live above ground among vegetation the colors of which these more or less closely resemble. Many of these latter are known to feed upon plant-lice, hence are to be looked upon as our friends. On the other hand some of these insects deposit their eggs in the stems of plants which they kill unintentionally.

Perhaps the habits of the little wingless cricket that is shown in Fig. 62, *a*, representing the female and *b*, the male, will be a surprise to many when they learn what these are. Imagine a very soft bodied creature of only the length and width shown by the cross lines in the cut, living in the nests of ants larger than itself. Yet such are the facts in connection with this insect's life. It lives in the "thickest" of the nest, unmolested by the ants. Just what its food-habits are, and why it is here entomologists have thus far failed to learn. It is one of the largest of these "ant-nest-inhabiting" crickets, species of which are found in both hemispheres.

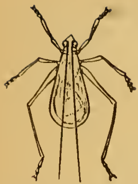


FIG. 58.—Snowy-winged Tree-cricket—male.

FIG. 59.—Snowy-winged Tree-cricket —fem After Harris].

FIG. 60.—*Orocharis saltator:* **a**, female; **b**, male. [After Riley].

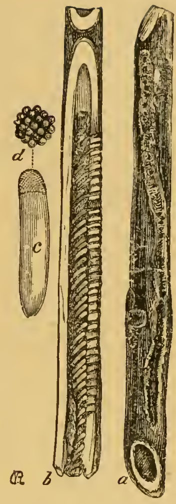


FIG. 61.—Twig showing eggs and punctures of *Œcanthus*. [After Riley]

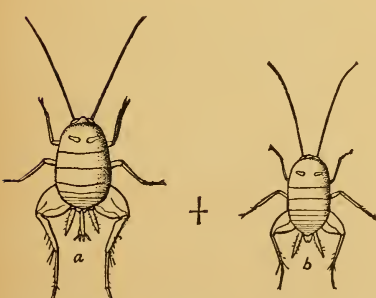


FIG. 62.—*Myrmecophila pergandei.*—[Original.]

FIG. 63.—Field Cricket.

ORDER VIII. THYSANOPTERA.—(*Trips, Fringe-wings.*)

Following the Orthoptera in the series of orders as we have adopted the classification, we come to a number of very minute insects that differ greatly from all others in the structure of their wings, mouth-parts, and feet. The wings are four in number and both pairs very similar in form, being long and narrow and either veinless or with but few veins. The margins of the wings are fringed with long, delicate hairs as seen in the illustration Fig. 65; and when at rest these members are folded lengthwise upon the body. The feet (tarsi) are only two-jointed and are inflated or "blown up," hence the name *Physopoda* "bladder-foot" which is sometimes given them instead of *Thysanoptera*.

All the members of the order are quite small—seldom exceeding a fifth, and oftener being less than one-tenth, of an inch in length. Although so small, these insects are not at all rare; on the contrary, they are very common, for almost every clover, apple, rose, daisy, and other blossom contains numbers of them. When disturbed thrips are very active and readily take to flight.

Fig. 64.—Grass Thrips.

Fig. 65.—Green-house Thrips.—[Original.]

A reference to the illustrations (Figs. 64 and 65) will at once indicate to the reader the appearance of these little creatures. Their body is long, and the head narrower than the prothorax to which it is attached without a distinct neck. The eyes are large and composed of comparatively few distinct ocelli; and there are usually three simple eyes upon the forehead between the compound eyes. The lower part of the head is somewhat drawn out into the form of a cone or beak and directed backwards upon the prosternum. Within this beak-like projection the mouth-parts are concealed and can only be made out with the aid of a rather high-power microscope. This arrangement of the mouth-parts reminds us not a little of the Thysanura, and has been the cause for not a little uncertainty among naturalists as to their location in the system of classification. Even at this late date various ideas are entertained by naturalists as to their affinities with other groups. Their active larvæ with similar formed bodies to those of their parents, of course, at once suggests their relationship to some of the *ametabola* series, *i. e.*, those in which there is no complete transformation in their growth from the larva to imago. Among these forms the Thysanoptera have been considered at various times and by different authors as belonging with the Orthoptera, the Neuroptera (the old order Neuroptera), and the Hemiptera. A careful study of their mouth-parts has finally resulted in their being placed just before the Hemiptera, as possibly representing one of the stages in the long line of development from the Thysanuran type to that of the Hemipteran type of mouth-parts.

In their food-habits these insects differ greatly. Some of them are carnivorous, while others are herbivorous. The carnivorous forms feed upon mites, eggs of other insects, etc.; and the herbivorous forms attack the parts of blossoms and often occur upon delicate and juicy plants the leaves of which they injure more or less by wounding the lower surfaces and causing them to turn brown and wither.

The order has been but comparatively little studied; and our best paper upon the group is one that was written by Haliday over fifty-six years ago. Only about one dozen species have thus far been described from this country; and, judging from number of species now in collections, it is likely that there are more than one hundred distinct species in the United States alone. For a further study of the interesting little creatures the reader is referred to Comstock's "Introduction to Entomology."

ORDER IX. HEMIPTERA.—(*Insects with sucking-mouths.*)

The order Hemiptera is composed of those insects which are properly called "bugs" by the "bug man." It is needless to say here that not everything small that creeps and that is commonly called by this name belongs to the order. Some of these bugs are also called by other names, as "plant-lice," "leaf-hoppers," "tree-hoppers," "scale-insects," and "water-boatmen." These latter are, however, group names, instead of general ones applicable to all the members of the order.

This order, Hemiptera, is divided into three well-marked suborders, Heteroptera, Parasitica, and Homoptera. The first of these suborders contains forms in which the two pair of wings, when present, are unlike in texture; the second are without wings and comprise the sucking lice of man and mammals; and the third have the two pairs of wings alike in texture.

The order is one of great extent as well as of much importance from the economic standpoint. The food-habits of its members are various—some being predaceous and others vegetable feeders. Unlike the members of the previous orders which have been described, these insects live upon liquid food, which they take through a jointed, tube-like beak, which is composed of the usual mouth-parts that have undergone the necessary change to form this tube. Those that attack plants live on sap, those that attack animals feed upon the life-blood. Some of these insects are directly or indirectly of great value commercially. The

Cochineal is utilized for the coloring matter which it produces; some of the scale-insects are the producers of lacs, which are used in the manufacture of varnishes.

The various members of this order, with a single exception, do not possess a complete metamorphosis, but they develop direct. The young when they hatch from the eggs are very similar in form to their parents. There is no quiet pupa stage as in the other orders that will be taken up one after the other beyond this point in the classification. The wing-pads show after the second or third molt, and are quite large before the final one; but they are not inverted, and seemingly transposed, in their position as they appear to be in the jumping Orthoptera.

Suborder Heteroptera.—(*True Bugs.*)

The representatives of this suborder are quite readily recognized from other insects by the structure of their front pair of wings. These have the basal half thickened so as to resemble the elytra of beetles, the remaining portion being membranous or wing-like. These front "half-wings" cover and protect the second pair which is entirely membranous. The name "hemelytra" has been given the front wings of Heteropterous Hemiptera, it meaning half elytra. In addition to their peculiar wing structure, most of these insects are provided with glands for the secretion of pungent or offensive odors that protect them more or less completely from the attacks of most birds and insectivorous mammals.

Fig. 66.—Water Boatman.—[After C. M. Weed.]

Among the representatives of the suborder we find those that are aquatic, as well as those that are terrestrial. In Fig. 66 is shown one of the insects that are commonly called "water-boatmen." These Notonectidæ, or back-swimmers, as the name signifies, are very common insects that occur in all waters and at all times of the year. There are quite a number of species and several genera of them in this state. They feed upon the blood of very young fishes, snails, crustaceans, and insects. Unlike the different representatives of such other orders as are provided in their larval stages with gill-like attachments, these water-boatman must frequently come to the surface for air. Another species of water bug is figured herewith (Fig. 67). It is known variously as the "Giant Water-bug," the "Electric-light bug," etc. It is one of the largest representatives of the order in this part of the country, and is very destructive to minnows and young fishes of other kinds which it captures and holds fast while sucking their blood. This and most of our other representatives of the order are capable of inflicting very painful wounds by means of their short, sharp beak. When they do this they at the same time inject a whitish fluid that produces numbness and fever.

After night, both in spring and fall, these water bugs leave the water and fly about in search of new waters, and possibly, also, of mates, before laying eggs for another generation. At such times many of them are attracted to lights, where they become dazed and die. Since the advent of electric lights especially has this been true of them, and consequently many formerly rare forms to collections have become commonplace, the entomologists having taken advantage of this method for enriching their cabinets.

FIG 67.—*Belostoma Americana.*—[After C. M. Weed].

FIG. 68.—Zaitha—[After C. M. Weed.]

A number of moderately large, rather slender, dark brown, dull-black, and other colored bugs that feed upon caterpillars and other soft-bodied insects are found in most parts of our country. These are represented by the species shown in Fig. 69. They belong to a family which entomologists call REDUVIIDÆ; while in Fig. 70 we see another type of a family called PHYMATIDÆ. This last mentioned bug often makes its home upon flowers of different kinds where its yellow, green, white, and black colors assist it in sneaking upon and seizing various insects which it kills. It is said to be quite a caterpillar destroyer.

The Squash-bug, which everybody is familiar with, but of which we have no figure to present, belongs to the family COREIDÆ. The insects shown herewith, in Figs. 73 and 74, are also quite familiar to most of us who have eaten berries under the name of "stink-bugs." They belong to the family PENTATOMIDÆ. Both of the insects which are figured here are known to destroy the young of the Colorado Potato beetle and many other insects. Some species of the family do not, however, destroy insects, but live upon the juices of various plants instead.

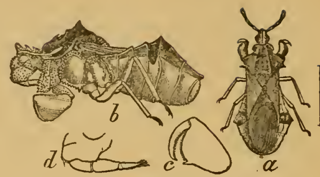


Fig. 70.—*Phymateus erosa; a*, dorsal view; *b*, side view; *d*, beak; *c*, front leg. All enlarged.—[After Riley.]

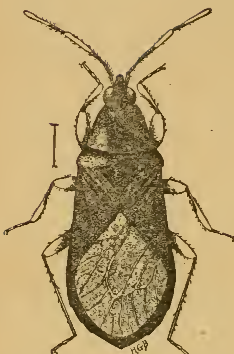


Fig. 69.—*Nabis fusca*.—[Original.]

Fig. 71.—a and *b*, Two true bugs.—[After Riley.]

Fig. 72.– *Euthoctha galeator*.—[Hubbard.]

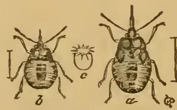


Fig. 73.—Young of *Podisus spinosus*.

Fig. 74.—*Podisus spinosus*.

Fig. 75.—*Perilus claudus*.

A number of other families of Heteroptera are represented within the state. Of these a few are such as Capsidæ, Tingidæ, etc. One of the Capsidæ is shown in Fig. 76. It is the insect that is known as the Four-ined Leaf-bug (*Poecilocapsus lineatus*). The Chinch-bug and various 'false chinch-bugs" belong to the family Lygæidæ. Two of the latter are shown in Figs 78 and 79.

It would be slighting one of our old acquaintances too much were we to pass without notice the representative of this suborder that is shown in Fig. 77. Everybodywill at once recognize the likeness at first glance,

Fig. 76.—*Poecilocapsus lineatus*, enlarged.—[After Lintner].

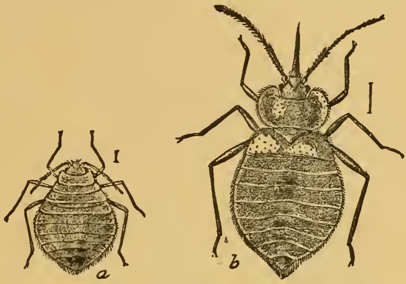


Fig. 77.—Bed-bugs; *a*, larva; *b*, imago.—[After Riley].

Fig. 78.—*Trapezonotus nebulosus*.—[Original].

Fig. 79.—*Emblethis arenarius*.—[Original].

hence it would hardly be necessary to say it is the insect known by the name Bed-bug. As old, perhaps, as man himself in its love for human habitations, this insect has spread over the greater part of the civilized world. It occasionally also takes up its abode in hen houses and the rookeries of birds where it obtains nourishment in the form of blood. Not all of the reported cases of bed-bugs having been found in new lumber, and even in logs before they had been sawed into lumber, should be accepted as truth. Many of these so-called bed-bugs are, no doubt, the young cock-roaches shown in Fig. 31, at *b*.

SUBORDER PARASITICA.—(*Sucking Lice*).

The "sucking lice," as distinguished from the "biting lice," are so greatly different in their habits and appearances from the other Hemipterous insects that they have been separated from them as a distinct group. While not nearly so numerous in species as the Mallophagidæ, there are many kinds of these disgusting creatures. Man is subject to the attacks of at least three distinct forms, viz., the "head-louse" (*Pediculus capitis*), Fig. 80, the "body-louse" (*Pediculus vestimenti*), Fig. 81, and the "crab-louse" (*Phthirius inguinalis*), Fig. 82. The sucking lice of cattle, horses, swine, dogs, cats, squirrels, etc., some of which are shown herewith, Figs. 83-85, belong to other genera.

FIG. 80.—Head-louse.

FIG. 81.—Body-louse.

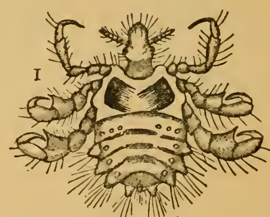


FIG. 82.—Crab-louse.

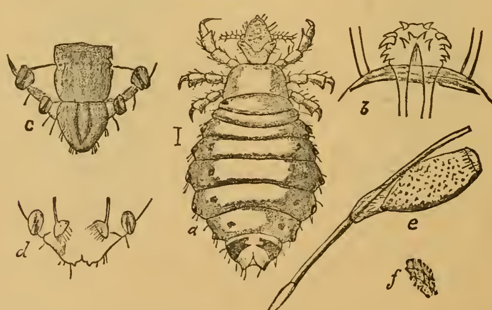


FIG. 83.—Short-nozed Ox-louse *Hæmatopinus eurysternus*: *a* female, *b* rostrum, *c* ventral surface of last segments of male, *d* do. female, *e* egg, *f* surface of egg greatly enlarged.—[After Osborn].

REMEDIES.—Various remedies have been suggested and used with success against these lice. Some form of grease if so placed as to come in contact with them will kill most kinds of lice. An ointment, therefore, composed of vaseline, lard, etc., when smeared upon the bodies of cattle and other domestic animals will usually rid them of their lice. A much more expeditious remedy, discovered in recent years, is the kerosene emulsion which has been so often recommended for the destruction of all kinds of lice and sucking insects. This wash can either be applied in the form of a spray by means of a force-pump, or it can be used as a dip.

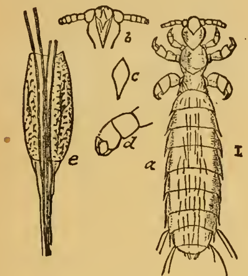


FIG. 84.—Louse of the field mouse (*Hæmatopinus acanthopus*)—[After Osborn].

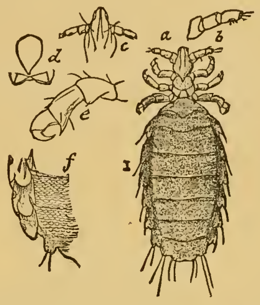


FIG. 85.—Sucking louse of the Pocket Gopher (*Hæmatopinus squamosus*): *f*, portion of abdomen showing scales.—[After Osborn].

The remedy kills by contact, *i. e.*, the breathing holes or *stomota* of the insects are choked up and they die of suffocation. Strong decoctions of tobacco are also sometimes used with like results; while fresh insect powder, which is made from the pulverized flower-heads and stems of several species of plants belonging to the genus *Pyrethrum*, will also kill these lice if sprinkled freely over the animals to be protected from them.

SUBORDER HOMOPTERA.—(*Tree-hoppers, Cicadas, Plant-lice, Scale Insects, etc.*)

The representatives of this suborder of the Hemiptera, while varying greatly among themselves in habits, structure, and modes of development, form a rather well-marked group. In fact, these insects seem to be so well marked and distinct from the Heteroptera that some entomologists make a distinct order of them. Their wings are of the same thickness throughout, and when folded usually rest roof-like over the body. The beak and mouth-parts are attached at the hind part of the lower side of the head. Sometimes it is so far to the rear that it appears to arise from the sternum of the prothorax, instead of from the head. There is no prolongation of the back portion of the head into a neck, and the front coxæ or basal joints of the first pair of legs sometimes touch the cheeks.

The suborder is divided into ten or a dozen families, nearly all of which are of sufficient economic importance to call for a much more extended account than can be given here. Some of the most interesting features belonging to the subject of entomology are also found in connection with the life-histories and development of some of these insects.

FAMILY COCCIDÆ.—(*Scale-insects, Bark-lice, Mealy-bugs, etc.*)

The insects which have been separated from other Homoptera and placed in the family now under consideration, are very peculiar creatures indeed. In writing of them Professor J. H. Comstock, who has made a special study of the family, says: "In many respects this is a very anomalous group, the species differing greatly in appearance, habits, and metamorphosis from those of the most closely allied families. Not only do the members of this family appear very unlike other insects, but there is a wonderful variety of forms within the family; and even the two sexes of the same species differ as much in the adult state as members of distinct orders."

The males of these insects alone are provided with wings and undergo a complete metamorphosis. The wings are limited to a single pair—the front ones. In place of the hind wings we find small club-like "halters," each of which is provided with a hooked bristle that joins it with the wing on the same side of the body. In this sex the mouth-parts have disappeared and their place taken by a second pair of eyes. The females are always "scale-like or gall-like in form, or grub-like and clothed with wax." This waxy covering varies greatly in different forms. It may be in the form of powder, thread-like filaments, large tufts or plates, or it

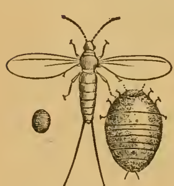


FIG. 86.—*Coccus cacti.* —[After Packard.]

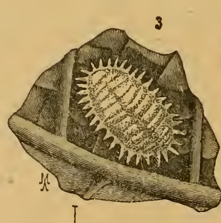


FIG. 87.—*Dactylopius destructor.* —[After Comstock.]

FIG. 88.—*Dactylopius longifilis.* —[After Comstock.]

may comprise a continuous layer or scale under which the insect lives a more or less protected life. Many of them are serious pests to cultivated plants, and have become spread over much of the civilized world by means of commerce. Most of our fruit trees are subject to the attacks of one or more species, and numbers of forms occur in every green-house of any size where they have been introduced by shipments of plants from different countries.

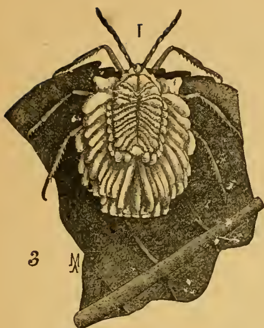


FIG. 89.—*Orthesia*, enlarged.—[After Comstock.]

There are also a number or species of this family that might be termed "useful insects" on account of the uses to which they are put by man in the arts. Several species produce dye-stuffs. One of these is known as *Coccus cacti*, and is shown in Fig. 86. Its dried bodies are called Cochineal, and can be purchased in almost any drug store. This insect lives in tropical countries where it feeds on the various species of cactus called Prickley-pear. Another species secretes the substance that is used in the preparation of shellac. It is called *Carteria lacca* by the entomologist. It also is a native of tropical countries where it clusters upon the young branches of sev-

FIG. 90.—*Kermes* sp. Adult females on stem; immature males on leaves.—[After Comstock.]

eral kinds of trees. Others of these coccids produce different kinds of wax in quantities that render them of economic value.

The "Mealy-bugs," two of which are shown in Figs. 87 and 88, are too well known to require a description at this time. They are green-house pests at the north, but in tropical regions occur out-of-doors. The insect which is shown in Fig. 89 also belongs in this family, and may quite frequently be obtained in the spring by sifting over fallen leaves in open woods. The white plates or tufts upon this insect's body are lime-like. Perhaps the different species of Kermes as found on our various oaks are the most abnormal of all these bark-lice that we have in this country. In figure 90 the large gall-like females are shown attached to the twigs and the immature males on the leaves.

The *Pulvinaria innumerabilis*, which is shown in Fig. 91, is the insect commonly known as the Cottony Maple-scale, although it is by no means confined to the maple tree as a food-plant. It also attacks many other trees and shrubs, all of which are at times more or less severely injured by it. The life-history of this scale insect is practically the same as that of other species of coccids, and can be best given in the following words, which are quoted from the Annual Report of the U. S. Entomologist for year 1884:

"The young lice hatch in spring or early summer, walk about actively as soon as born, and settle along the ribs of the leaves (very rarely on the young twigs). They then insert their beaks and begin to pump up the sap and to increase in size, a thin layer of a waxy secretion immediately beginning to cover the dorsum. In a little more than three weeks they have increased to double their size at birth, and undergo their first molt, shedding the skin, it is supposed, in small fragments. After this first molt the waxy secretion increases in abundance, and a differentiation between the sexes is observable. The males grow more slender and soon cease to increase in size, covering themselves with a thick coating of whitish wax. The pupa then begins to form within the larval skin, the appendages gradually taking shape, the head separating from the thorax, the mouth-parts being replaced by a pair of ventral eyes. A pair of long wax filaments is excreted from near the anus, and these continue to grow during the life of the insect. It is the protrusion of these filaments from beneath the waxy scale which indicates the approaching exclusion of the male. The posterior end of the scale is in this manner raised up, and the perfect insect backs out with its wings held close to the sides of its body.

FIG. 91—The Cottony Maple Scale (*Pulvinaria innumerabilis*): the mature females after the eggs have been deposited.—[After Comstock.]

"Meanwhile the female larvæ have been undergoing but slight changes of form. They grow larger and also broader across the posterior portion, but remain flat. * * * Just before the appearance of the adult males, they undergo another molt, and change in color from a uniform pale yellow to a somewhat deeper yellow with deep red markings.

"The males make their appearance from August 1st to September 15th, issuing most abundantly about the middle of the former month, and their life is short, seldom exceeding two or three days. They copulate with the females and then die. The latter, soon after the disappearance of the males, gradually lose their bright-red markings and change to a deep brown color. They grow more convex, and the dorsal layer of wax becomes thicker and more cracked. Before the falling of the leaves they migrate to the twigs and there fix themselves, generally on the under side. After feeding as long as the sap flows, they become torpid and remain in this condition until spring.

"At the opening of spring the eggs develop with great rapidity and distend the body greatly, causing it to become convex instead of flat. The color is now yellowish, marked with dark brown, and the insect now absorbs sap with great rapidity and ejects drops of honey-dew. From the middle of May to the first of June the egg-laying commences. The eggs are deposited at the end of the body, in a nest of waxen fibers secreted from pores situated around the anus. This nest is attached to the posterior ventral portion of the body, and adheres somewhat to the twig. As the eggs are protruded into the waxy mass the posterior portion of the body is gradually raised up until it often reaches an angle of forty-five degrees with the bark. The egg-laying continues until on into July, and, after one or two thousand eggs have been deposited, the female dies. It is almost always within this period of egg-laying that the insect is noticed, on account of its large size, but more particularly from the conspicuous white cushion at the end of its body. After the death of the female, her beak breaks off and her body shrivels up, but remains attached to the twig by the cottony mass for a long time, often a year or more."

FIG. 92.—*Parlatoria pergandei*: *a*, female; *b*, male scale.—[After Comstock.]

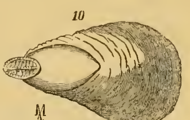


FIG. 93.—*Mytilaspis* sp.; female scale.—[After Comstock.]

This insect spreads from one plant to another in various ways, but chiefly by the aid of winds which carry the very light young just after hatching, and also upon the bodies of the various insects that are attracted by the honey-dew, and also upon the feet and legs of birds which alight upon the trees that are occupied by the young lice. Then, too, they migrate by walking. Only the males of these Bark-lice are provided with wings. What is true of this bark-louse is also true of other species.

REMEDIES.—The very best direct remedy against these bark-lice is the use of kerosene emulsion at the time when the young are hatching and wandering about over the trees. One or two careful sprayings at such times will effectually destroy the insects. The use of alkali washes is also strongly recommended as remedies for scale-insects.

Others of these scale-insects are figured at 92 and 93, also in several of my reports to the State Horticultural Society.

The family ALEYRODIDÆ is comprised of minute insects, which in their immature stages somewhat resemble the scale-insects; but which after maturing have four wings in both sexes. As these insects are all small and differ but little in color they are rather difficult to separate. The species are quite numerous and seem to be pretty closely confined to certain special host plants, which they often injure by their presence in immense numbers.

FAMILY APHIDIDÆ.—(*Plant-lice.*)

There is perhaps no other group of insects that attracts an equal amount of attention with the plant-lice belonging to the family APHIDIDÆ. No year passes without one or more of the species appearing in damaging numbers in different portions of the country. Neither is there an important crop grown but that suffers more or less from the ravages of some member of this family. Notable examples of such injury are to be cited in the species that infest the small grains, corn, sorghum, cabbage, apple trees, plum trees, the hop vine; and, in fact, almost any other plant that is grown for food or ornament, as well as those that are native and uncultivated. Every housekeeper who has tried to grow a few plants for ornament during the long, dreary winter months, is familiar with one or more of these insects from seeing them on her tender charges; while the professional gardener and horticulturist is too well acquainted with the "green-fly" of the hot house to need instructions concerning its injurious nature.

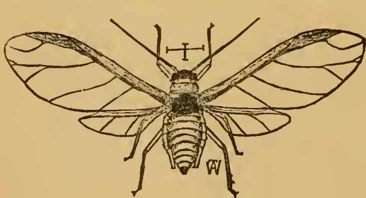


FIG. 94—Apple tree Leaf-louse.

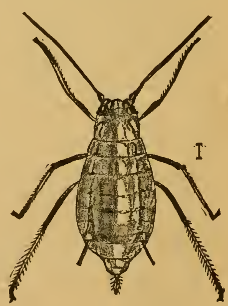


FIG. 95.—Grain Plant-louse.

Briefly these plant-lice or "Aphides," as they are quite commonly called, can be characterized as small soft-bodied insects which receive their nourishment in the form of juices pumped up by means of a jointed beak which the owner inserts into the tender portions of growing plants.

They are provided with six legs, and are winged or not, as happens. When the former, they have two pairs of these members. One of each form is shown in the accompanying illustrations—the winged figure representing the Apple tree Leaf-louse, and the other the Grain Plant-louse.

In their mode of life these lice differ greatly one from another; but roughly speaking, they can be classed as root-feeders or as above-ground feeders. They may also be separated into gall-makers and non-gall-makers, accordingly as each species attacks its host plant.

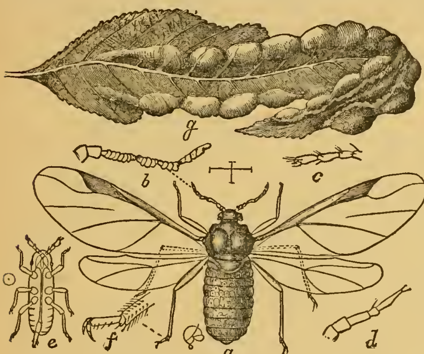


FIG. 96.—*Pemphigus populi-monilis*; *a*, winged female; *g*, galls.—[After Riley.]

In their modes of reproduction, the majority of the members of the family are both oviparous and viviparous, *i. e.*, they multiply both by means of eggs and by a sort of "budding" process. The group is further specialized by containing members which occur in two or more distinct forms, each of which works on different portions of the same plant or upon different plants during different seasons of the year. The egg-laying females are also distinct from the viviparous females. In fact, taken as a whole, the family Aphididæ is composed of a large number of species that vary greatly among themselves in life-history and food habits; and it becomes quite necessary for the economic entomologist to acquaint himself with these facts in order to prescribe remedies for any particular species.

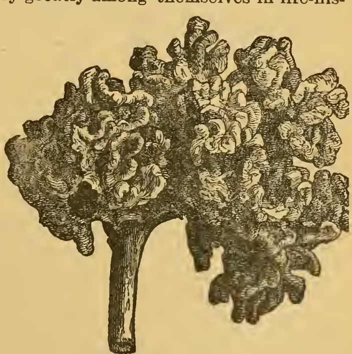


FIG. 97.—Gall of *Pemphigus vagabondus*.—[After Riley.]

In writing of the life-history of Boxelder plant-louse I have said: "This insect begins its work just as soon as, or before, the leaves appear in spring, with the viviparous, agamous female, or stem mother. She becomes full grown in a few days, and begins the process of reproduction by 'budding' internally and expelling small lice of her kind, which in turn, after maturity, repeat the operation. The successive generations continue without interruption during spring and summer, some of them being furnished with wings, which enable them to migrate from place to place. In this manner new localities become infested, damp weather favoring and very dry weather retarding their excessive increase." By this method of reproduction it has been estimated that at the end of the twelfth generation alone there could be alive ten sextillions of individuals, not to mention those of former generations. Of course this could never occur in nature, since there are too many counter checks which prevent the greatest possible increase in any insect.

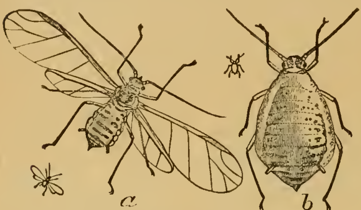


FIG. 98.—*Aphis brassicæ: a*, so-called male; *d*. wingless viviparous female.—[After Curtis.]

"Like many others of the family to which it belongs, the Box-elder louse is provided with a pair of 'honey-tubes,' or nectaries, as they are sometimes called. These are the two short tubular projections which arise from the sixth abdominal segment above, and on each side of the middle. They are connected with internal glands, which secrete a sweet or saccharine fluid, that flows continually while the insect feeds. The 'honey dew' has its source here, and is nothing more or less than the secretions of some aphid. Wherever any of the nectar-bearing aphids occur in large numbers, and sometimes even in small numbers, there are many species of different insects congregated about, having been enticed thither by the 'honey dew' upon which they are fond of feeding. Chief among these 'camp followers' of plant-lice are a number of species of ants, that live upon the fluid secreted from the 'honey tubes' of the lice. So fond are these ants of this saccharine fluid that many species of them are known to stand guard over their 'cows,' driving away parasites and other insects where this is possible. Some of the different kinds of ants even make the lice captives, carrying them down into their nests, where they feed them so as to be able to milk them at their leisure."

REMEDIES.—Usually there is no need of making special war against these tiny creatures, for they are held in check by natural enemies in the shape of predaceous and parasitic insects. Climatic conditions, too, are usually such as to prevent their greatest possible increase. Occasionally, however, when all the conditions favoring their increase are present, these natural checks fail to do their work, and it becomes necessary for us to resort to artificial means to accomplish the desired end. When this is the case, the use of kerosene emulsion, strong soap-suds, pyrethrum, tobacco decoction, tobacco smoke, etc., all prove very effectual. All of these remedies, natural and artificial, have been several times described by me, as well as by nearly every other entomological writer in the country, therefore will not be repeated here.

FAMILY PSYLLIDÆ.—(*Jumping Plant-lice.*)

This family is made up of a number of small insects that remind one not a little of the Seventeen-year Locust or Cicada in their form, if we examine the imagoes alone. They are called "Jumping Plant-lice" or Psyllids, in order to distinguish them from other plant-lice. They also feed entirely upon the juices of plants, and many of them form galls. Others of them live without these protections, "out of doors," either upon the leaves or twigs, as do the aphids. The hackberry seems to suffer most from the attacks of these jumping lice, at least ten species having been found thus far. Figs. 99 and 100 will give the reader some idea of the appearance of these insects, as well as their mode of attack. Like other gall-forming insects, each species of these psyllids forms a characteristic gall and infests some particular portion of the infested plant.

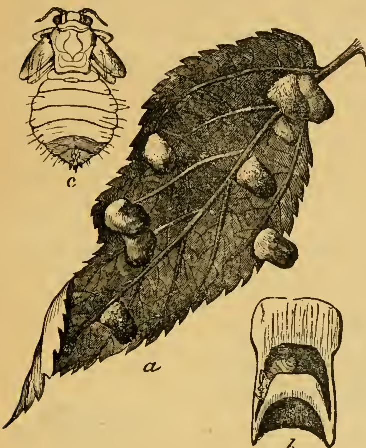


FIG. 99.—Gall of *Pachypsylla c. mamma*: *a*, leaf with galls from underside—natural size; *b*, section of gall showing cup-like depression, and insect in cavity; *c*, pupa—enlarged.—[After Riley.]

FIG. 100.—*Pachypsylla c. mamma*; imago—enlarged.—[After Riley.]

The family MEMBRACIDÆ embraces a number of small jumping bugs that usually receive the name of "Tree-hoppers." Of these insects we have a number of distinct forms within the state of Nebraska; and not a few of them are remarkable on account of the peculiar and grotesque forms of their large pronotum. Our Buffalo Tree-hopper is a characteristic form that will at once indicate to the reader what these insects are like. Some of the species have their backs greatly humped, and others are provided with spines and angles which render them very ferocious in appearance at least if not in reality. In general they remind one of the Tettiginæ among the Orthoptera.

The family CICADIDÆ or "Harvest-flies," as they are sometimes called, is well represented by the illustration numbered 101, where our common large species in Nebraska is shown in different positions and sexes.

These insects are interesting on account of their peculiar mode of life; and because of the great length of time that is required for some of the species to complete their life-cycle. The Seventeen-year Cicada (*Cicada septendecim*), as the name implies, requires seventeen years for a single generation; while the Thirteen-year species (*Cicada tredecim*) is thirteen years in attaining its full growth. Some of our other species are also evidently quite long in reaching maturity; but, as these latter do not appear in such overwhelming numbers as do those just mentioned, it is a more difficult matter to trace their life-cycles. The female cicada is provided with a horny ovipositor with which her eggs are inserted in the stems of various plants. These eggs soon hatch, and the young drop to the ground where they burrow quite deeply and attach themselves to the roots of various plants where they subsist upon sap and gradually increase in size. When full-grown they come to the surface of the ground, creep up the stems of plants, shed their skins, and appear as winged insects ready to provide for a succeeding generation.

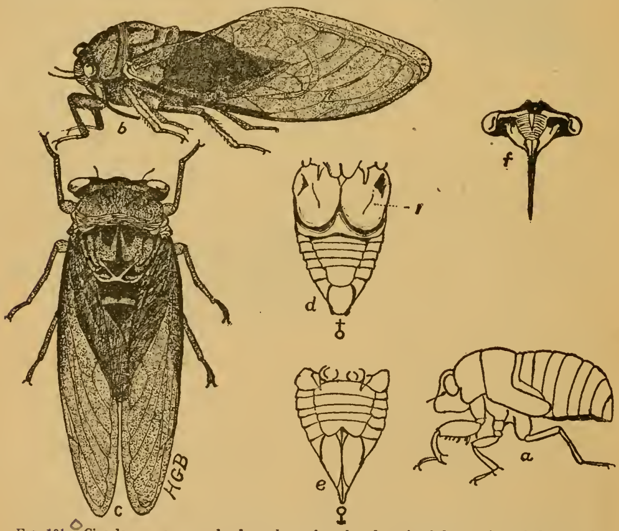


FIG. 101.—*Cicada* sp.: *a*, nymph; *b*, male; *c*, female; *d*, male abdomen from below; *e*, do, female; *f*, front of head showing beak.—[Original H. G. Barber.]

The males of this family are provided with a musical apparatus (see Fig. 101 at *d* 1) by means of which they are enabled to produce very loud noises. Each species produces a characteristic "song" by which it can be distinguised from all others. When present in large numbers the din produced by the host of males stridulating in unison is almost deafening.

The family FULGORIDAE, while very well represented in the state by a number of rather small insects, is really more characteristic of the tropics. No type form can be figured that would illustrate the group. The Lantern-fly of Brazil and the Candle-flies of China and the Indian Empire are among the interesting examples that belong to the family. Some of these insects resemble those of the following family, others remind one a little of butterflies and moths, while still others might be mistaken for members of the orders Neuroptera and Trichoptera. The Fulgoridæ are vegetable feeders, but none of our species have thus far proved to be especially injurious. Some of the tropical species are phosphorescent, hence their names.

The family CERCOPIDAE is composed of jumping bugs which bear a sort of general resemblance to the members of the families Membracidæ and Jassidæ; and, like those insects, are sap-suckers. Unlike them, though, the "Spittle-insects," or "Frog-hoppers," as they are sometimes called, are protected under a mass of froth which the growing insects cover themselves with while feeding. This family is very well represented by the illustration at Fig. 102, the larva at *a*, the "spittle" at *b*, and the imago at *c*. Some of these insects often do considerable injury to vegetation upon which they cluster and pump up the sap.

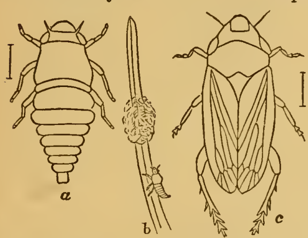


FIG 102.—Spittle Insect: *a* larva enlarged, *b* natural size of larva, *c* adult enlarged.—[After Packard].

By far the largest family of these jumping bugs is that known to the entomologist as JASSIDÆ; and it contains a number of representatives that are very destructive to different kinds of vegetation. Unlike the Aphiddiæ and Psyllidæ which are pretty closely restricted in their food-habits to particular plants, the Jassidæ are more general feeders.

The form of the body in these insects "is commonly long and slender, often spindle-shaped, with a large transverse prothorax not much wider than the head. The front is generally an oblique, cross-ribbed, inflated prominence, with the cheeks touching the anterior coxæ, but rarely, if ever, restraining their movement. They have a rather large triangular scutellum; the wing-covers curve over the sides of the abdomen, appear as tapering towards the tip, and the *membrane* is distinguished from the more leathery *corium*" (Uhler).

These insects have received the popular name "Leaf-hoppers" since they are powerful jumpers and are most frequently found on leaves and grasses. The family is subdivided into smaller groups by different writers; but for our present purposes no subdivision need be made. Several of these Leaf-hoppers are shown in the accompanying figures. (See Figs. 103, 104, and 105.)

Professor Herbert Osborn, of Ames, Iowa, who has made a special study of these insects, says they are accountable for fully one-half of the insect injury to meadows. As a remedy he suggests the use of a form of

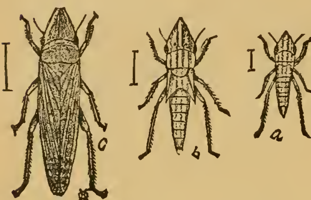


FIG. 103.—*Diedrocephala mollipes*—[After Osborn].

FIG. 104—*Agalia Sic-cifolia*, enlarged—[Original].

FIG. 105—*Deltocephalus inimicus*—[After Osborn].

"hopper dozer" similar to that described for fighting the various species of destructive locusts and grasshoppers. The species that attack trees and vines can be reduced in numbers by the use of kerosene emulsion.

ORDER X. COLEOPTERA.—(*Beetles.*)

The insects which comprise this order are, for the most part, very well marked in their characters, and have always been the favorites with young entomologists. They have also been studied more as perfect insects than have any of the other orders, unless we except the Lepidoptera. Their compactness and hard bodies also render them more readily cared for in collections than are those of other orders. If, however, we should include the larval forms also in this category, we must acknowledge that some of the other orders are better known than are the beetles. This is due to the fact that their larval forms are more difficult to find than are those of some of the other groups. There are upwards of 100,000 species of these insects described and now contained in the various large collections of the world.

In writing of these insects Prof. A. S. Packard says:* "The most productive places for the occurrence of beetles are alluvial loams covered with woods, or with rank vegetation, where at the roots of plants or upon their flowers, under leaves, logs, and stones, under the bark of decaying trees, and in ditches, and by the banks of streams, the species occur in the greatest numbers. Grass lands, mosses, and fungi, the surfaces of trees and dead animals, bones, chips, pieces of board, and excrement, should be searched diligently. Many are thrown ashore in sea-wrack, or occur under the debris of freshets on river banks. Many Carabidæ run on sandy shores. Very early in spring stones can be upturned, ants'

*Guide to the Study of Insects, p. 427.

nests searched, and the muddy waters sifted for species not met with at other times of the year."

Beetles have the front pair of wings horny and of little or no use in flight. These "wing-covers" or *elytra*, as they are called, cover the two hind joints of the thorax, and the greater part of the abdomen. The hind wings are membraneous and are tucked away under the front pair, where they are protected. In their development these insects pass through a complete metamorphosis, *i. e.*, they have a quiet pupa stage. The larvæ, which are called "grubs," vary greatly in form, ranging from the Thysanuriform larva as found in the Carabidæ and several other families, to that of the footless grubs of the snout beetles. A few of the families of beetles possess both the active and inactive larval forms in the same species during the different ages of these immature stages. In the Meloidæ and Stylopidæ the larvæ are at first provided with six legs and are very active, but later they become footless and inactive. In their general structure beetles are also just as variable as they are in size and food-habits. The characters that are used by systematists in the classification of beetles are also numerous and variable. Some of these are the form and relative position of the various mouth-parts, eyes, antennæ, prothorax, sterna, coxæ, tibiæ, etc.

FIG. 106.—Various forms of beetle antennæ: 1, filiform; 2, 3, serrate; 4, pectinate or comb-toothed; 5, capitate or knobbed; 6, 7, 8, clavate or club-shaped; 9, 10, lamellate or plated.—[After Le Comte.]

Some of the forms of beetle antennæ are shown in the accompanying illustration. (See Fig. 106.)

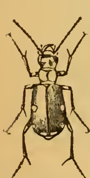


FIG. 107.—Six-spotted tiger bettle (*Cicindela 6-guttata.*)—[After Riley.]

The family CICINDELIDÆ is composed of a number of brightly colored active species that live for the most part on the ground where they pursue and capture other insects of various kinds upon which they feed. On account of their bright colors and predaceous habits they have received the name of "Tiger-beetles." Some of our tiger-beetles prefer to make their homes upon mud flats, others choose hardly beaten roads and paths, and still others frequent sandy localities. The larvæ of these beetles live in perpendicular burrows which they construct for themselves. Like the mature beetles these larvæ are also predaceous, and lie in wait for their prey at the top of their burrows. These grubs or larvæ are enabled to hang in their burrows by means of a pair of tubercles with hooks that arise from the ninth segment of their bodies. The head of

Fig. 108.—The Bordered Tiger beetle (*Cicindela limbata*.)—[From Insect Life.]

these larvæ is large and ungainly and is usually covered with dirt so as to resemble the surrounding earth and render its presence unobserved by the unsuspecting prey. When disturbed these tiger-beetle larvæ drop to the bottom of their holes; and by this means we are often surprised when walking along a mud flat to suddenly see a number of round, clean-cut holes appear, and then again just as suddenly disappear as the insects come to the surface and thrust their heads into the openings. While most of our native tiger-beetles are ground dwellers, there are many species in tropical countries that live on the trunks of trees and among their branches where they find their prey.

Immediately following the "Tiger-beetle" family, and closely related to it, we have a second group of these predaceous beetles. These are the ones that are usually known as "Ground-beetles." The family is a very extensive one since in the United States alone it contains upwards of 1,000 distinct species that have already been described. Without exception these ground beetles are predaceous or feeders upon such other insects, snails, and crustaceans as they can capture and kill. The best haunts for the beetles of the family Carabidae is the margins of streams, among fallen leaves and other vegetation lying upon the ground, where they can hide away during daytime. Like most other predaceous animals these "ground-beetles" are chiefly nocturnal in their prowlings. The larvæ, as well as the imagoes of this family, are predaceous in their food-habits. Several species of Carabidæ are figured in the illustrations numbered 100 to 103. A number of exceptions as to habits, at least, might be mentioned here if the writer had the time and space for doing this. The members of both this and the preceding family are, therefore, of much interest economically.

Fig. 109.—Larva of Ground beetle (*Harpalus pennsylvanicus*).—[After Riley].

Fig. 110.—Ground beetle (*Harpalus caliginosus*).—[After Riley].

There are several species of water beetles found within the state that are also of more or less importance on account of their food-habits. Some of these latter play very important parts in the equalization of the

FIG. 111.—The Fiery Calosoma (*Calosoma calidum*.)—[After Riley].

FIG. 112.—Elongated Ground Beetle (*Pasimachus elongatus*.)—[After Riley.]

FIG. 113.—Gronnd beetle. —[After Riley].

aquatic life of our lakes and streams. Examples of three families of these water beetles are shown in the figures from 114 to 116. The first of these (Fig. 114) is one of the DYTISCIDÆ or "Water-tigers," as these beetles are called. The members of this family are readily distinguished from the other water beetles by the antennæ which are long and thread-like. The second insect, which is shown in Fig. 115, is a representative of

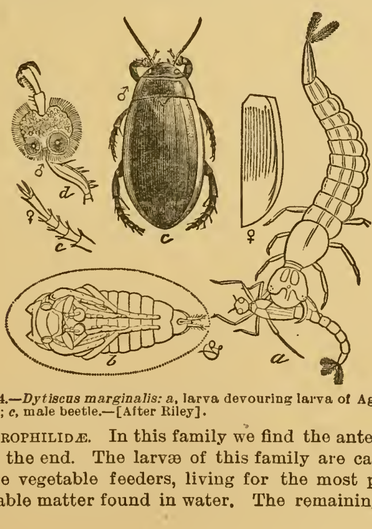


FIG. 114.—*Dytiscus marginalis: a*, larva devouring larva of Agrion; *b*, pupa; *c*, male beetle.—[After Riley].

the family HYDROPHILIDÆ. In this family we find the antennæ short and with a knob on the end. The larvæ of this family are carnivorous, but the imagoes are vegetable feeders, living for the most part upon the decaying vegetable matter found in water. The remaining figure shows to the reader the insects that ordinarily are called "Whirilgig beetle " or "Lucky-bugs." They bear the family name GYRINIDÆ.

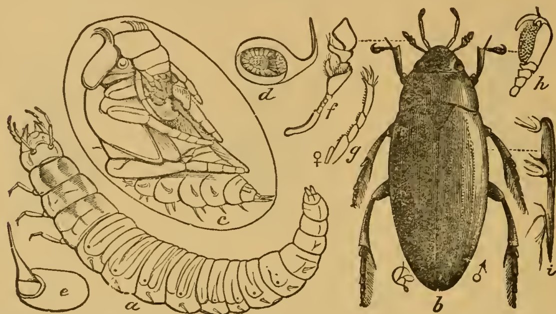


FIG. 115.—*Hydrophilus triangularis:* a, larva; b, male beetle; c, pupa.—[After Riley].

Many of these aquatic beetles aid greatly in reducing the number of fishes in our waters by attacking and destroying both the spawn and the young fishes before they are able to care for themselves. They also do a little good on the other hand by feeding upon the larval forms of various gnats and mosquitoes. If we wish to observe the nicety in which Nature works, we need only to notice how admirably these creatures are formed for the lives which they lead.

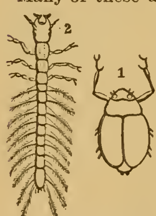


FIG. 116.—*Gyrinus*: 1, beetle; 2, larva.—[After Packard]

The family STAPHYLINIDÆ is a very extensive one indeed, and its representatives quite variable in their food-habits and consequently also in their haunts. These insects which are known popularly as "Rove beetles" are well illustrated by Fig. 117. The elytra of the Staphylinidæ are short, and only cover one or two of the basal segments of the abdomen. Under these short wing-covers the membranous wings are tucked away in a manner somewhat similar to that adopted by the Dermaptera and described on a preceding page. These insects have a peculiar habit of carrying the tip of the abdomen elevated when running about or even when resting. Several other small families possess a similar habit in this respect. Since many species of these rove-beetles feed upon decaying vegetable and animal matter, as well as the droppings of various animals, they are to be included among the scavengers belonging to the class insecta. Others are found in the nests of ants, and still others infest the different species of "toad-stools."

FIG. 117.—*Philonthus apicalis*—[After Riley].

Several other families of beetles with abreviated elytra occur within the state; but as these latter are not especially destructive, neither beneficial, in their relations to man,they will be omitted from the present paper.

There are two families that systematists place immediately after the water beetles which include minute forms that live as parasites upon the bodies or within the nests of certain Rodents. One of these, the Beaver parasite (*Platypsyllus castoris*), is shown herewith in Fig. 118 greatly magnified. This insect lives upon the animal among the fur just as lice do. Its larvæ are also found in the same place; but the pupa stage and eggs have not, as yet, been located. The insect, although of no apparent importance economically, is of much interest to the working entomologist who desires to learn the relationship existing between the various insects that occur about him. To find a representative of an order like the Coleoptera living the life of a Mallophagous insect seems very difficult for the entomologist to account for.

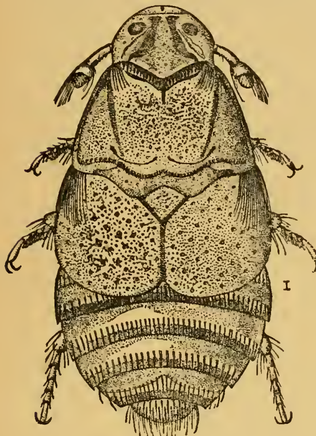


FIG. 118.—*Platypsyllus castoris.*—[Insect Life.]

The "carrion-beetles," families SILPHIDÆ, and allies, as the common name indicates, are devourers of decaying animal and vegetable matter of various kinds. The large "Burying-beetles" that are so familiar to most of us, have the habit of burying dead animals in which they first lay their eggs. Later, when the eggs have hatched, the larvæ feed upon the food thus provided by their parents. These beetles are black and red in color. Other representatives of the family are flattened beetles of dull black and browish colors.

Several additional families of these carrion-infesting beetles occur in almost every region of the earth. They are the HISTERIDÆ, or "Pill-beetles," NITIDULIDÆ, and DERMESTIDÆ. The Histerdiæ also frequent decaying vegetation and droppings of animals as well as carrion. They are small, oval, hard-shelled beetles with shining bodies. Some of them are bright green, bronzy, black, or pitchy in color; and a few of them have blotches of red upon their wing-covers. The Nitidulidæ are usually found upon dry carrion; and are small, flat-bodied beetles that are variously marked and mottled with yellow, dull brown, and gray. A few of them also infest decaying vegetable substances. One of these latter is shown in Fig. 119. The third family, Dermestidæ, often attack various dried meats, skins, collections of insects, etc., and make themselves generally detested by man. The insect figured

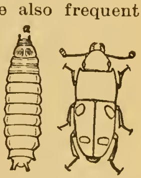


FIG. 119—*Ips fasciatus*, larva and beetle enlarged.—[After Packard].

at 120 is a common household pest where it enters pantries, kitchens, and other places in which stores are kept. It is also quite a dreaded museum pest that must be guarded against if we would preserve our specimens intact. The name of this insect is *Dermestes lardarius.* Other species of the genus are seldom found indoors but are very plentiful out of doors where they can be found in early spring upon carrion of different kinds. Other forms are especially known as museum pests; and one is known as the "Buffalo-moth" of carpets. It often gathers about the edges of carpets in rooms that are kept dark and there does much injury by eating the carpets full of holes. The insect also infests different articles of woolen clothing when stored for any great length of time. Sometimes the larvæ and imagoes of this beetle are found in feather pillows, and when this is the case they soon reduce the entire contents into a powdery mass.

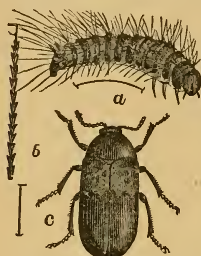


FIG. 120—*Dermestes lardarius:* larva and beetle.—[After Riley.]

The "Lady-bugs" or "Lady-birds," as the insects are called which entomologists have grouped together under the family name COCCINELLIDÆ, are none of them very large; neither are any of them among the smallest representatives of the order Coleoptera. These insects are oval in form and can be very well represented by the nine-spotted Lady-bird which is shown in Fig. 122, along with its larva at 121. The illustrations are both much enlarged. These insects are among our best friends, since they occupy most of their time in feeding on various kinds of plant-lice and the eggs and young larvæ of many injurious insects, such as the Colorado Potato-beetle and various other leaf feeding beetles of the family Chrysomelidæ. Recent importations of several Australian Lady-birds have greatly reduced a scale-insect in California, where it had become a very dangerous pest.

FIG. 121.—Larva of Lady-bird.—[Ater Smith.]

FIG. 122.—*Coccinella, 9-notata.*—[After Smith.]

The family CUCUJIDÆ contains a number of rather small, brownish beetles that are very general feeders. Sometimes they become injurious to stored grains, meal, and even to drugs and groceries of various sorts. A few of them are also known to be museum pests. Several of these insects have been described by me as small grain pests. One of these beetles is shown in Fig. 123.

The insects known as "Snapping-bugs," Click-beetles, etc., family ELATERIDÆ, are very well represented by the illustration (Fig. 124) which is intended for *Melanotus communis*, one of our commonest species in Nebraska. The larvæ of these beetles are known as "wire-worms," and are among the most troublesome pests the farmer has to deal with. Some of these wire-worms require several years in which to attain their growth; and others are phosphorescent, showing as beautiful objects after night. One of our largest beetles of this kind here in Nebraska is known as *Alaus oculatus*, or the Eyed Snapping-beetle. It is gray and black, with eye-like spots upon the prothorax. Its larvæ live in rotten wood.

FIG. 123.—*Silvanus surinamensis.* —[Original.]

Immediately following the "Snapping-beetles" we have a very extensive family of insects known as the BUPRESTIDÆ. These beetles bear a general resemblance to the Elateridæ; but instead of working in the ground the larvæ of these latter insects are borers, and work within the stems and trunks of trees and various other plants. Their larvæ have the thoracic joints greatly enlarged and somewhat flattened so as to give the front end of the body a flattened appearance. It is this feature that has given them the name of Flat-headed borers in distinction to the larvæ of the Cerambycidæ which are sometimes called "round-headed" borers. These Buprestidæ are very destructive to various kinds of fruit, shade, ornamental, and forest trees in the trunks, limbs, and twigs of which they bore. The beetles are all more or less metallic in color, have hard, flattened bodies with very short antennæ, and their legs are rather short and folded close to the body. While some of the species naturally select strong, healthy trees upon which to work, most of them attack those that have been injured in some way or other. A few of the species are confined in their attacks to certain kinds of trees and shrubs, but others of them are quite general in their selection of their host-plants. The Buprestidæ have been treated in a general way in several of my annual reports to the State Horticultural Society, where remedies for their suppression have also been suggested.

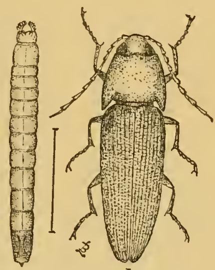


FIG. 124.—The Common Snapping-beetle (*Melonotus communis*): *a*, larva; *b*, beetle. —[Original.]

The Fire-flies or LAMPYRIDÆ are represented by the illustration given herewith. (See Fig. 125.) Most of the beetles bear a rather strong resemblance to the Elateridæ, but are soft-bodied instead of hard as in the snapping-beetles. The larvæ of this family are also soft-bodied, and instead of being vegetable feeders are predaceous in their food habits. In some forms the larvæ are phosphorescent, and in others the perfect insects possess this chacteristic. A few of the species are wingless during their entire lives. The insect which is figured is known as *Photinus pyralis*, and the food of the larva is said to be earth-worms and soft-bodied insects. Another insect that belongs in this family is a very common one here in Nebraska, and occurs in late summer and during fall upon the blossoms of various plants. It is the slender ochraceous beetle with an oblong black patch upon each elytron that we so often see in numbers in such localities as those mentioned above. Its larvæ are something like the one figured, but a trifle more robust, of a dirty brown color, and has the entire upper surface covered with a soft velvety bloom.

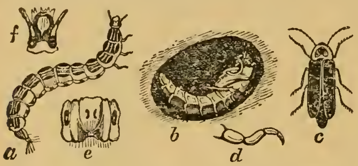


FIG. 125.—*Photinus pyralis: a*, larva; *b*, pupa; *c*, beetle.—[After Riley.]

There are several other families of beetles that are closely related to the Lampyridæ, in food habits at least, that follow closely. The MALACHIDÆ are all small species and may be found upon various plants which they frequent for the sake of obtaining food. This food consists of various small insects, mites, etc. The CLERIDÆ also have carnivorous habits, some of the species living in the nests of bees, and others making their home under bark of dead trees, where they feed upon the larvæ of boring beetles. The members of both families are rather bright in color.

The large "Stag-beetles" or "Pinch-bugs" that most of us as boys played with, belong to the family LUCANIDÆ. The larvæ of these large beetles which closely resemble those of the next family that are sometimes called "Grub-worms" and "White Grubs" live in decaying logs and stumps where they work between the wood and bark. They are very likely several years in attaining their growth. The members of this family can be readily recognized by the form of the antennæ which is a little like that of the next family and like the illustration numbered 9 in Fig. 106. The club or head is less compact than that of the members of the family Scarabæidæ. No illustration of the family is given.

Perhaps the family SCARABÆIDÆ is the most interesting one in the order Coleoptera, since it contains so many giants among the forms that are classed here. Its representatives also include forms of very varied food-habits. It is a group that is easily limited notwithstanding that some of its representatives are less than one-tenth of an inch in length and others fully six inches long and one-third as wide. The attennæ have the club composed of thin, plate-like joints as shown at 10 in Fig. 106. The family contains many odd looking creatures in which the head and pronotum are provided with horns and spine-like projections that render them formidable in appearance if not in reality. The true home of these insects is the tropics, but even here in Nebraska many of them are to be found. A few of the beetles that belong to the family and that are familiar to most of us are such as the "May-beetles," the "Rose-chafer," the "Rhinoceros beetle," "Tumble bugs," and the "Goldsmith beetle." Some of the manure-infesting beetles of this family are beautiful in color, being bright green varied with various shades of red and yellow bronze. Some of the leaf-feeding forms also possess beautiful hues of green, yellow, brown, and red. A rather large per cent of these insects are carrion eaters, while others are known to live a sort of parasitic life in the nests of various ants. Some of these ant-nest dwellers as perfect insects have their mouth-parts protected by a sort of shield-like piece that fits in the mouth like an oval lid. One of the leaf-feeding species (*Pelidnota punctata*), and also a coprophagous form are shown herewith.

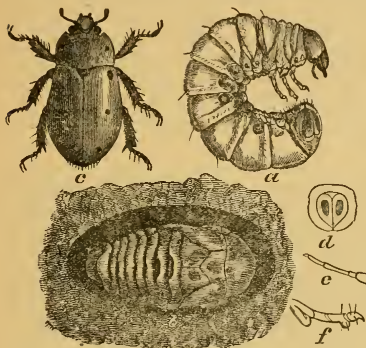


Fig. 126.—*Pelidnota punctata*: *a*, larva; *b*, pupa; *c*, imago.—[After Riley].

The former is represented by Fig. 126, while the latter (*Copris carolina*) is shown at 127. This latter insect is known popularly as a "tumble-bug" because of its habit of forming pellets of dung in which it lays its eggs and afterwards rolls them about until a hard shell is formed on their outside and then buries them in the ground. The egg soon hatches, the grub feeds upon the food that has been supplied, grows rapidly, and soon changes to the pupa stage within the hard outer shell of the ball that now furnishes a compact cell that protects it until mature. When it has thoroughly hardened, the young beetle eats its way out of the cell and burrows to the surface of the ground and soon begins life by rolling balls for itself. Some kinds

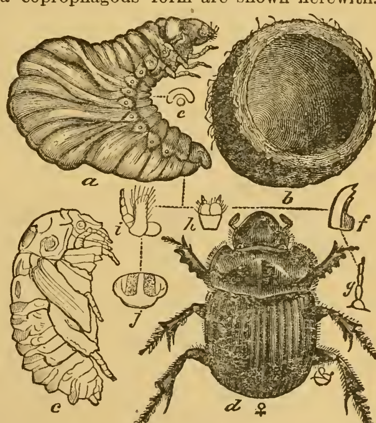


Fig. 127.—*Copris carolina*: *a*, larva; *b*, a section of excrementitious ball; *c*, pupa; *d*, female beetle.—[After Riley].

of these beetles do not roll the food supply intended for their young into pellets, but burrow into the ground and pack the substance, among which eggs are laid, away in gallaries. The larva of *Pelidnota punctata*, which is shown in Fig. 126, have been taken by me from rotten apple tree stumps; and the beetles reported as doing considerable injury to the foliage of grape-vines. A couple other beetles that belong to this family have been described in my various reports to the Horticultural and Agricultural societies of the state, where the reader is referred for a presentation of their life-histories, etc.

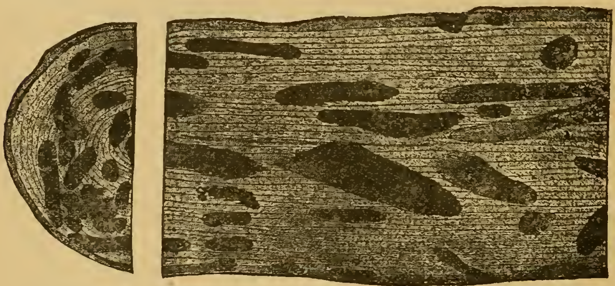


FIG. 128.—Work of Hickory Borer, showing longitudinal and cross section of stick with burrows. One-half natural size.—[After Osborn, in *Garden* and *Forest*.]

Among the insects that are considered very injurious are the long-horned boring beetles (family CERAMBYCIDÆ). These insects are known as the "round-headed" borers in distinction to those of the family Buprestidæ which are called the "flat-headed borers." While most of the representitives of the other family attack trees that have become injured in some way and have their vitality lessened, the Cerambycidæ on the other hand, mostly attack healthy trees and often kill them outright in a short time. Several of these insects have been described in reports already referred to in preceding pages of this paper. The reader will find the description of these insects recorded there. A few of these insects are quite general in their attacks, but most of them are confined to certain trees. Some of the borers become full-grown in a single year, but others require several years in which to attain their growth. The members of one genus of these beetles have been know to live as larvæ for a dozen or more years. Some idea of the destructiveness

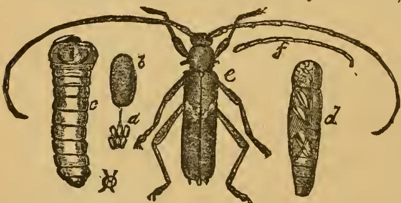


FIG. 129.—*Chion cinctus*, Hickory Borer: *a*, eggs; *c*, larva; *d*, pupa; *e*, imago.—[After Osborn in *Garden* and *Forest*.]

of these insects can be had by a reference to the accompanying cut (Fig. 128) illustrating the work of the Banded Hickory borer (*Chion cinctus.*) The beetle is also shown at Fig. 129. This is one of the species that works in wood that has been killed. Since it is a typical insect and very common wherever the hickory grows, I will therefore give the following brief mention of it here:

"Hickory wood, one or two years after cutting, is often badly infested with a borer that may so riddle it as to reduce its value even for fire wood, and render it entirely worthless for any purpose of manufacture. One of the most common of the borers infesting it is the one here mentioned, and the cuts will give an idea of its character and the appearance of its work. The beetles issue in May and the eggs are deposited soon after, and it is evident that they select cut timber rather than standing trees. The larvæ work into the wood and before becoming full grown penetrate the hardest heart-wood. They probably require two or three years to complete their growth, and some instances are recorded of the adults issuing from wood years after it had been made into articles of furniture, showing that growth may be retarded so as to carry the length to a number of years.

"For firewood it is sufficient to see that the wood is used the first year after cutting, but for timber to be used in manufacturing implements or tools some method of protection during June and July of the first season after cutting must be resorted to. Storing in sheds, the openings of which are protected with wire screen, would be effectual. Stripping the bark is considered by many as a preventive, and as it doubtless hastens the drying of the outer portions of the wood and avoids the presence of any sap as an attraction, it would seem to be based on good grounds. Probably cutting the timber in late summer or autumn so as to allow pretty thorough drying before the time of appearance of the beetles the following year would also be an advantage."—(Osborn.)

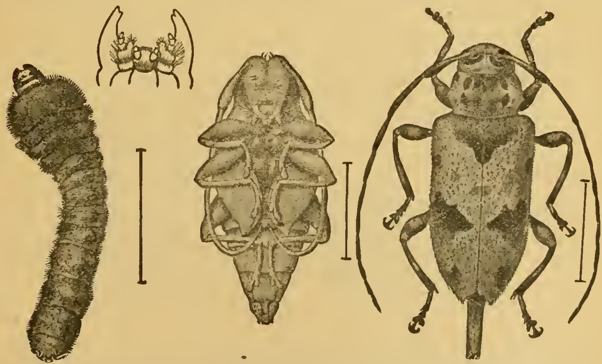


FIG. 130.—The Hackberry *Graphisurus*: *a*, larva; *b*. pupa; *c*, female beetle—all enlarged.—[After Riley.]

Another of these long-horn borers is shown herewith in Fig. 130.

The family of "Leaf-beetles, CHRYSOMELIDÆ, contains a large number of quite destructive insects. They are all rather small, roundish, or oblong, bright green, yellowish, brown, black, and metallic blue, beetles

FIG. 131.—*Chrysomela multipunctata*, beetle and larva—Slightly enlarged.—[Original.]

FIG. 132.—The Spotted Cottonwood Beetle (*Lina Lapponica*) showing variation in the markings.—[Original.]

FIG. 133.—The Five-lined Flea-beetle, Slightly enlarged.—[Original.]

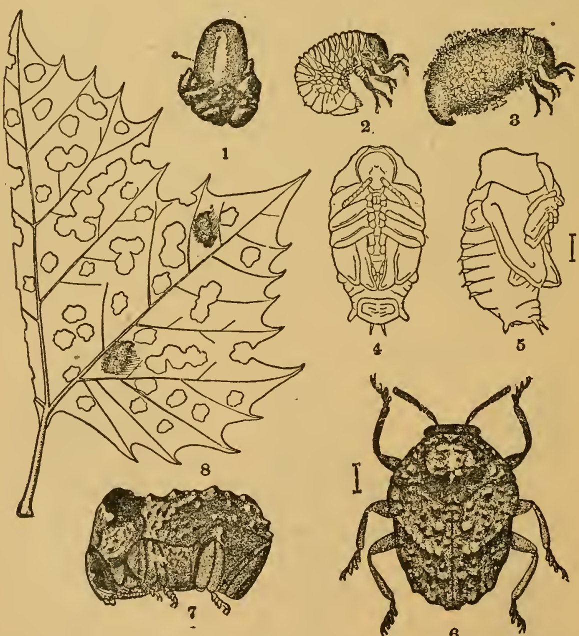


FIG. 134.—The Sycamore Leaf-beetle (*Chalmys plicata*): 1, egg; 2, larva; 3, larva in case; 4 and 5, pupa, front and side views; 6 and 7, the beetle, seen from above and the side—all greatly enlarged; 8, sycamore leaf, showing two cases and work of larvæ.—[After C. L. Marlatt.]

that are variously mottled and striped in their coloration. They feed upon vegetation exclusively, both as larvæ and mature insects. Some examples of the family are the Colorado potato-beetle, the Cucumber flea-beetle, and the Grape-vine Colaspis. A few of these insects are shown in the illustrations from Figs. 131 to 138.

FIG. 135.—The Pennsylvania Flea-beetle, slightly enlarged.—[Original.]

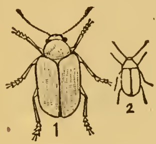


FIG. 136. — *Colaspis brunnea*.—[Copied after Riley.]

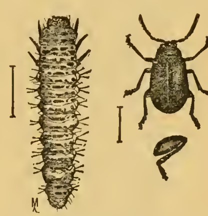


FIG. 137.—Grape-vine Flea-beetle, beetle and larva.—[After Comstock.]

The family BRUCHIDÆ contains a number of rather small insects that make their homes in the seeds of various plants, and especially in those of the Leguminosæ or pulse family. The Bean and Pea-weevils are examples of this family that all of us are familiar with. No figures of these insects are given simply because we do not happen to have them on hand.

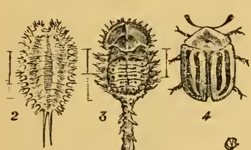


FIG. 138.—*Cassida bivittata;* 2, larva; 3, pupa; 4, imago.—[After Riley.]

The family TENEBRIONIDÆ is also a very extensive one and contains a great many variations as to habits among its members. Some are plant-eaters and attack growing herbs of different kinds. Others live under bark of dead trees, and still others infest houses where they feed on meal and grains. The "meal" beetles belong here, as do also the large black beetles that we so often see running along roads and paths during late summer and early fall. These latter insects can be recognized from the habit they have of standing upon their heads and elevating their tails into the air when disturbed. They belong to the genera *Eleodes* and *Asida*. Another one of these beetles that is interesting on account of its peculiar form, frequently occurs in cellars and other dark, damp places. This peculiarity consists of a rather high, wall-like ridge which borders its pronotum and wing-covers. Its scientific name is *Embaphion muricatum*.

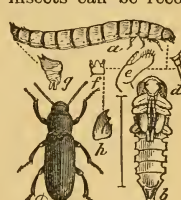


FIG. 139.—American Meal-worm; *a*, larva; *b*, pupa; *c*, beetle.—[After Riley.]

The insects that are popularly known as "Blister-beetles" are members of the family

MELOIDÆ. These insects have various food-habits, and are interesting from different standpoints to the entomologist.

These blister-beetles are among our most interesting forms of insect

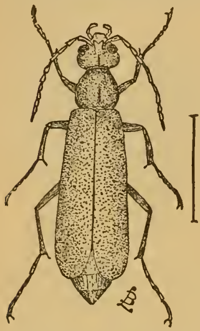


FIG. 140—The One-colored Blister-beetle (*Macrobasis unicolor.*)—[Original.]

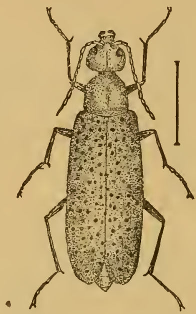


FIG. 141.—The Spotted Blister-beetle (*Epicauta maculata.*—[Original.]

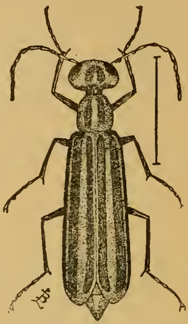


FIG. 142.—The Striped Blister-beetle (*Epicauta vittala.*—[Original.]

life, both as regards their life-histories and their economic importance; and it is quite difficult for us to decide whether their existence is really more of a benefit than a detriment to us, or *vice versa.* They appear during the months of June and July, and are both diurnal and nocturnal in their habits. Prof. C. V. Riley, who has been our most energetic American entomologist in working out the life-history of insects of economic importance, published an account of the life-histories of several species of the genus *Epicauta* on pages 297 to 302 of the First Report of the United States Entomological Commission. In that work he shows how the eggs are laid, hatched, and the young larvæ, which at first are very active, search for locust or grasshopper eggs upon which they feed. The life-history of these little triungulins, as they are called, is an interesting one as portrayed by that author, but not more so than are the succeeding stages through which the same insect must pass before it can issue into the world as a full-grown blister-beetle. Were it not for the lack of space I would quote the author's paper entire. Those who would like to read the account for information can do so by referring to the above named report.

As a rule, these blister-beetles are gregarious in their habits, and feed in company—sometimes by the thousands. When they gather upon any particular plant or plants they are not long in finishing such portions of it as they can devour. Juicy plants are special favorites of theirs at times, while at other times these are passed by and they seem to prefer just the opposite qualities in their food-plants. Just as they are in their comings and goings, so they are in the selection of what they subsist upon as mature insects. They come and go mysteriously, sometimes only as a few stragglers, but more frequently in large swarms. One year they prefer one food-plant, and another year another; so that they will include most of our common plants in their bill of fare inside of a dozen years.

The family contains a number of other forms, some of which are parasitic in bees' nests and others that we are ignorant as to where the preparatory stages are passed. The name "Oil-beetles" which is frequently bestowed upon members of the group, is derived from the

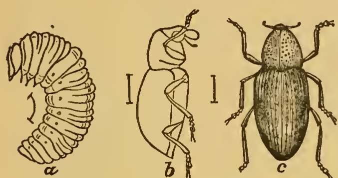


Fig. 143.—*Tyloderma fragariæ*: *a*, larva; *b*, beetle side view; *c*, same from above.—[After Riley].

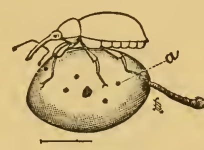


Fig. 144.—Plum gouger; *a*, puncture in fruit.—[Original.]

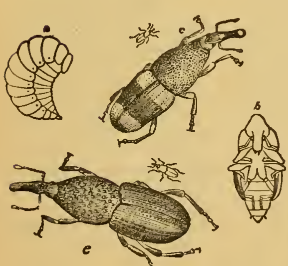


Fig. 145.—*c* *Calandra oryzæ*: *a*, larva; *b*, pupa; *c*, *Calandra granaria*—all enlarged. —[After Packard.]

Fig. 146.—*Sphenophorus ochreus*: larva and imago.—[Insect Life.]

peculiar habit that most of them have of excreting an oil-like fluid from the knee joints, sometimes in large quantities. This oil frequently produces a blister when it comes in contact with the bare skin. It is this feature in the beetles that has brought the "Spanish-fly" into medicinal use.

A number of families of the Coleoptera have been grouped under the name of Rhyncophora and placed at the top of the order. These insects are to be distinguished from the other beetles by their beak-like prolongation of the mouth parts. Under the group several well defined families are recognizable. Some of these are the RHYNCHITIDÆ with the red Rose-weevil as a type; the OTIORHYNCHIDÆ with the Imbricated Snout

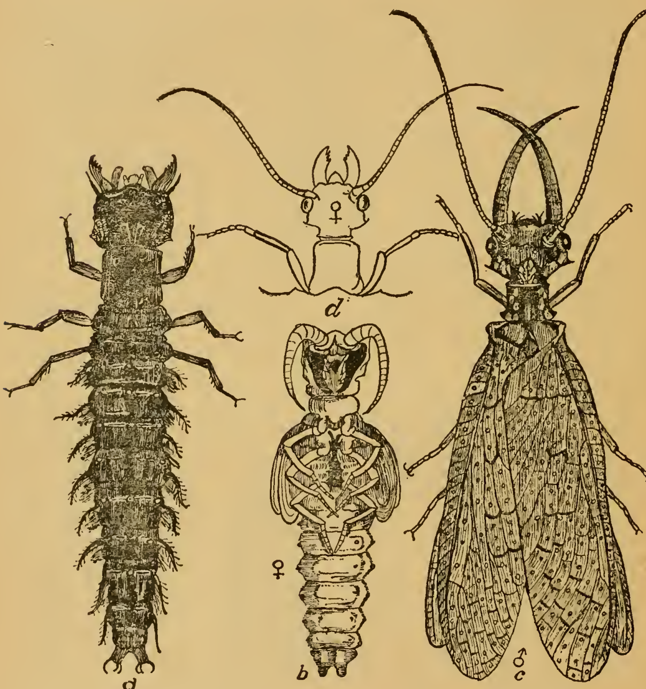


FIG. 147.—Hellgramite Fly: *a*, larva; *b*, pupa; *c*, male imago; *d*, head of female.—[Redrawn for Riley.]

beetle as a type; the CURCULIONIDÆ with the Plum Curculio and Gouger as types; the CALANDRIDÆ with the Grain and Rice weevils and the "Bill-bugs" as types; and the SCOLYTIDÆ with the Bark-beetles as types. Some of these insects are shown in the illustrations from 143 to 146. Others are described and figured in my various reports made to the state societies of Horticulture and Agriculture.

ORDER XI. NEUROPTERA.—(*Nerve-winged Insects.*)

This order as now limited by most systematic writers is composed of comparatively few species. These are distinguished from the other insects which are usually classed here by having the larvæ active, the pupa quiescent, and the imago provided with two pairs of rather large many-veined wings. A good type of the order is shown herewith in Fig. 147. It is shown life size as larva, pupa, and imago. The mouth parts of this insect, which is called *Corydalis cornutus*, are well developed for seizing and killing its prey which consists of other insects and even fishes of small size. The larvæ live in swift running streams where they hide under stones and other objects that afford shelter to them. As will be seen by reference to the illustration, this larva is provided with gill-like appendages for extracting air from the water. When full grown, which requires nearly three years' time, these larvæ leave the water and crawl upon the bank where they construct earthern cocoons and transform to the pupa state (See Fig. 147, *b*), and in about ten days to two weeks later to the perfect insect. The two sexes of the Hellgramite Fly, as the insect is called, are quite different. The male has its mandibles changed into the form of strong, curved horns, while in the female they remain normal.

A number of others of these large, aquatic Neuroptera are to be met with in different parts of the country. In some localities they are quite numerous and are used by anglers as bait for trout and other fish. In Colorado and on the Pacific slope are found some very peculiar appearing representatives of this same family (SIALIDÆ) of Neuropterous insects. They have the prothorax long and cylindrical, the head broad and quite large, and the female is provided with a long curved ovipositor. These insects are much smaller than the one figured above, and the larvæ are said to live under bark of trees instead of in the water. This assertion however, may be a mistake since the insects are far too common to permit of such a habit in their larvæ.

The "Mealy-winged" Neuroptera (COMOPTERYGIDÆ) are all rather small creatures, the larvæ of which are supposed to feed upon plant-lice. The imagoes are fairly common during the months of June and July when they can be collected by beating the foliage of trees of various kinds.

In the family (HEMEROBIINIDÆ) are several divisions of the larval habits which differ much although they are probably carnivorous. Some of them live in the water while others live upon land and make a business of eating plant-lice. We have no illustration of any of these insects to present here for the reader's inspection. One form of these insects is known by the popular name "Shad-fly."

Probably one of the most characteristic as well as common forms of the Neuroptera is shown in Fig. 148. It is known as "Lace-wing" or

"Aphis-lion." There are quite a large number of these lace-wings to be found in this country. Professor Comstock has the following to say of these insects in his introduction to Entomology, page 225: "The lace-winged flies are very common insects throughout the summer months upon herbage and the foliage of trees. They are usually a light green or yellowish. While alive their eyes are very bright; and on this account they have also received the popular name of Golden-eyed Flies. Some species, when handled, emit a very disagreeable odor. A remarkable fact in the history of these insects is the way in which the female cares for her eggs. When about to lay an egg she emits from the end of her body a minute drop of a tenacious substance; this is drawn out into a slender thread by lifting the abdomen; then an egg is placed on the summit of this thread. The thread dries at once and firmly holds the egg in mid air. These threads are usually .4 to .6 of an inch in length, and occur singly or in groups. It is probable that this placing of the eggs on stalks protects them from the ravages of predaceous insects, including the Aphis-lions themselves. When the young Aphis-lion hatches it crawls down the thread that held the egg up, and starts in quest of some small insect or egg which it can feed upon. While doing so it may wander through a forest of egg-stalks, not observing the eggs far above it. The larvæ are spindle-form, and have long, sickle-shaped mandibles. They feed chiefly on plant-lice, but will eat such other insects as they can overcome. The cocoon in which the pupa state is passed is spherical, and composed of dense layers of silk. In order to emerge the insect cuts a circular lid from one side of the cocoon."

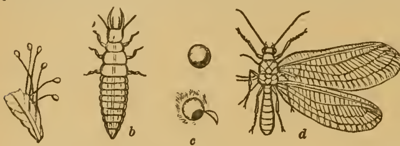


FIG. 148.—Lace-wing: *a*, eggs on leaf; *b*, larva; *c*, *d*, mature insect.—[After Riley.]

The "Ant-lions" comprise another family of the Neuroptera, viz., MYRMELEONIDÆ. These are also very interesting creatures for study. As will be seen by a reference to the figure (No. 149) it will be seen that the imago bears some resemblance to this stage of the Odonata; but of course this resemblance is only accidental, as will be seen by a closer examination of the figures or of specimens of the insects themselves. More than twenty-five of these insects have been described from North America. The larvæ bear a general resemblance in their appearance to those of the "Lace-wings" and allied groups; but their habits differ greatly from those of the larvæ of groups referred to. These "Ant-lion" larvæ live in sandy places where they burrow into the loose sand and

FIG. 149.—Ant-lion and larva.—[After Packard.]

construct pits for themselves by digging away the sand until the least disturbance will cause the loose particles to roll to the bottom. When a wandering ant chances to step over the brink of this pit some particles give way and roll to the bottom, notifying the hidden proprietor of the approach of prey. A vigorous digging on the part of the ant-lion now draws down sand and the ant into the jaws of the enemy. When these Ant-lions are ready to transform they spin for themselves spherical cocoons, which are composed of sand and silk. A very interesting object lesson can be had by securing some of these Ant-lions and placing them in a shallow dish of sand.

The last of the representatives of the order Neuroptera that will be mentioned here is the one shown in the accompanying illustration (Fig. 150.) This insect, as will at once be seen, resembles the Mantidæ among

FIG. 150.—*Mantispa.*—[After Packard.]

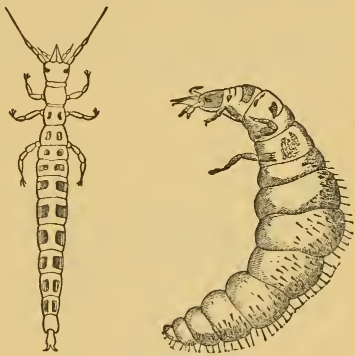


FIG. 151.—Larva of *Mantispa.*—[After Packard.]

the Orthoptera. Like them it is also predacious in food-habits, using its front pair of legs for grasping and holding its food. Aside from this resemblance in the front legs and the prothorax the other structure is distinctly neuropteroid. The larvæ are more or less "grub-like" (see Fig. 151) during part of their existence. The life-history of *Mantispa* has been studied by Brauer, who obtained eggs from a female kept in a breeding cage. "These eggs were rose-red in color and fastened upon stalks like the eggs of *Chrysopa.* The eggs were laid in July, and the larvæ emerge twenty-one days later. The young larvæ are very agile creatures, with a long, slender body, well developed legs, and long, slender antennæ. They pass the winter without food. In the spring they find their way into the egg-sacks of the above named spiders (*Lycosa*). Here they feed upon the young spiders, and the body becomes proportionately thicker. Later the larva molts and undergoes a remarkable change in form, becoming what is known as the second larva. In this stage the body is much swollen, resembling in form the larva of a bee. The legs are much reduced in size, the antennæ are short, and the head is very small. When fully grown this larva measures three to four inches in length. It then spins a cocoon and changes to a pupa within the skin of the larva. Later the larval skin is cast; and, finally, after being in the cocoon about a month, the pupa becomes active, pierces the cocoon and the egg-sack, crawls about for a time, and then changes to the adult state."

ORDER XII. MECOPTERA.—(*Scorpion Flies.*)

The illustration presented herewith represents the small order of insects that has been separated from the old Neuroptera under the name of Mecoptera. These insects are known by the popular name of "Scorpion-flies." They can be described as bearing some resemblance to the "Daddy Long Legs" among the Diptera, only that they are provided with four instead of two wings. They have both pairs of wings similar, long and narrow, and provided with rather many longitudinal and a few cross-veins. The prothorax is small; the middle and hind wings are much larger and bear the wings. The abdomen is rather long and slender, with the last joint enlarged and bearing at the extremity a clasping arrangement in the male of *Panorpa* whence the name of "Scorpion-fly." The terminal segments of the female body are small and tapering, and bear a pair of short, thread-like organs. The insect which is shown in the figure belongs to the genus *Bittacus*, and has the abdomen the same shape in both sexes. It is the representatives of this last named genus that most resemble the "daddy long legs."

FIG. 152.—*Bittacus*.—[Original.]

The mouth-parts of these insects are arranged for biting, but are at the end of a kind of beak not unlike that to be seen in the "weevils" or snout beetles. A number of other characters might be mentioned as belonging to these insects.

"The larvæ * * are caterpillar-like, with the head small, the feet short and small, and there are eight abdominal feet. * * The metamorphoses are complete, the pupa being somewhat like those of the lowest moths, the limbs being free."—(Packard).

There is but little said in our American books about the food-habits of the different members of the order. It is supposed, however, that the imagoes at least are predaceous, feeding upon other insects which they capture. Of the larval food not so much is known.

Some of the species of the genus *Boreus* are found upon the snow in midwinter.

ORDER XIII. TRICHOPTERA.—(*Hairy-winged Insects—Caddis flies.*)

The members of this rather small order are very interesting insects because of the habits of the larvæ. These latter live in the water, and are both vegetable and animal feeders. They construct cases of different kinds and forms, each species making a particular pattern. In fact,

FIG. 153.—Caddis Fly: *a*, case; *b*, larva; *c*, pupa.—[*a*, *b*, *d*, after Packard; *c*, after Hyatt and Arms.]

the cases are sufficiently permanent in form with these insects to permit of their being used as a means for classifying the larval forms.

The Caddis Flies, as the perfect insects are called, resemble some of the moths in their general appearance. They have the wings provided with but few cross-veins, and more or less thickly covered with hairs, hence the name "Trichoptera" which signifies "hair-wings." The head is small, with widely separated eyes; the three thoracic rings are distinct, the meso-thorax being largest in conformity with the greatest use of the front wings in flight. The mouth-parts, although of the biting type, are small and weak, the insects probably taking but little, if any, food in this stage. It has been observed that some of the more delicate white forms found here in Nebraska show indications of having their abdomen more or less filled with green vegetable matter. The antennæ are very long and thread-like.

The larvæ of these Caddis-flies, as stated above, are aquatic, and construct cases of bits of sticks, hollow grass, and weed-stems, grains of coarse sand and small gravel, in which they live. These cases are either fastened to some object or are carried or dragged about by their occupants over the bottoms of quiet pools and even rapid-running streams. The larvæ are distantly caterpillar-like in their appearance, but, as will be seen by reference to the illustration (Fig. 153, *b*) have rather long legs all of which are directed forwards. The anal or tail end is provided with a pair of strong, jointed pro-legs which are used by the insect in retaining a hold upon the case in which it lives. These larvæ are provided along their sides with gill-like tufts of hair or filaments for extracting the necessary oxygen from the water. Various devices are resorted to by different species of Caddis fly larvæ in the construction of their cases and for the securing of their food. In some instances much intelligence seems to be displayed by them. Hyatt and Arms, in their little book, "Insecta," describe and figure one species that occurs in streams about Boston, Massachusetts. They say of it that "One of these makes apparently a tunnel and attaches it to a stone. The insect, however, economizes material by allowing the stone to serve as the lower part of the tunnel. Close to the opening, which is towards the current, the larva erects a vertical frame-work and across it stretches a net. The food brought down by the current is caught in the meshes of the net, and the insect, without wholly leaving the protection of its house, is able to enjoy the meal its ingenuity has secured." When ready to transform to the pupa stage, these larvæ close the end of the case and sometimes spin a light cocoon of silk. The pupa stage of Caddis flies resembles that of the moths, only the limbs are always free, while in the moths they are not.

FIG. 154.—*Euptoieta claudia.*—[After Scudder.]

FIG. 155.—*Vanessa antiopa.*—[After J. G. Wood.]

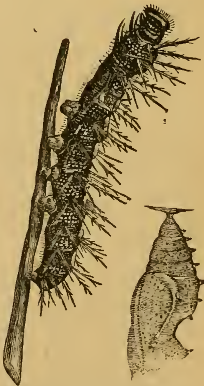


FIG. 156.—*a*, larva, and *b*, pupa of *Vanessa antiopa.* —[*a* after Scudder; *b*, after Harris.]

ORDER XIV. LEPIDOPTERA.—(*Butterflies* and *Moths.—Scale-winged Insects.*)

The members of this order can readily be separated from all other insects by means of their scale-covered wings and bodies, the peculiar development of the mouth-parts, and the form and transformations of their larvæ. The group is almost without exception plant-feeding, and its members are therefore to be classed as injurious.

These insects on account or their attractive colors and the comparative ease with which their larvæ can be reared in confinement have been studied more than those of any other order. Their life period, too, is com-

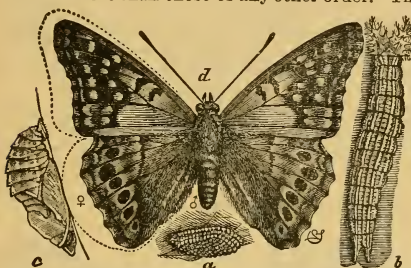


FIG. 157.—Hackberry Butterfly.—[After Riley]


FIG. 158.—*Thecla calanus.*—[After Scudder.]

paratively short in the majority of cases; which, in addition to their above-ground habits, also adds to the ease with which they can be studied. A few of the forms are to be considered of commercial value; as for example, the silk-worms. A very few also destroy scale insects and plant-lice, and for this reason must be admitted among beneficial insects. Aside from these few exceptions we are compelled to look upon the Lepidoptera as enemies, notwithstanding their beautiful colors and graceful forms as imagoes.

The order is readily separable into two well-defined groups know as

FIG. 159.—*Pieris rapæ:* *a*, larva; *b*, chrysalis.—[Riley].


FIG. 160.—*Pieris rapæ*, female.—[After Riley.]

RHOPALOCERA and HETEROCERA. The former includes those forms known popularly as " moths " and the latter those which have received the name " butterflies."

The metamorphosis in these insects is complete, *i. e.*, the larvæ or caterpillars are active, the pupæ or chrysalids inactive, and the changes between the different stages great. The caterpillars vary much among themselves in appearances. Some are smooth, others tuberculated and covered with hairs and spines. Some feed in colonies, other are solitary. Many of them feed openly upon the foliage, while some draw leaves together and in that manner protect themselves to a certain extent from enemies. When mature, the devices adopted by lepidopterous larvæ preparatory to pupating are also variable. Some spin cocoons of silk, some enter the earth and construct neat cells for themselves, and still others make the change in the open air without any protection whatsoever.

In the selection of food-plants for their larvæ the parent insects also exhibit various degrees of intelligence. Some butterflies select their host plants unerringly, and in doing this the future life of their progeny is assured, so far at least as their food supply is concerned. Others drop their eggs upon the ground and trust to the larvæ for finding their food.

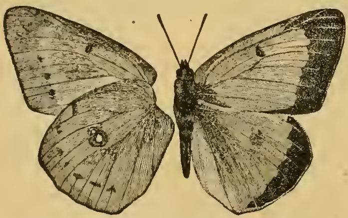


FIG. 161.—*Colias eurytheme*, male, both surfaces.—[After Scudder.]

FIG. 162.—*Colias eurytheme*, female.—[After Scudder.]

The Lepidoptera probably suffer from the attacks of parasites more than any other group of insects. They are attacked both in the egg state and as larvæ by a host of Hymenoptera, and as larvæ by Diptera. For this reason these insects seldom become excessively numerous. One or two exceptions are the plagues of "army-worms" and "web-worms."

FIG. 163.—*Anthocharis genutia*.—[After Scudder.]

FIG. 164.—*Hesperia montivaga*.—[After Scudder.]

RHOPALOCERA.—(*Butterflies.*)

The "Butterflies" or day-flying Lepidoptera can be readily distinguished from the "Moths" or night-fliers by several well-marked characteristics where typical forms from each group are selected for the purpose. When this is true the butterfly is an insect with knobbed antennæ, rather small and smooth abdomen, and that folds its wings with their upper faces touching above the body. They are principally diurnal in their movements and frequenters of flowers which they visit for nectar.

Fig. 165.—*Epargyreus tityrus*.—[After Scudder.]

The division is separated into a number of families, and the United States and that portion of America north of us contains about 650 described species.

The family NYMPHALIDÆ contains a number of our well-known butterflies and is well represented by the insect shown herewith in Fig. 154. It is known as *Euptoieta claudia* to the entomologist. Both surfaces of the wings are shown in the illustration. The detached wings represent the under side. Another member of the family, along with its larva and chrysalis, is shown in Figs. 155 and 156. This last species is occasionally quite numerous, at which times it becomes destructive to the foliage of the willows and elms. Still another representative of the family is the one known as the "Hackberry Butterfly." It is shown in Fig. 157. These butterflies have been described more fully in several of my former reports to the Horticultural and Agricultural societies.

The family LYCÆNIDÆ is made up of rather small butterflies that are somewhat varied in their appearance. The one figured at 158 will, however, give the reader a general idea as to their identity. It is called *Thecla calanus*. The larvæ of this family of butterflies are usually brightly colored and slug-like in form. Their food-habits are also quite variable. The little blue butterflies belong here.

The family of butterflies known as PAPILIONIDÆ contains a number of

Fig. 166.—Larva of *P. turnus*.—[After Saunders.]

Fig. 167.—Pupa or chrysalis of *P. turnus*.— [After Glover.]

familiar forms in this country. The various kinds of "cabbage-worms" (*Pieris*), the sulphur-yellow butterflies and the swallow-tails are classed here. Some of the forms are shown in the illustrations numbered 159 to 163. The Rape Butterfly (*Pieris rapæ*), which is one of our most destructive cabbage pests, is shown as larva and chrysalis at Fig. 159, and as imago in Fig. 160. The Sulphur-yellow butterflies so common about clover fields and upon the prairies, are very well represented by the species which is figured in 161 and 162. The larvæ of these butterflies belonging to the genus *Colias* feed on leguminous plants, which they sometimes greatly injure. Still another of these butterflies is shown in

FIG. 168.—*Papilio turnus.*—[After Saunders.]

Fig. 163. This last mentioned is known as *Anthocharis genutia*, one of our early spring forms, that occurs along the Missouri river bluffs in the timbered portion of the state. Its larvæ feed on various kinds of peppergrass and other Cruciferæ. The swallow-tails that are generally placed in the genus *Papilio* are rather common insects in most parts of the state. The one shown herewith (Fig. 168) is our commonest species and has been described several times in former reports and in bulletins from the Experiment Station. Its larva feeds upon a number of our trees. Other species are fond of the various umbelliferæ, hence their striped caterpillars can often be found on parsnips, carrots, and allied garden plants.

The "Skipper butterflies" (family HESPERIDÆ) are well represented by the two illustrations numbered 164 and 165. The former of these is *Hesperia montivaga*, the common gray and white skipper; and the latter the Tityrus Skipper (*Epargyreus tityrus*). The larva of the first feeds on hollyhock and other plants belonging to the Mallow family; that of the latter chooses the foliage of various locust trees and their allies for food. Most of the "skippers," however, are grass feeders in their caterpillar state.

HETEROCERA.—(*Moths.*)

The moths or night fliers among Lepidoptera are separated from butterflies by a number of characters. Some of these are the thread-like, feathered, and other shaped antennæ that end in a point instead of a knob; the hairy bodies, etc. A good type of the group, and one that can most readily be obtained, is the Cecropia Silk-worm Moth (*Attacus cecro-*

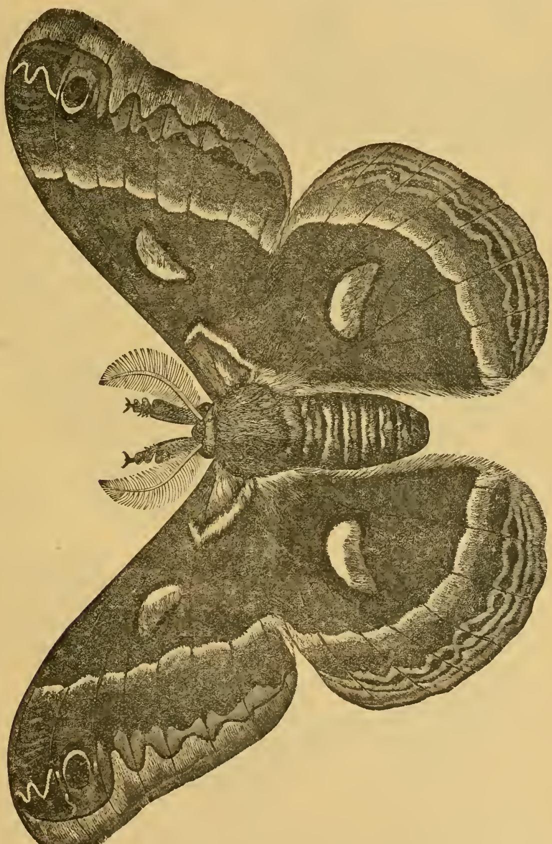


FIG. 169.—*Attacus cecropia*, male moth.—[After Riley.]

pia) which is shown natural size in Fig. 169. It is a member of the family SATURNIIDÆ, one of the group of silk-spinning Lepidoptera. Its larva is the very large, rough green "worm" that is so often met with upon Maple and Boxelder trees. The cocoon of an allied species in which the larva

FIG. 170.—Cocoon of American Silk-worm.—[After Riley.]

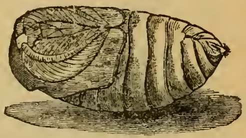


FIG. 171.—Chrysalis of American Silk-worm.—[After Riley.]

changes to the chrysalis and remains during winter is figured at 170, while the chrysalis of the same species is shown in the illustration numbered 171.

The large "hawk-moths" that are the parents of "tobacco-worms" belong to the family SPHINGIDÆ. These insects can at once be recognized by referring to the accompanying figure (Fig. 172) in which the larva and

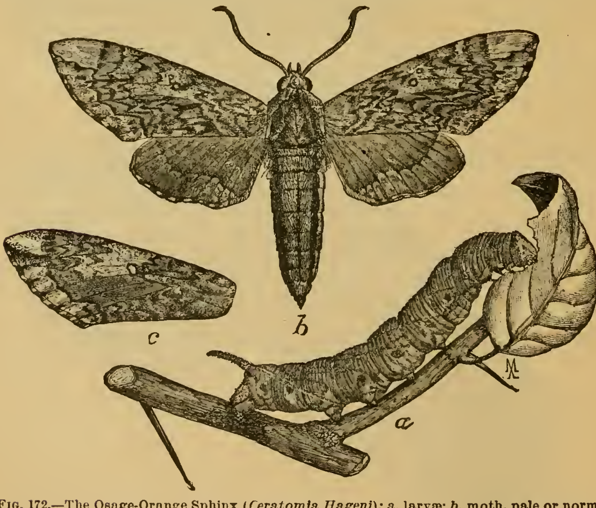


FIG. 172.—The Osage-Orange Sphinx (*Ceratomia Hageni*): *a*, larvæ; *b*, moth, pale or normal form; *c*, front wing of dark variety, natural size.- [After Riley.]

imago of one of our common species is illustrated. There are upwards of seventy distinct species of this family found in America north of the Mexican boundary. Some of the species are very destructive to the plants upon which they feed, and hence are to be classed among the injurious insects of the country.

The moths that belong to the family SESIIDÆ are very beautiful objects, and may readily be mistaken by the untrained individual for wasps or

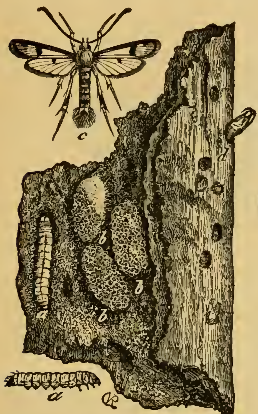


FIG. 173.—The Sixteen-legged Maple Borer (*Ægeria acerni*): *a*, larva; *b*, cocoon; *c*, male moth; *d*, pupa case —natural size.—[After Riley.]

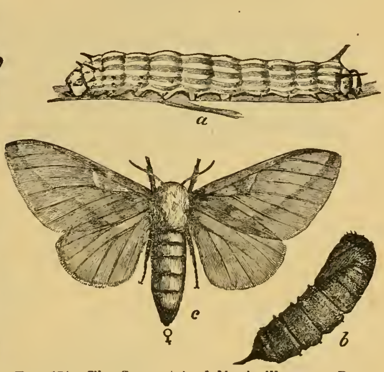


FIG. 174.—The Green-striped Maple Worm, or Rosy Forest Caterpillar (*Anisota rubicunda*): *a*, larva; *b*, pupa; *c*, female moth, all natural size—[After Riley].

bees on account of their bright colors and clear wings. The larvæ of all of them are borers in the stems of plants. Some of them being confined

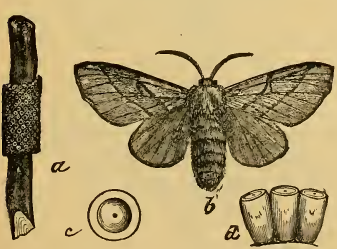


FIG. 175.—The Forest Tent-caterpillar: *a*, eggs; *b*, female moth; *c*, magnified upper view of egg; *d*, same, side view.—[After Riley.]

FIG. 176.—Larva of Forest Tent-caterpillar.—[After Saunders.]

in their attacks to herbaceous, while others work in the hardest of wood. One of these latter (the Sixteen-legged Maple Borer) is shown in Fig. 173. The squash and peach-tree borers belong in this family.

The family known as ARCTIIDÆ is represented in this state by a number of species. The larvæ of these insects are more or less hairy and the moths are rather compact, and well covered by tufts of hair. They are

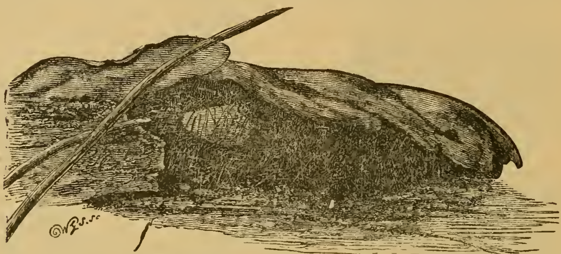


FIG. 177.—Cocoon of Forest Tent-caterpillar.—[After Saunders.]

rather prettily colored as moths and caterpillars, and are very general feeders. The Isabella Moth is figured along with its larva and pupa in the illustration numbered 185.

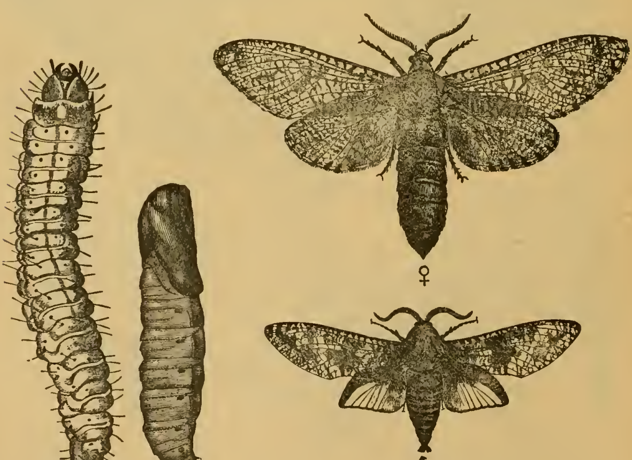


FIG. 178.—*Prionyxtus robiniæ:* larva, chrysalis, pupa, imago—male and female.—[After Riley.]

We have in this country several species of moths that belong to a family called BOMBYCIDÆ by the entomologists. The caterpillars of these insects are well represented by the species known as the Forest Tent Caterpillar (*Clisiocampa distria*) which is shown in figures 175, 176, and 177. These tent caterpillars are very destructive to the foliage of trees when ever they appear in large numbers. Some species are social, and spin unsightly webs in the forks of the trees which they infest.

In the illustration numbered 178 is shown one of the most destructive of all our moths. It is known as the Locust Carpenter Moth (family COSSIDÆ), although it is by no means confined to this one tree in its injuries. It also attacks numerous other trees, the trunks and larger branches of which it bores full of large holes that greatly weaken them. A single borer ofter kills a large tree in the course of its life. These borers are at least three years in attaining their growth. A reasonably full account of this insect's life-history has been given in the fifth report of the United States Entomological Commission.

The family of "Owlet Moths" (NOCTUIDÆ) is a very extensive one in this country. It can be represented by one of our "cut-worms" that are so destructive that they have not escaped the vigilance of any of us even though we live in cities and towns instead of the country. Many of them have been mentioned from time to time in the various reports of the Experiment Station and the state societies. One of them is illustrated herewith (see Fig. 179). The Army-worm and allies also are representatives of the family.

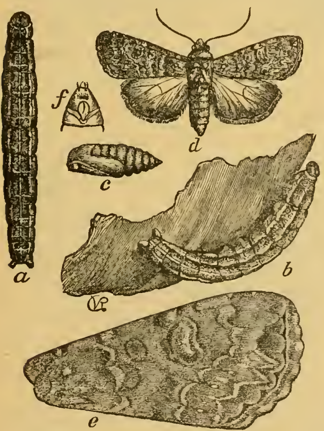


FIG. 179.—*Mamestra chenopodii: a, b*, larva; *c*, pupa; *d*, moth; *e*, wing of same—enlarged. —[After Riley.]

The family GEOMETRIDÆ contains certain moths, the larvæ of which are known popularly as "measuring-worms," on account of their peculiar looping locomotion. The Canker-worms and Span-worms are also typical examples of the group.

The TORTRICIDÆ or "leaf-rollers" is also quite a large family of moths that is of considerable economic importance here in the state as well as elsewhere. The TINEIDÆ and PYRALIDÆ should also be represented in a work of this kind; but I have already taken up too much of the space allotted to me for this paper.

ORDER XV. HYMENOPTERA.—(*Bees, Wasps, Ants, Parasites and Saw-flies.*)

The insects which comprise this order can be distinguished at once from all others by their four membranous wings which are furnished with comparatively few veins; their well developed mouth-parts, their hard, compact bodies, and their sharp stings and ovipositors. The order, as a whole, is one of great interest both to the systematist and to the economic entomologist, and should be given much more attention than it is possible to give it here. The seeming intelligence exhibited by many of its members in their life-habits might be made the theme for an extended paper alone; while the great variation in structure that is to be observed among the forms found even in the species of a single family could be made to supply very interesting reading. While the order contains a vast number of species that are of moderately large size, and which are more or less familiar to most of us, by far the greater proportion of these insects are very small and are known only to a few specialists even among entomologists.

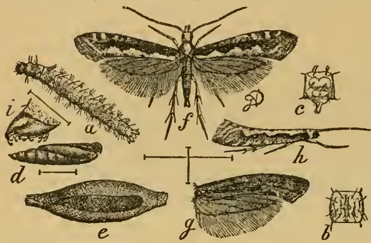


FIG. 180.—*Plutella cruciferarum: a*, larva; *d*. pupa; *e*, cocoon; *f*, imago—all enlarged.—[After Riley.]

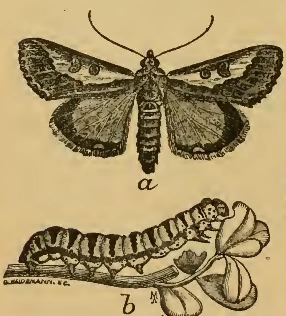


FIG. 181.—*Copidryas gloveri: a*, moth; *b*, larva.—[Geo. Marx.]

FIG. 182.—*Lagoa opercularis* and cocoon.—[After Hubbard.]

The order Hymenoptera is divided naturally into two sections, viz., TEREBRANTIA and ACULEATA. The members of the former group are distinguished by "having the abdomens of the females furnished with an instrument employed as a saw or borer for depositing the eggs." Those of the latter by "having the abdomen of the females (and workers) armed with a sting connected with a poison reservoir, the antennæ of the males thirteen-jointed, and of the females twelve-jointed."—(Cresson.)

The family TENTHREDINIDÆ or "saw-flies" comprises a rather extensive group of leaf-feeding Hymenoptera, the larvæ of which are provided with legs and resemble more or less closely some of the caterpillars of the Lepidoptera. Cresson says "The anterior tibiæ have two apical spurs,

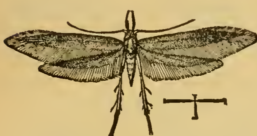


FIG. 183.—Scale-eating Tineid.—[After Hubbard.]

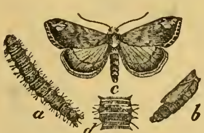


FIG. 184.—*Pionea rimosellis*: *a*, larva; *b*, pupa; *c*, moth.—[After Riley.]

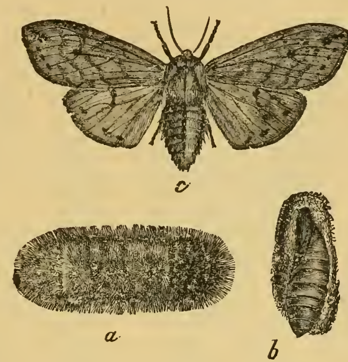


FIG. 185.—*Arctia isabella*; *a*, larva; *b*, pupa; *c*, female moth.—[After Riley.]

and the ovipositor consists of two compressed saw-like plates applied against each other, and inclosed in a pair of outer sheaths. In the larva state these insects are the most injurious of all hymenoptera, feeding upon the leaves of trees and various plants and often completely destroying the foilage." The large Willow Saw-fly which is shown in Fig. 186 in its various stages is one of our most common and injurious species in the state. This insect reminds one not a little of a bumble-bee in its general appearance. In Fig. 187 is shown a second, but much smaller, species of saw-fly. This last insect is an enemy to the black locust tree, and is known to the entomologist as *Nematus similaris*, Norton.

As a remedy against these pests I would recommend the arsenites, London purple and Paris green, sprayed upon the foilage as directed for leaf-feeding caterpillars, beetles, etc.

The family UROCERIDÆ includes several species of saw-flies usually known as "horn-tails" that are well represented by the "Pigeon Tremex" figured herewith. (See Fig. 188). These insects differ from the "leaf-eating" species (PHYLLOPHAGA) by having the front tibiæ provided with but a single instead of two apical spurs, and having the ovipositor fitted for boring into solid wood. Although the larvæ of these "horn-tails" work in and do much harm to wood they seldom attack healthy trees, but rather select sickly or dead timber in which to deposit their eggs. They are usually kept in check by several species of parasites with exceedingly long ovipositors belonging to the family ICHNEUMONIDÆ mentioned on a succeeding page.

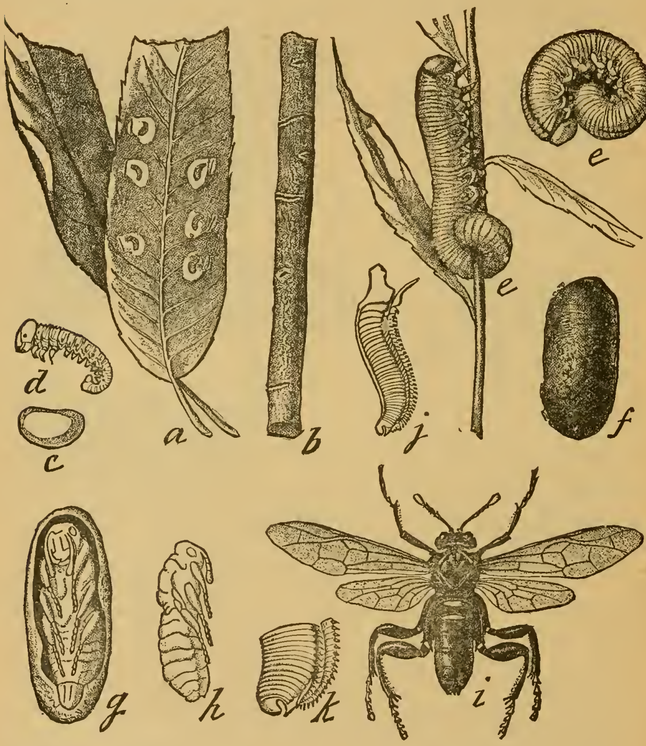


FIG. 186.—The Large Willow Saw-fly (*Cimbex americana*): *a*, willow leaves showing egg-blisters from above and below; *b*, twig showing girdlings; *c*, egg; *d*, newly hatched larva; *e*, *e*, full-grown larvæ; *f*, cocoon; *g*, cocoon cut open, with pupa; *h*, pupa, side view; *i*, male fly; *j*, saw of female detached, side view; *k*, tip of do.; *c*, *d*, *j*, *k*, enlarged, the rest natural size.—[After Riley.]

The "Gall flies" belonging to the family CYNIPIDÆ, are all rather small sized insects that can be described as creatures which sting and cause unnatural growths or galls to form upon different plants in which their larvæ live. The family is rather an extensive one and contains a large variety of forms, some of which are wingless. A few species are "dimorphic," *i. e.*, they occur in two forms. The accompanying illustrations (Fig. 189 and 190) will give the reader a fair idea as to the apearance of these insects and their galls. A study of the galls and their occupants belonging to this family is an interesting one. Each species of the flies produces its own charasteristic gall. The various kinds of oak seem to be most subject to their attacks; but a number of other plants are also chosen as host plants by some of the representatives of the family. The roses are among the plants that are most molested by them.

FIG. 187.—Locust Saw-fly: *a*, eggs; *b*, *c*, worms; *d*, tail of the same; *e*, cocoon; *f*, fly.—[After Comstock.]

These insects are best controlled by gathering and destroying the galls. They are also kept in check by representatives of the families CHALCIDIDÆ and PROCTOTRYPIDÆ mentioned beyond.

The very extensive family ICHNEUMONIDÆ of parasites is one of great importance since the larvæ of these insects live within the bodies of caterpillars and other larvæ which they destroy. A couple of them are illustrated herewith. (See Figs. 191 and 192.)

The family BRACONIDÆ is another group of these parasitic Hymenoptera which is of especial interest to us on account of the great amount of good which its representatives do towards keeping down the insect plagues of the country. The members of the present family are, as a rule, much smaller than those belonging to the previous one; and very frequently a number of individuals of a species are reared from a single host insect. One of these parasites is shown along with its cocoon in Fig. 196, while in Fig. 195 is represented a caterpillar that has been killed by the larvæ of *Rhogas intermedius*, one of these parasites, and from which the winged or perfect insects have issued through round holes which they first made in the skin of their host.

In Figs. 197 and 198 are shown two species belonging to the very extensive family of parasites known as CHALCIDIDÆ. These insects are generally very small and many of them are brilliantly metallic in their colors. The larger of the two, the Mary Chalcis fly, is a parasite of several of the large silk-worm moths, and the other a parasite of the Grain Aphis. Some of these Chalcid parasites are enemies of other parasites, and others destroy the gall-makers belonging to the family Cynipidæ. Cresson says of the Chalcididæ, "The antennæ are exceedingly variable

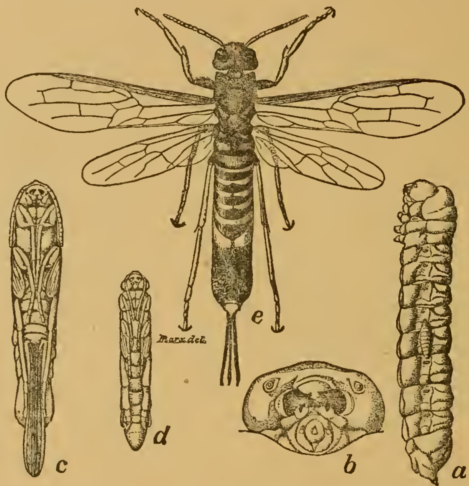


FIG. 188.—*Tremex columba: a*, mature larva; *c*, female pupa; *d*, male pupa; *e*, female imago.—[After Insect Life.]

in form in this family, and are often curiously developed in the males of some genera, being sometimes short and clubbed, or the joints nodose and ciliated with long hairs; sometimes they are beautifully branched, the number of joints varying from six to fourteen. The posterior femora are sometimes enormously swollen and toothed beneath, and in some genera the intermediate legs are very long and saltatorial, the tibial spurs being unusually developed; the tarsi although generally five-jointed, have sometimes only three or four joints. The abdomen is of varied shape, both in the different species and in the sexes of the same species; sometimes it is petiolate, but usually sessile or subsessile, or rather connected to the thorax by a very short narrowed portion of its base; the ovipositor is generally concealed, although occasionally it is exserted and longer than the body."

A second very extensive family of these minute parasitic Hymenoptera is that known as PROCTOTRYPIDÆ. It has been recently monographed for this country by William H. Ashmead, who has made a special study of these interesting minute creatures.

Passing to the Hymenoptera Aculeata we will now take up only a few examples from among the many that are classed here by entomologists. Being larger on an average than the representatives of the Terebrantia, they are more familiar to us.

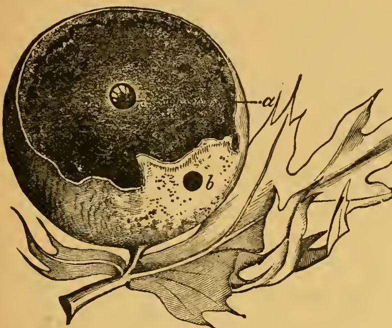


FIG. 189.—"Oak Apple," or gall of *Cynips quercus spongifica: a*, larva; *b*, exit of imago.—[After Riley.]

At the very beginning of this subdivision of the order are placed several families the representatives of which are popularly termed ants. These ants "are known by their habit of residing in more or less numerous societies under ground, whence arises the necessity for a great number of individuals (workers or neuters) having the sexual organs and instincts rendered abortive, whereby, being freed from the latter, they are the better fitted to perform the labors of the community, for which purpose they are moreover destitute of wings; whilest the males and females are much less numerous, possessing wings, and are produced only for the propagation of their species."—(Westwood.) Besides the workers, some species also have warriors and other special forms for the performance of certain duties belonging to the economy of the colony that could not so well be attended to by the workers alone. These ants have been studied by many special students, and the wonderful stories that have been published regarding their life-histories and habits would fill many large volumes. The "leaf-cutting" and "agricultural" ants of tropical and sub-tropical countries are objects of great interest to the naturalist; but we need not go beyond our own state to learn much of interest that pertains to some kinds of these insects. We can study the little brown ant (see Fig. 199), the "mound-building" ant, and other species, each of which will give us many surprises during the year. The slave-making habit is common among ants, while several species keep "cows" which they milk. These cows are various species of plant-lice which they often hold captive within their nests where they provide them with the proper food. Like their allies, ants are also very fond of sweets, and conse-

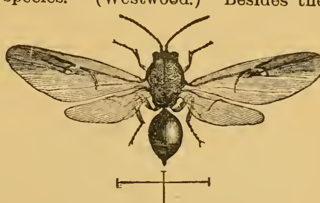


FIG. 190.—*Cynips q. prunus.*—[After Riley.]

quently many of them are always to be found frequenting plants infested with aphids, where they feed upon the "honey-dew" produced by the latter. Several examples of forethought as exhibited by insects are to be found among ants here in Nebraska. The Corn-root Louse (*Aphis*

FIG. 191.—The Long-tailed Ophion (*Ophion macrurum*).—[After Riley.]

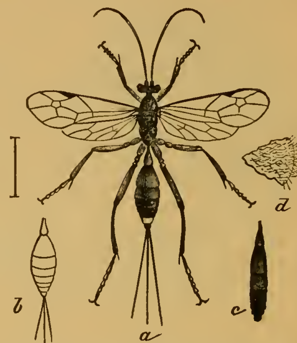


FIG. 192.—The Cecropia Cryptus (*Cryptus nuncius; a*, female fly; *b*, abdomen of *C. samiæ*, c, male abdomen.—[After Riley.]

maidi-radicis) lays its eggs about the roots of corn-stalks of the year. These eggs are gathered by a common small brown ant and stored away for the winter. The following spring, after special galleries have been

FIG. 193.—Larva of the Long-tailed Ophion.—[After Riley.]

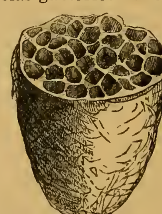


FIG. 194.—Transverse section of Cecropia cocoon, showing cocoons of the Cryptus fly.—[After Riley.]

dug near the surface of the ground, these eggs are taken from the recesses of the nests and placed in these galleries to hatch. Should cold, wet weather intervene the eggs are carried back until warm weather returns, when they are replaced. After hatching the young lice are placed by the ants upon the roots of various weeds, and finally upon the young corn. In return for this care on the part of the ants, they are repaid with a bountiful supply of honey-dew by their proteges.

Following the several families of true ants we have certain bright-colored, hairy, wingless, ant-like wasps which belong to the family Mutillidæ. These are provided with exceedingly long stings, and the males

Fig. 195.—Acronycta larva killed by *Rhogas intermedius*.—[Original].

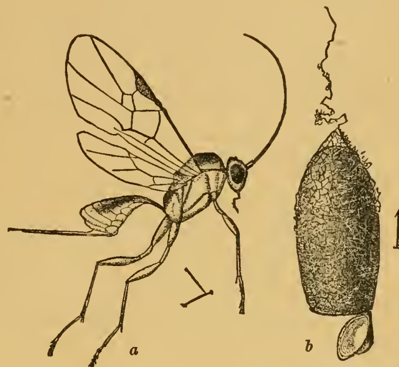


Fig. 196.—The Meteorus Parasite (*Meteorus hyphantriæ*): *a*, adult fly; *b*, cocoon—enlarged.—[After Riley.]

alone are winged. They are not "social" in their habits, so far as known; and at least some of the species belonging to the genus *Mutilla* are parasitic on the different species of bumble-bees, while it is to be presumed that other genera of the family possess like habits.

The insect known as the White-grub Parasite (*Tiphia inornata*, Say) which is illustrated in Fig. 200, belongs to the family of wasps called Scoliidæ by entomologists. The female wasp finds a grub and lays an egg upon it. This egg hatches and the larva at first feeds externally, where it hangs fast by means of strong hooks with which it is provided. Finally it kills the grub, matures, and spins for itself a cocoon, and the following spring issues as an imago.

Fig. 197.—The Mary Chalcis fly (*Chalcis mariæ*) female.—[After Riley].

The many species of black, blue, and other unattractively colored wasps belonging to the family Pompilidæ are also parasitic in a certain measure. These insects burrow in sandy soil and provision their nests with spiders and the larvæ of various insects, which they first paralyze by stinging them. The different species of the family resemble one another very closely, and, therefore, are rather difficult to determine save by the specialist.

FIG. 198.—*Pachyneuron micans*, enlarged.—[After Howard.]

The members of the family SPHECIDÆ have similar habits with the preceding, and can be recognized by having the basal segment of the abdomen usually narrowed "into a long, smooth, round petiole, and the head and thorax usually clothed with long, thin pubescence." Several additional families of "digger" wasps occur within the region, and possess similar habits with the above. All of these occur only as males and females, while the true wasps sometimes are social and occur as males, females, and workers, like the social ants, bees, and termites.

FIG. 199.—The Little Red Ant (*Monomorium pharaonis*): *a*, female; *b*, worker.—[After Riley.]

The true wasps are usually bright colored insects, and can at once be distinguished from those of the preceding families by having their wings folded longitudinally. Some of these insects are known popularly as "yellow-jackets," "paper-wasps," and "hornets." Some of the solitary species make "their nests in sandy banks, in the crevices of stone walls, in holes bored by other insects in wood, etc., using their powerful mandibles in excavating" since their legs are not constructed for burrowing. Some genera make "mud nests, in the open air, on stems of weeds, or under leaves, or loose bark of trees." The social wasps are paper makers and construct their nests of wood fibres which they scrape off and manufacture into a delicate grayish paper. These nests are familiar objects to most every one of us. The "Bald-faced Hornet" (*Vespa maculata*) builds large globular nests on trees and bushes. The different species of *Polistes* make comb-like structures which they attach to the eaves and gables of buildings, old fences, stone walls, etc. The food-habits of the paper-wasps are not so well known as are those of the digging wasps, perhaps for the reason of their agressive natures; but it is supposed that they are predaceous rather than otherwise, capturing and devouring flies and other soft-bodied insects. They are also exceedingly fond of meats of all kinds. Wasps sometimes frequent blossoms where they feed upon nectar; and they also have a decided fondness for honey-dew, and hence can be taken where plant-lice abound.

Passing to the ANTHOPHILA or group of the Hymenoptera known as "bees," we find a very large number of species that are of great benefit to the horticulturist, since it is chiefly through their agencies that most fruit blossoms are fertilized. Bees are the marriage priests for the flowering portion of the plant kingdom. They are readily separated from other Hymenoptera by having the basal joint of the hind tarsi more or less dilated, flattened, generally hirsute and furnished with an apparatus for collecting and conveying pollen. A few of the parasitic species, however, lack this last named characteristic. The group is separated into two families, viz., the ANDRENIDÆ and APIDÆ, the members of which are distinguished from each other by differences chiefly in their mouth structure. All of the first family are solitary, while some of the second family are social in their habit, as for example, bumble-bees and the honey-bee. Much of interest might be written about these insects; but no attempt will be made to treat of special forms in the present paper.

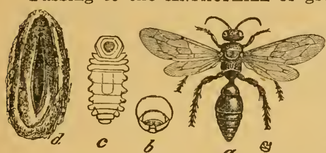


FIG. 200.—White Grub Parasite: *a*, imago; *b*, head of larva; *c*, larva; *d*, cocoon.—[After Riley.]

FIG. 201.—Honey bee: drone, queen, and worker—drone enlarged.

ORDER XVI. DIPTERA.—(*Two-winged Insects.*)

The flies or two-winged insects appear to be most widely removed from the original Thysanuran type of all orders; and hence the order DIPTERA has been placed at the very head of the class Insecta by at least a few of our most recent writers on systematic entomology. This decision has been reached only after some very careful research on the part of these writers; and it is on this authority that this arrangement has been adopted. Hyatt and Arms, whom we have already quoted several times, maintain that modifications in any direction from the normal types is an indication of advance in the scale of development. In the present order we find more examples of such specialization than in any of the orders previously treated. I quote the following from their book "Insecta":

"The young of even the generalized forms of Diptera are, as a whole, farther removed from the Thysanuriform type than those of any other group. The secondary larval form, which in the case of the Diptera is always footless and often an almost headless maggot, has complete possession of the younger stages. As Friedrich Brauer has pointed out, the general absence in the larvæ of Diptera of the thoracic legs, even although living in situations that seem to demand their development, shows that they must have inherited this peculiarity from an ancestral form whose larva had lost them. This comparative inflexibility of the larval stage is sufficient of itself to show that there is now a wide gap between the existing Diptera and all other insects, and that this chasm is not closed by the resemblances of the parts in the adult to those of the Lepidoptera or isolated forms in other orders."

"There is in this order also marks of extreme specialization in the mouth parts of the adult, which are, as a rule, modified for the office of sucking. The abdomen has not the flexibility of the pedunculated abdomen of the Hymenoptera Aculeata, no stinging apparatus present, but is, nevertheless, narrowly pedunculated in some forms. The aspect of the highly complicated and concentrated thorax accompanies the reduction of the wings to one functional pair. This last characteristic and the tendency to reduce the useless pair of wings is carried to an extreme throughout this order, and can thus be compared as a whole with such isolated specialized types in other orders as the *Coccidæ* among the Hemiptera, and the *Stylopidæ* among Coleoptera."

The common house-fly can be taken as the type for the order. Its eggs are laid in the manure of stables and barn yards, and in about twenty-four hours hatch to legless maggots that attain their growth in a week or even less. When full-grown the larval skin contracts and hardens, at the same time separating from and serving as a protection for the pupa within. In about a week more the perfect insect issues.

The order Diptera is composed of a large number of families, the members of which vary greatly in habits and appearance. None of them are very large when compared with some of the representatives of the other orders. Only a very few of these families can be mentioned in this little work. Packard has estimated that there are probably as many as 10,000 distinct species of flies in the United States alone.

The family Tipulidæ is composed of rather large, long-legged insects that are variously known as "Crane-flies," "Daddy Long-legs," "Giant mosquitoes," etc. Their larvæ are known as "leather jackets" on account of their tough or leathery skins, and in some parts of the country are considered great pests to clover and grass meadows. They live in the ground and work upon the roots of the different plants which are attacked by them. Some of these insects have been described by me in my report on "Insect Enemies of Small Grains" published in the annual report for 1893.

The members of the mosquito family (CULICIDÆ) are similar in appearance to the crane-flies, only that they are much smaller than the forms of that family with which we are most familiar. In these insects, it is needless to state, the mouth-parts are well developed. The females feed upon the blood of animals and the juices of plants, preferring the former when it can be obtained. The mouth-parts of the mosquito, like those of other Diptera, are very complex. Their eggs are laid in boat-shaped masses that float upon stagnant or standing water and soon hatch into "wiggle-tails" such as so frequently occur in rain barrels. One of these mosquitoes is illustrated in Fig. 203 where the insect is shown as larva, pupa, and imago.

FIG. 202.—Robber-fly. *Erax Bastardii*; *a*, female fly; *b*, pupa.—[After Riley.]

The ASILIDÆ or "Robber-flies" are very well shown by the accompanying illustration of *Erax bastardii* (See Fig. 202). These robber-flies are very voracious creatures, and do much good by capturing and destroying many injurious insects such as locusts, moths, butterflies, etc. Even the larvæ of some of these flies are known to be of value by destroying various ground-inhabiting grubs.

The large flies commonly known as "horse-flies," "deer-flies," and "breeze-flies" belong to the family TABANIDÆ. This is a rather well-defined group composed of species that have a taste for blood. The larvæ of these horse-flies are aquatic in their habits, hence the reason for the greater abundance of flies in the vicinity of ponds, streams, and other bodies of water.

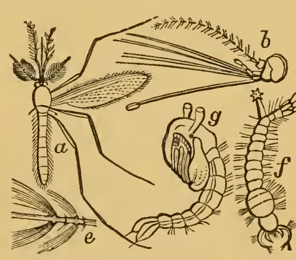


FIG. 203.—A Mosquito (*Culex pipens*); *a* adult male; *b*, head of female; *f*, larva; *g* pupa.—[After Westwood.]

There is a family of rather small, gnat-like flies known as the CECIDOMYIDÆ. These are known as "gall-gnats" because many of them produce galls or swellings upon various plants which they infest. The Hessian-fly is an example of this family, and will give the reader a fair idea of what these insects are like. Each species produces its characteristic gall, inside of which the maggots live and seemingly absorb most of the substance used in their growth.

The family BOMBYLIIDÆ, or as they are commonly known, the "Bee-flies" are quite an interesting group on account of their parasitic habits.

One of these flies is figured herewith which has been bred from cut-worms. Other species are known to feed upon the eggs of different species of locusts or grasshoppers. Several of these latter species are described at length in the Second Annual Report of the United States Entomological Commission. These bee-flies are beautiful creatures and some of

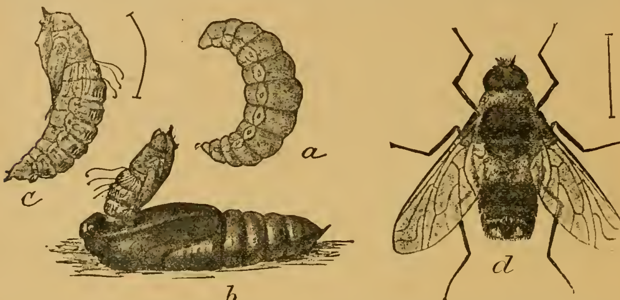


FIG. 204.—A Bee-fly (*Anthrax hypomelas*): *a*, larva from side; *b*, pupal skin protruding from cutworm chrysalis; *c*, pupa; *d*, imago—all enlarged.—[From Insect Life.]

them remind one not a little of the insects from which they have taken their common name. They vary much in general appearance, but most of them bear sufficient resemblance to the one here figured (Fig. 204) to enable any one to decide the family relations at least of any specimen that may come into his or her possession.

The families that have been mentioned thus far are separated from

FIG. 205.—*Mesograpia polita:* *a*, larva; *b*, pupa: c, imago—all enlarged.—[Insect Life.]

other Diptera under the group name ORTHORHAPHA. Those which follow are placed in the group CYCLORHAPHA by systematists. The grounds for this separation are based on the manner in which the several forms be longing to the different families form their pupa cases.

The family SYRPHIDÆ or "Sun-flies" is very extensive. Prof. S. W. Williston, in his synopsis of the family for North America, says of them: "The family of Syrphidæ is one of the most extensive in the order of

Diptera. Nearly or quite two thousand species are known from throughout the world, and many new forms are constantly being added. They contain among them many of the brightest colored flies, and numerous specimens are sure to appear in every general collection of insects. None

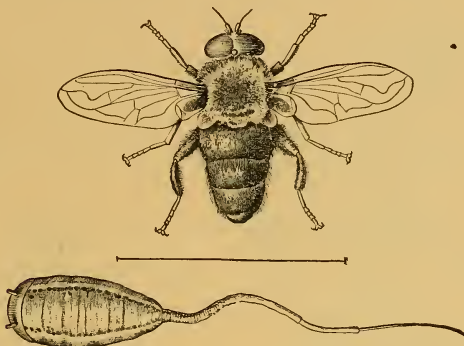


FIG. 206.—*Mallota posticata* and puparia.—[After Lintner].

are injurious in their habits to man's economy, and many of them are very beneficial." The larvæ of these flies are predaceous in their food habits—feeding for the most part on plant-lice of different kinds. A few of them are aquatic in their larval state. One of these is shown in Fig. 206, where it is figured both as imago and larva.

The family ANTHOMYIDÆ, of which the accompanying illustration represents one species, is composed of moderately small flies that bear a general resemblance to the house-fly and some of the flesh-flies that are known to live as parasites within the bodies of other insects. Most of the representatives of this family are known to be vegetable feeders. A few of them are, however, destroyers of locust eggs. The one figured being of this latter class.

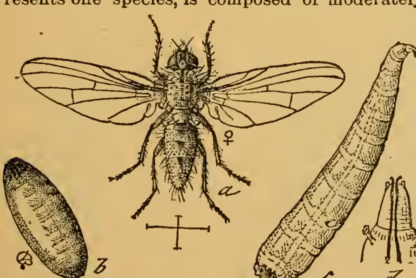


FIG. 207.—*Anthomyia* sp.: *a*, fly, *b*, puparia; *c*, larva; enlarged.—[After Riley.]

The "flesh-flies" belonging to the family TACHINIDÆ is a very extensive group. Most of the species are parasitic within the bodies of other insects. Several of these flies have been figured and described in various of my reports published during former years. A single species is figured herewith (see Fig. 208).

The "bot-flies" (family ŒSTRIDÆ) are among the most interesting of the Diptera, living as they do within the bodies of various mammals and varying their habits to suit each host upon which any one of them is parasitic. The horse bots live in the stomach as larvæ; those of the cattle and allied animals under the skin upon the back; and that of the sheep within the nose cavity. Some species infest the bodies of rabbits, squirrels, and other rodents; and an African species is the enemy of the elephant, and

FIG. 208.—Tachina Fly.—[After Riley.]

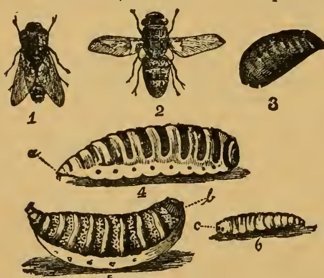


FIG. 209.—*Œstrus ovis;* Sheep Bot.—[After Riley.]

FIG. 210.—*Hypoderma lineatus.*—[After Packard.]

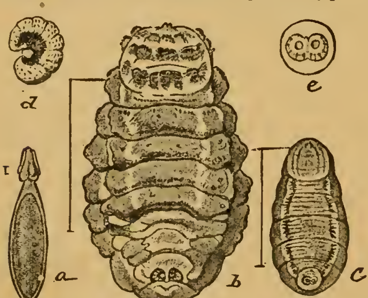


FIG. 211.—*H. lineatus: a.* egg; *b, c,* larva.—[Insect life.]

FIG. 212.—Sheep Tick.

lives within its trunk. Some of these bots are shown in Figs. 209, 210, and 211.

The fleas (Fig. 213) are included among the Diptera by most systematists, but by others are made a separate order, viz., APHANIPTERA. These insects are very peculiar creatures, living as they do upon the blood of various animals. The larvæ feed upon vegetable and other substances. Fleas can be killed by the use of "flea-powder" or pyrethrum. A wash made by diluting the kerosene emulsion will also kill these insects if used upon cats and dogs.

Lastly, we come to a very peculiar group of insects called the PUPIPARA, that is included among the Diptera. These insects are parasitic in their habits and are peculiar on account of their larvæ being retained within

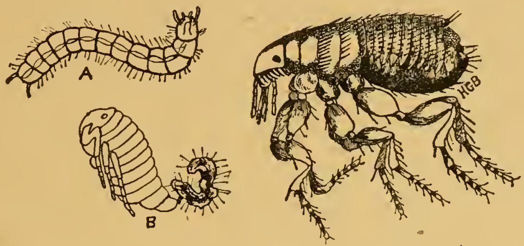


FIG. 213.—Flea: *a*, larva; *b*, pupa.—[After Westwood.]

the bodies of the parent insects until they arrive at the pupa stage, when they are expelled. The group is separated into three families, viz., BRAULINIDÆ, known as "bee-lice," NYCTERIBIDÆ, "bat-ticks," and HIPPOBOSCIDÆ, "sheep-ticks" and "forest-flies." The illustration shown at Fig. 212 is the sheep-tick.

REMEDIES, OR METHODS

THAT CAN BE USED IN
FIGHTING

INJURIOUS INSECTS.

REMEDIES, OR METHODS THAT CAN BE USED IN FIGHTING INJURIOUS INSECTS.

After having learned something about the appearance, life habits, and classification of the insects in the world about us, it naturally follows that we wish also to know something concerning the various methods that can be adopted for getting rid of such of them as prove injurious. The following suggestions are therefore given on this topic, with a hope that they will be of some use to the reader.

A number of remedies have been suggested and tried in the past with varied success by divers persons in different localities. Some of these, while successfully destroying the insects against which they have been or might be used, are not practical on account of the great cost and amount of labor required in their application. Others, again, have been very successfully employed with financial gain, as well as in the destruction of the pests against which used. Here, as elsewhere, we must always aim at profit to the parties interested. A remedy that requires more expense for its application than the value of the article to be protected is no remedy at all. Such remedies should, therefore, be practical, easily applied, effective, and also of comparatively little cost in labor and money. There are a few of such remedies known to us, and these might be termed "standard." These remedies should also be applied in accordance with the nature, methods of attack, and the life-habits of the insects that are to be fought. Unless this be done, much labor and money are liable to be expended uselessly; this, too, even in the use of these "standard" remedies which are described hereafter.

In order to fight an enemy intelligently and at the same time successfully, we must be more or less familiar with its modes of action—with its tactics, as it were. So in attempting to wage war with insects we can do it best if we first learn something of their nature and life-habits. We should study about them in schools, both public and private.

After having carefully studied the life-histories and habits of the different insects that attack our trees, shrubs, herbs, etc., externally, we find that they all belong to either the one or the other of two classes as regards their mode of attack; *i. e.*, they either take their food solidly or else in fluid form. The former devour the foliage, and the latter suck the sap from the leaves and bark of the smaller limbs and twigs. Therefore, in the choice of our remedies we must take these habits into consideration. Those that devour the foliage can be killed by poisons taken into the digestive canal with the food, while such as live upon the juices of the plant only must be reached and destroyed otherwise. The first essential, then, in the selection of a remedy against an insect enemy must be based upon its food-habits—the manner in which its food is taken. Insects also feed openly upon the surface of the plants attacked, or they feed while concealed within the tissues of the leaf, stem, limb, trunk, or root, or while buried beneath the surface of the ground. It stands to reason that the representatives of the former class can be reached more readily than those of the latter. It is also quite evident that the remedies that would effectually combat the one class could not reach those of the other.

SPRAYING.

Chief among the many methods that can be adopted for controlling insect enemies is the application of certain insecticides in the form of fine sprays upon the food-plants attacked. These insecticides that can be thus applied are many, embracing mineral poisons, oils, acids, alkalies, plant decoctions, etc.

How Applied.—The method of applying these insecticides has much to do with their efficacy upon the insects which are intended to be destroyed. It is, therefore, quite as necessary for us to choose the *best* methods of applying the poisons as it is to secure the best and most sure insecticides. A loose, careless application of the very best material will often prove an entire failure, besides a waste of material and time; whereas, if properly applied with a good force-pump in the form of a fine spray the work will be all that could be desired.

Fig. 214.—"Little Gem" spraying pump.

A number of different pumps have been devised and placed upon the market for this purpose. These can be obtained from the manufacturers or through local dealers. For convenience to the reader some forms of these pumps and machines are illustrated herewith in Figs. 214 to 228. Figs. 214 and 215 show a couple of the smaller general-purpose pumps that can be carried about and used for spraying in the garden, flower beds, shrubbery, etc., as well as for window washing and buggy cleaning. The first is manufactured and sold by the Field Force Pump Co., of Lockport, N. Y., and the second by Henion & Hubbell, of Chicago, Ill. In the illustrations numbered 216 and 217 are shown two styles of knapsack sprayers for garden, vineyard, and orchard use. The Gallway sprayer is made and sold by Henion & Hubbell and the Garfield Knapsack Sprayer by the Field Force Pump Co. In the figure numbered 218 one of these knapsack machines is shown in use. For spraying large orchards and high trees pumps of greater power are required. One that comes between the first class and these latter is shown in Fig. 219. It is manufactured by P. C. Lewis, of Catskill, N. Y., who calls it the Combination Spray Pump. Of the more powerful machines for use from wagons the pumps illustrated in Figs. 220 and 221 are good representatives. That shown in Fig. 220 is placed on the market by Henion & Hubbell, of Chicago, under the name of the Improved Spray Pump, while the one represented in Fig. 221 is the production of Gould's Manufacturing Co., of Seneca Falls, N. Y. The use of these pumps in orchard work is well represented in Figs. 222 and 223. Still other spray machines are made and sold for special uses. One of these, the Steitz Potato-bug Sprinkler, made by J. R. Steitz, of Cudahy, Wis., is shown in Fig. 225; and still another sold by the Field Force Pump Co., in Fig. 226.

Fig. 215.—The Victor Force Pump.—Henion & Hubbell, Chicago.

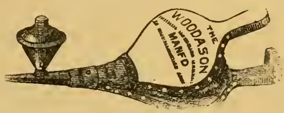


Fig. 228.—The Woodason Powder Bellows.

To the above might be added a number of other pumps for applying insecticides in liquid form, as well as contrivances for the application of powders and gases. To these we could also add machines for capturing and destroying different ones of the pests that belong to the class Insecta.

Fig. 216.—The Galloway Knapsack Sprayer. — Henion & Hubbell, Chicago.

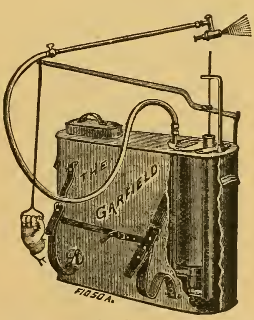


Fig. 217.—The Garfield Knapsack Sprayer.—Field Force Pump Co.

The Arsenites.—Under the name of arsenites we have several very effective insecticides. These are the Paris green and London purple of commerce, and arsenite of lead. The first is an arsenite of copper, and the

FIG. 218.—A Knapsack Sprayer in use.

second an arsenite of lime. The first two are preferable to white arsenic itself for use as insecticides on account of their color, which acts as a sort of a safeguard against accidents, and also from the fact that they are more readily held in suspension in the liquid while being used. The

FIG. 219.—The Combination Spray-pump—P. C. Lewis, Catskill, N. Y.

FIG. 220.—The Improved Spray-pump—Henion & Hubbell, Chicago.

London purple made by Hemingway's London Purple Co., of London, England, is much cheaper than the Paris green and is just as effective in its work on the many insects for which the latter has been recommended and used. It is less liable to adulteration, and its purplish color renders its detection quite easy; and it is also more finely pulverized and hence more readily kept in suspension. The arsenite of lead is a new insecticide of which we know comparatively little in a practical way. Recent experiments at the Hatch Station in Massachusetts, however, tend to show that it is less destructive to foliage than either of the other poisons.

HOW STRONG TO USE.—None of these poisons should be used stronger than one pound to 150 or 200 gallons of water, as arsenic is quite destructive to vegetation if applied stronger than this. Even these mixtures will injure the foliage of some trees and shrubs. These poisons should also be kept quite thoroughly stirred during spraying so as to keep them from settling to the bottom. Nor should the liquid be applied in such quantities as to run off the tree or other vegetation in streams. Merely enough should be used to wet the foliage thoroughly.

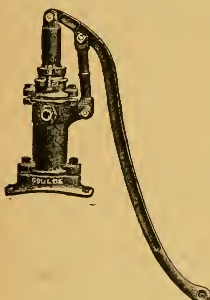


FIG. 221.—Force-pump made for applying insecticides to trees, etc.

TIME TO SPRAY.—The proper time to spray is when the insects to be fought begin to feed, since young larvæ and caterpillars are more susceptible to the action of insecticides than when they are older. Do not, however, spray trees or other plants with either London purple or Paris green while they are in bloom if it can be helped. The blossoms must be visited by bees in order to insure their proper fertilization. Blossoms that have been sprayed with these poisons will kill bees. Besides, the insects that are usually fought in this manner do not begin their attacks until several days after the blossoms have fallen and the young fruit has set. In case of heavy rains falling soon after spraying has been done, it will often be necessary to spray a second time a week or ten days later.

FIG. 222.—Showing use of Spray-pump from wagon.

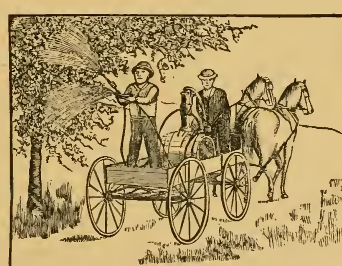


FIG. 223.—Showing use of Force-pump for spraying insecticides from wagon.

Insects That Can be Destroyed with Arsenites.—It might also be of benefit to mention just what kinds of insects can be destroyed by means of these arsenical sprays. All kinds of caterpillars, beetles, saw-flies, and other insects that attack the foliage and external portions of

Fig. 224.—Attachment for underspraying certain garden plants.

the plants with their jaws, and also a few that work in the fruit. Always avoid the use of these poisons upon plants that are to be used as articles of food for man or beast unless the poison is sure to be washed off later by rains.

Kerosene Emulsion.—Next to the "arsenites," as London purple, Paris green, and the arsenite of lead are called, possibly the best insecticide is "kerosene emulsion." This has, perhaps, even more varied uses than they, being, as it is, non-poisonous. It is also about the only practical remedy that we have for fighting the *sucking* insects It kills by contact, instead of entering the digestive canal and circulation as do the poisons. It suffocates the insects by choking up their breathing pores.

Pure kerosene or coal oil would be just as destructive to the vegetation as it is to insect life. It must therefore be diluted with water before using—a rather difficult matter to do, you will say; yet, by going at it in the proper manner this can be done. The following directions, if carefully followed, will give the desired result. It is the formula known as Hubbard's because first used by that gentleman in his experiments with orange insects, and is the one used by the United States Division of Entomology:

Kerosene (the common lamp oil)	2 gallons.
Water	1 gallon.
Common washing soap	½ pound.

Heat the solution of soap, and add it boiling hot to the kerosene. Churn or agitate the mixture by means of a force pump and spray-nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens on cooling, and should adhere without oiliness to the surface of glass. Dilute, before using, one part of the emulsion with nine parts of cold water. The above formula gives three gallons of emulsion and makes, when diluted, thirty gallons of wash.

How Applied.—Professor Cook says: "Many have complained of a lack of success in the use of kerosene emulsion. In such cases I presume the explanation lies in the manner of making the application. We must bear in mind that the lice are well concealed and protected by the thousand leaves from which they are sucking the life and a livlihood. Often the leaves curl up and thus make the protection more sure. But we must strike every louse or insect with the liquid. We cannot, then, turn on or sprinkle the liquid gently, we must dash it on with force, that every insect may be struck; then there will be no complaint of ill success. Thus the kerosene emulsion should always be applied with a good force-pump. It is doubtless better to *throw* all liquid insecticides in

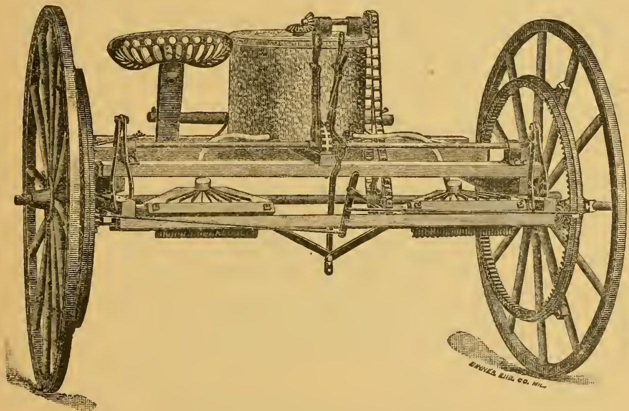


Fig. 225.—Steitz Potato-bug Sprinkler.

spraying for injurious insects; with the kerosene emulsion it is absolutely essential to success. The kerosene emulsion is superior to any other insecticide, so far as I have experimented, in destroying plant lice, scaly bark lice, many of the bugs, and not a few caterpillars, grubs, and slugs."

With the above facts before him the intelligent individual will be able to apply these several insecticides to the destruction of a great variety of injurious insects that attack other plants than the trees growing upon his premises. Of course, bearing in mind that the *poisons should never be* used to destroy insects that work upon vegetables or other articles of food. For these latter he can resort to the kerosene emulsion and also to the

Persian Insect Powder, or Pyrethrum as it is generally called. This last named insecticide is composed of the finely pulverized flower-heads and stems of a composite plant which bears some resmblance to the daisy and is known botanically by the generic name Pyrethrum. Most of the home-made "insect powder" is the product of a California firm, and is put up for the market as "Buhach." It is better to use this Buhach than to buy that of foreign make, for it loses its strength with age. Like the arsenites this may be used as a powder and dusted on the plants, but it is perhaps best to put it in water in the proportion of a heaping tablespoonful to two gallons of water. This insecticide kills by contact and not by being eaten. It is a splendid household article that should be kept on hand for emergencies in the warfare against fleas, flies, lice, bed-bugs, etc. To be kept as fresh as possible, a tight box or bottle is absolutely necessary. For house use a small bellows is essential so that the powder can be forced into the cracks and nooks where the insects take refuge. This insect powder is also a splendid remedy against fleas upon the bodies of pets, as cats and dogs. It is also a good plan for travelers to carry some of the powder along to use in self-protection against vermin of all kinds upon the body as well as in sleeping quarters.

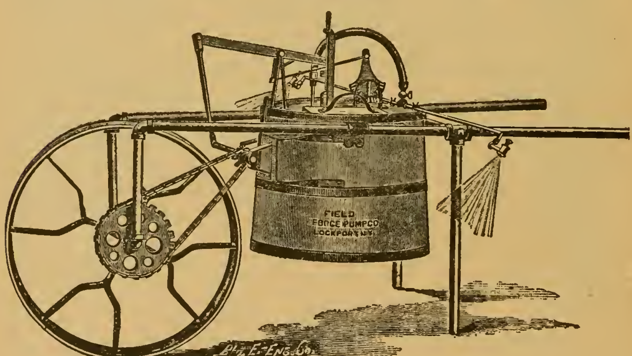


FIG. 226.—The Wheelbarrow Potato Sprayer.

CARBOLIC ACID in the crude form is also sometimes used as an insecticide, and is especially useful in destroying vermin about stables, hen coops, and such like places as long as it is kept out of the food of the animals that are kept there. It soon evaporates and becomes harmless. It is also used in connection with soap as a wash for trunks of trees as a protection against certain scales and borers.—Hard soap. 1 lb.; water, 2 gallons; crude carbolic acid, 1 pt.

BISULPHIDE OF CARBON.—This is a very volatile liquid, the fumes of which are destructive to animal life of all kinds, hence it is of much importance for the destruction of certain kinds of insects that cannot so well be destroyed by any of the other remedies that we know of. It is especially effective when used against insect enemies in stored grains. It is also quite effective in killing ants and other ground-living insects that withdraw from our view below the surface. In killing grain insects the best way to use it is to have the grain in tight bins, then pour the liquid over the top and allow it to penetrate to the bottom. If the grain be covered with a canvass sheet less of the liquid will answer the purpose than if left uncovered. For use in killing ants holes should first be punched into the ground a foot or more and several ounces of the liquid poured into these and the holes afterwards closed. In the use of the bisulphide of carbon it is quite necessary that great precaution be taken to keep it away from fire, for it is very explosive. It is also dangerous to breathe the fumes of it.

White Hellbore.—This is a vegetable poison made from the roots of the Indian Poke or *Veratrum album*, as it is known botanically. It is both an external irritant and an internal poison. It is applied in the same manner as the pyrethrum, and is especially fatal to the slugs of saw-flies.

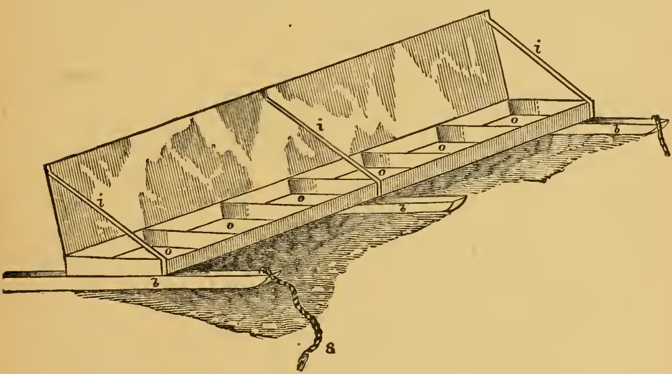


Fig. 227.—Kerosene Pan or "Hopper Dozer," for capturing and destroying locusts and leaf-hoppers.—[After Riley.]

Tobacco.—This is used both as a decoction and as a fumigating material for killing lice upon animals and plants. As a "sheep-dip" it has been in use for a long time. The decoction has also been regularly used for sprinkling house plants for destroying various vermin that at times infest them. For the latter purpose, however, it is best to use it in the form of a smudge.

Soap-suds and Soft-soap.—These are frequently used as insecticides when other kinds are not at hand. Strong soap-suds, if applied to vegetation covered with "green-flies" or plant-lice, will often kill the insects and save any further warfare necessary. Soap in the shape of soft-soap is an excellent tree wash for the protection from flat-head borers.

Hot Water.—Even hot water is sometimes a very excellent remedy against many of these creatures. It can be used for killing the various caterpillars that attack cabbages and like plants. Boiling water can also be used against the box elder bug and other insects when they gather in bunches.

In addition to these "standard" insecticides that we know, there are dozens of patent ones that can be bought in the market. These latter may be good, or they may be worthless. Just which ones are to be relied upon and which are to be avoided I cannot say. Like many other "patent" nostrums, some of them are put up and sold on their merits, while others are put up and sold for the money there is in them temporarily. I find that it is always safest to rely upon such things as we ourselves know to be good; and then we are sure not to be "duped."

Pruning and Hand-picking.—Careful pruning away of injured twigs and limbs that contain insect enemies or their eggs and afterwards burning them will destroy large numbers of destructive insects. Much good can also be done towards keeping down these pests by merely gathering their eggs, crushing their larvæ, picking their cocoons during fall, winter, and early spring; and even by hand-picking the imagoes or perfect insects themselves and destroying them. This includes also catching and destroying them by means of machines, etc., as the "hopper dozers," for catching and killing the various leaf-hoppers, destructive locusts, and other grass insects, torches for killing tent caterpillars, etc.

Agricultural Methods.—In many instances it is possible for us to do a great deal in the way of protecting our crops from the ravages of insect pests by simple agricultural methods without any or but little additional cost. By this I mean plowing, harrowing, rolling, and cultivating the land at particular times or in certain ways so as to disturb the enemy while in some critical condition. Burying deeply the eggs or newly hatched young of some insects by plowing will often save an entire crop. Rolling and crushing will destroy others, while harrowing frequently prevents others from gaining in numbers sufficiently large to do harm. Cleaning hedge rows, fence corners, and ravines by removing the lodged weeds and other *debris* will also aid greatly in keeping these pests within bounds. In other words, *clean farming* is one of the very best remedies against insect increase and consequent loss. Weeds often afford a bountiful food-supply to a certain class of insect pests that when once present in excessive numbers turn their attention to cultivated plants botanically related. For examples of this we need only cite the reader to a list of insect enemies of the sugar beet and potato.

Parasites and Other Natural Enemies.—Most all insect pests are naturally kept within bounds by parasitic and predaceous insects that busy themselves in feeding upon them. They are also subject to diseases of various kinds, as well as to the attacks of birds, reptiles, and small mammals. By encouraging and aiding these natural checks to the increase of insect pests, we can do much towards keeping them within bounds. We can also often introduce from distant regions parasites that by themselves may soon do the good work.

PROTECT THE BIRDS.—Of all things to be urged towards this end, that of protecting our song birds is of the utmost importance. Do not allow boys with guns to stalk abroad in the land shooting everything in the shape of a bird that comes in sight. Out of the 400 or more species of birds that visit our state during the year but two or three are to be classed as nuisances. They all, perhaps with these exceptions, many times repay us for the few grains of wheat, corn, and other cereals which they may eat, by destroying insects and the seeds of noxious weeds.

MECHANICAL MIXTURE OF WATER AND KEROSENE.—An attachment has been designed and perfected by Prof. E. S. Goff, of the Wisconsin station, with which kerosene and water can be mechanically mixed. Experiments that have been conducted at several of the agricultural stations, and especially at the Mississippi station, tend to show that this mechanical mixture of kerosene and water is fully as satisfactory as kerosene emulsion when applied as an insecticide. It has even been claimed that the mixture has an advantage over the emulsion, which is sometimes difficult to make and regulate so as not to injure the foliage of plants upon which applied.

This kerosene attachment has been applied to the "Perfected Galloway" Knapsack Pump, made by the Deming Company, of Salem, Ohio. It is also made by the W. B. Douglas Co., of Middletown, Conn., as an attachment to go with their "Perfection Knapsack Sprayer." Both machines are now in market and sell at the low price of eighteen dollars each, complete. The knapsack pump without the kerosene attachment is $15.

"This attachment can also be used for many purposes other than the mechanical mixture of kerosene and water. In many cases it may be best to dilute fungicides only when applied to the foliage in the act of pumping, and for this purpose it will prove useful."—H. E. WEED.

INSECT ENEMIES

OF THE

APPLE TREE AND ITS FRUIT.

Extracted from the Nebraska State Horticultural Report for 1894.—pp. 154-223.

INTRODUCTION.

In accordance with the expressed desire of the Society to make the present report an "Apple Report," I have prepared my paper upon the insect enemies of this particular tree and its fruit. While the number of species that have been detected feeding upon this tree appears to be very large, the present list is, no doubt, very incomplete, since but a small proportion of the entomological literature of our country has been gone over during its preparation. The compilation of this list is the work of Miss Maysie Ames, a special student of mine, who has been paying some attention to the insect enemies of the apple during the past four or five months. From among the large number of insects thus affecting the apple there have been chosen a number of the most injurious. These latter are described more in detail along with their modes of attack, life-history, and remedies.

It is but just here to acknowledge the liberality of the Society in the way of voting special funds for the purchase of cuts to be used in illustrating this and former reports. In addition to this, I wish also to take the present opportunity for thanking such of my colleagues as Forbes, Lintner, Riley, Osborn, Popenoe, and others for the use of cuts belonging to them.

Very respectfully,

LAWRENCE BRUNER,

Entomologist University of Nebraska.

INSECTS THAT HAVE BEEN FOUND TO FEED UPON THE APPLE TREE.

In presenting this subject for publication, I can do no better than to take Lintner's list, which was published in 1882, as a basis, and adding to it such references as have been recorded since. The introduction to Lintner's list will also apply here, hence "The following are all the United States species (281) that are known to me, or have been reported upon accepted authority, as depredating upon the apple tree. * * * An entire exploration of our entomological literature might add nearly or quite fifty species, and careful observation would unquestionably give us no inconsiderable number which have not yet been recognized as apple insects.

"It is hardly necessary to state that not all the species here recorded are to be included among those injurious to the apple tree, but as each one is known to make it, at times, its food-plant from choice (many others will feed upon it in confinement), the least harmful among them may at any time, through such sudden and inexplicable multiplication as is often witnessed in the insect world, become seriously injurious.

"The authority for including the species in the list is given in each instance." * * *

LEPIDOPTERA.

DIURNALS.

Papilio turnus LINN. *Turnus swallow-tail*, Harris, Ins. Inj. Veg., 268.
Limenitis dissipus GODT. *Dissipus butterfly*, Scudd., Bull. Buff. Soc., II, 250.
Limenitis ursula (FABR.). *Ursula butterfly*, Riley, Amer. Ent., II, 276.
Thecla liparops LE CONTE. *Streaked thecla*, Scudd., Bull. Buff. Soc., III, 111.
Thecla calanus HUEB. *Banded hair streak*, Scudd., Psyche, 1889, 276.

NOCTURNALS.

Deilephila lineata FABR. *White lined sphinx*............Riley, Amer. Ent., I, 206.
Paonias excæcatus (SM. & A.). *Blind-eyed sphinx*............Harris, Ins. Inj. Veg., 327.
Smerinthus geminatus SAY............Beut., Ann. N. Y. Acad., V, 203.
Sphinx drupiferarum (SM. & A.) *Plum sphinx*............Lintner, Proc. E. S. Ph., III, 658.
Sphinx gordius CRAM. *Apple sphinx*............Harris, Ins. Inj. Veg., 328.
Spilosoma virginica (FABR.). *Virginia ermine moth*............Walsh, Pract. Ent., II, 103.
Arctiid sp............Riley, Ins. Life, V, 17.
Hyphantria cunea DRU. *Fall web-worm*....Fitch, N. Y. Rept., III, 19.

Hyphantria sp. ?..................................Riley, Ins. Life, V, 17.
Halesidota caryæ (HARR.). *Hickory tussock-moth*..Fitch, N. Y. Rept., III, 19.
Halesidota maculata (HARR.). *Spotted tussock-moth*......................................Thaxter, *in lit.* to Lintner.
Halesidota sp. ?..................................Riley, Ins. Life, V, 17.
Orgyia leucostigma (SM. & A.). *White-marked tussock-moth*............................Harris, Ins. Inj. Veg., 366.
Parorgyia parallela GR.-RB.....................Coquillett, Ill. Rept., X, 166.
Lagoa opercularis (SM. & A.).....................Walsh, Amer. Ent., II, 29.
Lagoa crispata PACK..............................Beut., Ann. N. Y. Acad., V, 207.
Euclea cippus CRAM...............................Thaxter, *in lit.* to Lintner.
Ocneria dispar LINN. *Gipsy moth*..............Riley, Ins. Life, II, 209.
Porasa chloris HER. SCH. *Green hag-moth*, Riley, Amer. Ent., II, 307.
Empretia stimulea CLEM. *Saddle-back caterpillar*...Riley, Amer. Ent., I, 40.
Phobetron pithecium (SM. & A.). *Hag-moth*..Riley, Amer. Ent., II, 340.
Limacodes scapha HARR. *Skiff limacodes*, Thaxter, *in lit.* to Lintner.
Limacodes flexuosa GRT...........................Beut., Ann. N. Y. Acad., V, 207.
Lithacodes fasciola HER. SCH. *Banded lithacodes*..Thaxter, *in lit.* to Lintner.
Thyridopteryx ephemeræformis (HAW.). *Bag-worm*..Riley, Amer. Ent., II, 38.
Sesia pyri HARR. *Pear-tree borer*............Weed, Ins. Life, IV, 34.
Zeuzera pyrina LINN. *European Leopard-moth*..Clark, T. R., Ins. Life, IV, 77.
Datana ministra (DRURY). *Yellow-necked apple-tree moth*................................Fitch, N. Y. Repts., I–II, 235.
Datana integerrima GR. & R....................Gr. & Rob., Proc. E. S. Ph., VI, 12.
Datana contracta WALK..........................Forbes, Ill. Rept., 1884, 95.
Xyleutus robiniæ PECK. *Locust carpenter moth*..Forbes, Ill. Rept., 1884, 95.
Œdemasia concinna (S. & A.). *Red-humped apple-tree caterpillar*.........................Harris, Ins. Inj. Veg., 425.
Œdemasia eximia GROTE.........................Thaxter, *in lit.* to Lintner.
Cœlodasys unicornis (SM. & A.). *Unicorn prominent*......................................Harris, Ins. Inj. Veg., 424.
Callosamia promethia (LINN.). *Promethia moth*..Minot, Can. Ent., II, 100.
Ptelea polyphemus CRAM. *American silkworm*..Beut., Ann. N. Y. Acad., V, 209.
Attacus cecropia LINN. *Cecropia moth*......Harris, Ins. Inj. Veg., 388.
Callimorpha fulvicosta CLEM..................Riley, Mo. Rept., III, 132.
Hemileuca maia DRU. *Maia moth*............Marten, Ill. Rept., X, 128.
Hypercheria io FABR. *Io emperor moth*.....Saunders, Ins. Inj. Fr., 388.
Clisiocampa disstria HBN. *Forest tent-caterpillar*...Harris, Ins. Inj. Veg., 373.

Clisiocampa americana HARR. *Apple tent-caterpillar*	Harris, Ins. Inj. Veg., 375.
Clisiocampa thoracica STRETCH	Koebele, Bull. U. S. Div. Ent., 23, 42.
Clisiocampa erosa STRETCH	" " "
Clisiocampa sp.	" " "
Clisiocampa sp. ?	Stretch, Papilio, III, 19.
Clisiocampa sp. ?	" " 20.
Gastropacha americana HARR. *American lappet-moth*	Harris, Ins. Inj. Veg., 377.
Tolype vellida (STOLL). *Veleda Lappet-moth*	Harris, Ins. Inj. Veg., 379.
Acronycta occidentalis G. & R.	Lintner, Ent. Contrib., I, 62.
Acronycta morula G. & R.	" " II, 137.
Acronycta luteicoma G. & R.	Thaxter, Papilio, III, 17.
Acronycta radcliffei HARVEY	" " 17.
Acronycta hamamelis GUEN.	" " 17.
Acronycta brumosa GUEN.	Beut., Ann., N. Y. Acad., V, 210.
Acronycta oblinita SM. & A.	" " 211.
Agrotis clandestina HARR. *W-marked cut-worm*	Riley, Mo. Rept., I, 79.
Agrotis messoria HARR. *Dark-sided cut-worm*	Riley, Mo. Rept., I, 74.
Agrotis scandens RILEY. *Climbing cut-worm*	Riley, Mo. Rept., I, 76.
Agrotis saucia (HUEBN.). *Variegated cut-worm*	Riley, Mo. Rept., I, 72.
Agrotis ypsilon ROTT.	Thomas, Ill. Rept., 1880, 134.
Mamestra assimilis MORR.	Thaxter, *in lit.* to Lintner.
Mamestra confusa HUEBN.	Dyar, Ins. Life., III, 63.
Mamestra picta HARR. *Zebra caterpillar*	Coquillett, Ins. Life, V, 287.
Tæniocampa sp.	Koebele, Bull. U. S. Div. Ent., 23, 43.
Laphygma frugiperda GUEN. *Fall army worm*	Riley, Amer. Ent., II, 364.
Chamyris cerintha TR.	Beut., Ann. N. Y Acad., V, 216.
Microgonia limbaria HAW.	" " 220.
Plagodis keutzingaria GRT.	" " 200.
Amphipyra pyramidoides GUEN. *Pyramid grape-vine caterpillar*	Guenee, Noct., III, 398.
Orthosia instabilis SCHIFF. *Unstable drab-moth*	Fitch, N. Y. Rept., III, 25.
Xylina bethunei GR. & R. *Bethune's xylina*	Thaxter, *in lit.* to Lintner.
Xylina antennata WALK. *Ash-gray pinion*,	Riley, Mo. Rept., III, 135.
Nolophana malana (FITCH). *Shoulder-striped tortrix*	Fitch, N. Y. Rept., I–II, 241.
Aletia argillacea HUEBN. *Cotton-worm*	Riley, Amer. Ent., III, 68.
Catocala grynea CRAM.	Coquillett, Ill. Rept., X, 184.
Amphydasis cognitaria HUEBN. *Currant amphydasis*	Lintner, N. Y. Rept., II, 101.

Biston ypsilon FORBES	Forbes, Ill. Rept., XIV, 96.
Semasia sp. ?	Riley, Ins. Life, V, 17.
Heliothis sp. ?	Riley, Ins. Life, V, 18.
Eumacaria brunnearia PACK	Beut., Ann. N. Y. Acad., V, 221.
Boarmia pampinaria GUEN	" " 222.
Boarmia crepuscularia TR	" " 222.
Operophtera boreata HUEBN	" " 222.
Ennomos subsignaria HUEBN. *Snow-white linden-moth*	Dodge, Can. Ent., XIV, 30.
Corycia vestaliata GUEN. *Vestal corycia*	Perkins, G. H., *in lit.* to Lintner.
Hybernia tiliaria HARR. *Lime-tree winter-moth*	Harris, Ins. Inj. Veg., 472.
Phigalia strigataria MINOT. *Banded phigalia*	French, Ill. Rept., VII, 241.
Anisopteryx vernata PECK. *Spring canker-worm*	Harris, Ins. Inj. Veg., 463.
Anisopteryx pometaria HARR. *Autumn canker-worm*	Harris, Ins. Inj. Veg., 463.
Teras minuta ROB. *Apple-leaf tyer*	Le Baron, Ill. Rept., II, 20.
Teras cindrella RILEY. *Green apple-leaf tyer*	Riley, Mo. Rept., IV, 46.
Teras oxycoccana PACK. *Apple-leaf folder*	Riley, Bul. Div. Ent., 31, 15.
Cacœcia rosaceana HARR. *Oblique-banded leaf roller*	Harris, Ins. Inj. Veg., 480.
Cacœcia argyrospila (WALK.)	Riley, Trans. Am. E. Soc., X, 12.
Cacœcia rosana LINN	Beut., Ann. N. Y. Acad., V, 226.
Lophoderus triferana (WALK.)	Murtfeldt, Trans. Am. E. S., X, 15.
Eccopsis malana FERNALD. *Apple bud-worm*	Coquillett, Trans. Am. E. S., X, 72.
Eccopsis permundana (CLEM.). *Neat straw-berry leaf-roller*	Coquillett, Papilio, III, 102.
Tmetocera ocellana (SCHIFF.). *Eye-spotted bud-moth*	Harris, Ins. Inj. Veg., 482.
Grapholitha prunivora (WALSH). *Plum moth*	Riley, Mo. Rept., III, 6.
Phoxopteris nebuculana (CLEM.). *Apple-leaf folder*	Riley, Agr. Rept. for 1878, 239.
Carpocapsa pomonella (LINN.). *Codling moth*	Linnæus, Syst. Nat., X, 538.
Eurycreon rantalis GUEN. *Garden web-worm*	Popenœ, Kas. R. B. A., 1880, 100.
Canarsia hammondi RILEY. *Apple-leaf skeletonizer*	Riley Mo. Rept., IV, 44.
Phycis indigenella (ZELLER). *Leaf-crumpler*	Riley, Mo. Rept., IV, 38.
Anarcia lineatella ZELLER	Beut., Ann. N. Y. Acad., V, 228.
Argyresthia andereggiella F. v. R	" " 228.
Lyonetia saccatella PACK. *Apple lyonetia*	Saunders, Ins. Inj. Fr., 119.

Ypsolophus pomotellus (HARR.). *Palmer worm* ....Fitch, N. Y. Rept., I-II, 221.
Ypsolophus contubernalellus (FITCH). *Comrade plum-worm*....Fitch, N. Y. Rept., I–II, 233.
Ypsolophus malifoliellus (FITCH.) *Striped Palmer-worm*....Fitch, N. Y. Rept., I–II, 231.
Coleophora fletcherella FERNALD....Fernald, Can. Ent., XXIV, 122.
Coleophora malivorella RILEY. *Apple-tree case-bearer*....Riley, Agr. Rept. for 1878, 253.
Lithocolletis pomifoliella ZELL. *Thorn-apple leaf-miner*....Clem., P. A. N. S. Ph., 1860, 208.
Tischeria malifoliella CLEM. *Apple leaf miner*....Clem., P. A. N. S. Ph., 1860, 208.
Aspidisca splendoriferella CLEM. *Resplendent shield-bearer*....Comstock, Agr. R. for 1879, 210.
Ornix geminatella PACK. *Wild-cherry leaf-miner*....Chambers, Can. Ent., V, 50.
Bucculatrix pomifoliella CLEM. *Apple-leaf bucculatrix*....Clem., P. A. N. S. Ph., 1860, 211.
Micropteryx pomivorella PACK. *Apple micropteryx*....Packard, Inj. Ins , etc., 1870, 6.

COLEOPTERA.

Silvanus surinamensis (LINN.). *Grain silvanus*....Glover, Agr. Rept. for 1870, 66.
Tenebrioides corticalis (MELS.)....Hopkins, Bul. W. Va. Exp. Sta., 32, 180.
Tenebrioides nana MELSH. *Dwarf tenebriodes*....Riley, Mo. Rept., III, 6.
Ips fasciatus OLIV. *Banded ips*....Thomas, Ill. Rept., VI, 91
Lucanus dama THUNB. *Stag beetle*....Harris, Ins. Inj. Veg., 45.
Serica iricolor (SAY). *Iridescent serica*....Glover, Agr. Rept. for 1868, 87.
Macrodactylus subspinosus (FABR.). *Rose chafer*....Harris, Ins. Inj. Veg., 36.
Macrodactylus uniformis HORN. *Rose-beetle*, Riley, Ins. Life, II, 115.
Lachnosterna prunina LEC....Townsend, Ins. Life, II, 43.
Lachnosterna fusca (FROHL.). *May beetle*..Glover, Agr. Rept. for 1868, 104.
Lachnosterna micans KNOCH.... " " " 104.
Lachnosterna fraterna (HARRIS). *June beetle*....Harris, Ins. Inj. Veg., 32.
Lachnosterna hirticula (KNOCH). *Hairy May beetle*....Glover, Agr. Rept. for 1868, 88.
Lachnosterna crenulata (FROHL.).... " " " 88.
Lachnosterna tristis (FABR.)....Harris, Ins. Inj. Veg., 33.
Lachnosterna rugosa MELS....Bruner, collected on apple.
Lachnosterna affinis LEC.... " " "
Pelidnota punctata LINN....Bruner, breeding in apple stumps.
Cotalpa lanigera LINN. *Goldsmith beetle*.... " collected on apple.

Anomala marginata FABR. *Margined Anomala*.......................................Riley, Ins. Life, V, 45.
Anomala varians FABR. (*Anomala undulata* Mels.)..Le Baron, Ill. Rept., V, 89.
Macronoxia variolosa (HENTZ.). *Scarred Melolontha*..Harris, Ins. Inj. Veg., 33.
Euphoria melancholica (G.-P.). *Melancholy chafer*..Amer. Entom., II, 61.
Euphoria inda (LINN.). *Indian Cetonia*....Riley, Mo. Rept., III, 6.
Osmoderma eremicola (KNOCH). *Hermit Osmoderma*..Harris, Ins. Inj. Veg., 42.
Osmoderma scabra (BEAUV.). *Rough Osmoderma*...Glover, Agr. Rept. for 1868, 90.
Dicerca divaricata (SAY). *Divaricated Buprestis*...Glover, Agr. Rept. for 1868, 91.
Chrysobothris femorata (FABR.). *Flat-headed apple-tree borer*........................Fitch, N. Y. Rept., I, 25.
Chrysobothris semisculpta LEC.................Blaisdell, Ins. Life, V, 33.
Chrysobothris californica LEC.................. " " 33.
Alaus oculatus (LINN.). *Eyed snapping beetle*...Fitch, N. Y. Rept., III, 11.
Alaus myops (FABR.). *Blind click-beetle*..... " " 12.
Melanotus incertus (LEC.). *Uncertain snapping beetle*..Riley, Mo. Rept.-III, 6.
Melanotus communis (GYLL.). *Common snapping-beetle*..................................Riley, Mo. Rept., III, 6.
Sinoxylon basilare (SAY). *Red-shouldered Sinoxylon*..Riley, Mo. Rept., IV, 54.
Amphicerus bicaudatus (SAY). *Apple-twig borer*...Fitch, N. Y. Rept., III, 12.
Bostrichus bicornis WEB. *Two-horned Bostrichus*..Hopkins, Bul. W. Va. Exp. Sta., 32, 189.
Polycaon confertus LEC...........................Riley, Amer. Nat., XVI, 747.
Prionus laticollis (DRURY). *Broad-necked Prionus*..Amer. Ent., I, 233.
Prionus imbricornis (LINN.). *Tyle-horned Prionus*..Riley, Mo. Rept., III, 6.
Chion garganicus (FABR.)......................Fitch, N. Y. Rept., III, 8.
Chion cinctus (DRURY). *Banded Chion*..... " " 8.
Elaphidion villosum (FABR.). *Apple-tree pruner*...Riley, Amer. Ent., III, 239.
Elaphidion parallelum NEWM. *Parallel Elaphidion*..Riley, Amer. Ent., III, 239.
Neoclytus erythrocephalus FABR..............Hopkins, W. Va. Exp. Sta., 32, 195.
Psenocerus supernotatus (SAY)................Packard, Guide St. Ins., 500.
Leptostylus aculifer (SAY). *Prickly leptostylus*..Fitch, N. Y. Rept., III, 8.
Sternidius alpha (SAY.)..........................Riley, Amer. Ent., III, 270.

Liopus facetus SAY. *Facetious Liopus*......Fitch, N. Y. Rept., IV, 65.
Hyperplatys maculatus HALD..................Riley, Amer. Ent. III, 271.
Eupogonius tomentosus HALD..... ....Smith, Ins. Life, IV, 43.
Oncideres cingulatus (SAY). *Twig-girdler*..Riley, Amer. Ent., III, 271.
Saperda candida FABR. *Round-headed apple-tree borer*..........Harris, Ins. Inj. Veg., 107.
Saperda cretata NEWM........................Osborn, Amer. Nat., XV, 244.
Saperda calcarata SAY.........................Riley, Prairie Farmer, 1867, 397.
Glyptoscelis crypticus (SAY). *Cloaked Chrysomela*..........Fitch, N. Y. Rept., III, 18.
Diabrotica vittata (FABR.). *Striped cucumber beetle*..........Riley, Mo. Rept., III., 6.
Diabrotica 12-punctata OLIV. *12-spotted cucumber beetle*..........Riley, Ins. Life, IV, 107.
Diabrotica longicornis SAY. *Long horned Diabrotica*..........Forbes, Ill. Rept., XII, 23.
Odontota dorsalis THUNB......................Hopkins, Bul. W. Va. Exp. Sta., 32, 202.
Odontota nervosa PANZ. *Rosy Hispa*.......Harris, Ins. Inj. Veg., 120.
Xanthonia 10-notata SAY. *Ten-spotted Xanthonia*..........Riley, Bul. Dept. Ent., 31, 17.
Graptodera chalybea ILLIGER. *Grape flea-beetle*..........McMillan, Bul. Neb. Exp. Sta., 2, 43.
Graptodera foliacea LEC. *Apple-tree flea-beetle*.......... Popenœ, Bul. Kas. Exp. Sta., 3, 37.
Crepidodera helxines LINN.....................Forbes, Ill. Rept., XIV, 98.
Crepidodera cucumeris HARR. *Cucumber flea-beetle*..........Forbes, Ill. Rept., XIV, 98.
Haltica punctipennis LEC......................Riley, Sc. Amer., 56, 384.
Notoxus calcaratus HORN.......................Insect Life, V, 197.
Syneta albida LEC...................... .... " " IV, 396.
Hymenorus obscurus (SAY)......................Lintner, Count. Gent., 1882, 605.
Macrobasis unicolor (KIRBY). *Ash-gray blister-beetle*..........Glover, Ag. Rept. for 1868, 105.
Pomphopœa æenea (SAY). *Pear-tree blister-beetle*..........Riley, Mo. Rept., III, 6.
Epicærus imbricatus (SAY). *Imbricated snout-beetle*..........Glover, Agr. Rept. for 1870, 71.
Ithycerus noveborascensis (FORST.). *New York weevil*..........Fitch, N. Y. Rept., III, 13.
Anthonomus cratægi WALSH. *Thorn curculio*..........Riley, Amer. Ent., II, 308.
Anthonomus quadrigibbus SAY. *Apple curculio*..........Walsh, Amer. Ent., I, 36.
Coccotorus prunicida WALSH. *Plum gouger*, Bruner, collected on apple.
Conotrachelus nenuphar (HERBST). *Plum curculio*..........Harris, Ins. Inj. Veg., 76.
Anametis grisea HORN..........................Riley, Amer. Nat., XVI, 915.
Otiorhynchus picipes (FABR.). *Pitchy-legged weevil*..........Packard, Rep. Geol. Surv., 1875, 757.

Monarthrum mali (FITCH). *Apple-bark beetle*.......................Fitch, N. Y. Rept. III, 8.
Pityophthorus sp. ?.......................Hopkins, Bul. W. Va. Exp. Sta., 31, 132.
Hypothenemus sp. ?....................... " " 132.
Hypothenemus sp. ?....................... " " 133.
Coscinoptera dominicana (FABR.). *Dominican case-bearer*.......................Riley, Mo. Rept., VI, 127.
Xyleborus pyri (PECK). *Pear-blight beetle*, Harris, Ins. Inj. Veg., 90.
Xyleborus xylographus SAY.......................Hopkins, Bul. W. Va. Exp. Sta., 31, 136.
Xyleborus obesus LEC.......................Riley, N. Y. Trbune, 1877, 231.
Scolytus rugulosus RATZ.......................Webster, Ins. Life, III, 299.

HEMIPTERA.

HETEROPTERA.

Nysius angustatus UHL. *False chinch-bug*, Riley, Mo. Rept., V, 112.
Lygus pratensis LINN. *Tarnished plant-bug*.......................Riley, Mo. Rept., II, 114.
Trapezonotus sp.?....................... " Ins. Life, V, 18.
Leptocorus trivittatus SAY. *Box-elder bug*, " " IV, 273.
Brochymena carolinensis WEST.......................Bruner, collected on apple.
Brochymena annulata FABR.......................Walsh-Riley, Amer. Nat., I, 237.

HOMOPTERA.

Cicada tibicen LINN. *Dog-day cicada*.......Uhler, *in lit.* to Lintner.
Cicada septendecim LINN. *Seventeen-year cicada*.......................Fitch, N. Y. Rept., I, 45.
Cicada tredecim RILEY. *Thirteen-year cicada*.......................Riley, Mo. Rept., III, 6.
Ceresa bubalus (FABR.). *Buffalo tree-hopper*.......................Riley, Mo. Rept., V, 122.
Ceresa taurina FITCH. *Calf tree-hopper*.....Fitch, N. Y. Rept., III, 17.
Thelia cratægi FITCH. *Thorn-bush tree-hopper*.......................Saunders, Ins. Inj. Fruits, 46.
Empoasca albopicta WALSH. *Apple leaf-hopper*.......................Riley, Ins. Life, II, 340.
Empoasca obtusa.......................Walsh, Prairie Farmer, 1862, 147.
Empoasca viridescens .... " " 1863, 212.
Typhlocyba rosæ.......................Riley, Ins. Life, V, 18.
Enchenopa binotata SAY.......................Goding, Ins. Life, V, 93.
Jassus irroratus SAY.......................Uhler, *in lit.* to Lintner.
Psylla pyrisuga FORST. *Pear-tree psylla*....Glover, Agr. Rept. for 1876, 33.
Aphis mali FABR. *Apple-tree aphis*..........Fitch, N. Y. Rept., I, 49.
Aphis malifoliæ FITCH. *Apple-leaf aphis*... " " " I, 56.
Schizoneura lanigera HAUS. *Apple-root plant-louse*.......................Fitch, N. Y. Rept., 1, 5.
Callipterus mucidus FITCH. *Mouldy aphis*, " " " III, 16.
Aleurodes sp. ?.......................Walsh, Pract. Ent., II, 58.

Lachnus dentatus LE BARON. *Spotted willow aphis*......Thomas, Ill. Rept., VIII, 116.
Chionaspis fufurus (FITCH). *Scurfy bark-louse*......Walsh, Pract. Ent., II, 31.
Diaspis ostreæformis (CURTIS). *Circular bark-louse*......Comstock, Agr. Rept. for 1880, 312.
Mytilaspis pomicorticis RILEY. *Apple bark-louse*......Harris, Ins. Inj. Veg., 252.
Aspidiotus perniciosus COMSTOCK. *Pernicious scale*......Comstock, *sup. cit.*, 304.
Aspidiotus rapax COMST. *Greedy scale*......Coquillett, Bul. Div. Ent., 26, 25.
Lecanium oleæ BERNARD. *Black scale of California*......Comstock, *sup. cit.*, 336.
Lecanium pruinosum COQUILLETT. *Powdered lecanium*......Coquillett, Ins. Life, III, 384.
Ceroplastes floridensis COMSTK *Wax-scale of Florida*......Riley, Ins. Life, I, 326.

THYSANOPTERA.

Thrips tritici FITCH. *Wheat thrips*......Osborn, Ia. Hort. R., 1892, 122.
Phlœothrips mali FITCH. *Apple thrips*......Fitch, N. Y., Rept., I, 102.
Heliothrips hæmorrhoidalis BOUCHE......Pergande, Psyche, III, 381.

ORTHOPTERA.

Œcanthus niveus SERV. *Snowy tree-cricket*, Riley, Mo. Rept., V, 120.
Orchelimum glaberrimum BURM......Dodge, *in lit.*
Tragocephala viridifasciata DE G. *Green-faced locust*......Saunders, Ins. Inj. Fruits, 158.
Camnula pellucida SCUDD......U. S. Ent. Com. Rep., I, 445.
Schistocerca americana (DRURY). *American locust*......Lintner, *in lit.*
Schistocerca shoshone THOMAS......Townsend, *in lit.*
Melanoplus femur-rubrum DE G......U. S. Ent. Com. Rep., I, 445.
Melanoplus spretus THOS. *Rocky mountain locust*......U. S. Ent. Com. Rep., I, 253.
Melanoplus atlanis RILEY. *Lesser migratory locust*......U. S. Ent. Com. Rep., I, 445.
Melanoplus differentialis THOS. *Differential locust*......Bruner, collected on apple.
Melanoplus bivittatus SAY. *Two-striped locust*......Bruner, collected on apple.
Melanoplus herbaceus BRUNER......Townsend, *in lit.*
Melanoplus cinereus SCUDD......
Melanoplus cyaneipes MSS......
Melanoplus devastator SCUDD. *Devastating locust*......
Pezotettix chenopodii BRUNER......Bruner, *in lit.* to Riley.

HYMENOPTERA.

Formica noveboracensis FITCH. *New York ant*..........Fitch, N. Y. Rept., I–II, 63.
Vespa maculata LINN. *White-faced hornet*, Authors.
Vespa vulgaris LINN. *Yellow jacket*......... "
Polistes fuscata FABR. *The common wasp*.. "
Tremex columba LINN. *Pigeon tremex*......Amer. Entom., II, 128.

PLATYPTERA.

Termes flavipes KOLLAR. *White ants or termites*..........Insect Life, V, 201.

DIPTERA.

Sciaria mali FITCH. *The apple midge*.......Fitch, N. Y. Rept., I–II, 252.
Trypeta pomonella WALSH. *Apple maggot*, Walsh, Ill. Rept., I, 29.
Drosophila ampelophila LOEW. *Pickled-fruit fly*..........Comstock, Agr. R. for 1881, 199.
Drosophila amœna LOEW. *Pretty pomace fly*, " " 201.
Ampelophila sp. ?..........Lintner, N. Y. Rept., II, 23.
Euxesta notata O. S..........Riley, Ins. Life, VI, 270.
Helops micans.......... " Prairie Farmer, 1867, 397.

ACARINA.

Bryobia speciosa (KOCH)..........Webster, Ins. Life, I, 363.

MYRIAPODA.

Julus marginatus SAY..........Riley, Prairie Farmer, 1867, 397.

A KEY FOR THE DETERMINATION OF APPLE INSECTS, BASED IN PART UPON THEIR METHOD OF ATTACK.

A. ATTACKING THE ROOTS.

(*a.*) Causing swellings on smaller roots..............Apple Root-louse
(*b.*) Cutting off roots in nursery...................Tyle-horned Borer

B. ATTACKING THE TRUNK AND BRANCHES.

(*a.*) *Internally, boring in the wood.*
(1.) At or near the surface of ground.
* Legless borer of moderate size ....Round-headed Borer
** Large borer with legs............................Moth Borers
(2.) Usually in upper trunk and branches......Flat-headed Borer
(3.) In the twigs at axils..........................Apple-twig Borer
(4.) In twigs at base of buds.....................Pear-blight Beetle

(*b.*) *Internally, between bark and wood.*
(1.) Attacking young trees, causing bark to loosen, Apple-bark Beetle
(2.) Attacking trees of various ages.............Fruit Bark Beetle

(*c.*) *Amputating smaller limbs.*
(1.) Larva working internally....................Apple-tree Pruner
(2). Beetle gnawing around outside...................Twig Girdler

(*d.*) *Attacking the bark.*
(1.) Gnawing off from new growths......Grasshoppers or Locusts
(2.) Gnawing off in patches. Beetle. ....Epicærus imbricatus

(*e.*) *Piercing and laying eggs in twigs.*
(1.) Entering and injuring the wood.
* In summer..................Dog-day Cicada, 17-year Cicada
** In fall...Tree Crickets
(2.) Piercing bark only.
* Making triangular slit....................Buffalo Tree-hopper

(*f.*) *Piercing the twigs with beak for food.*
* Gathering in clusters on new growths...Buffalo Tree-hopper

(*g.*) *Immovably fixed to bark.*
* Mussel-shaped scale.................Oyster-shell Bark-louse
** Irregular flat scale..........................Scurfy Bark-louse

C. ATTACKING THE BUDS.

(*a.*) Living within before it opens..........Leaf-rolling Caterpillars
(*b.*) Eating them out...Bud-worms
(*c.*) Piercing with sucking tube and causing to wither and drop, Tarnished Plant-bug

D. Attacking the leaves.

(*a.*) *Feeding in colonies. Gregarious.*

(1.) Protected by a web. Caterpillars.

* Web in forks of branches. Spring......Tent Caterpillars

** Web covering leaves. Summer............Fall Web-worm

*** Leaves partly eaten and drawn together with web, Palmer-worm

(2.) Not protected by a web. Caterpillars.

* Gathering in clusters on limbs and trunks, Yellow-necked Caterpillars

** Red hump on fourth ring..................Trim Prominent

*** Horn on fourth ring........................Unicorn prominent

(3.) Not protected by a web: Beetles.

* Eating holes in leaves. Nurseries. Apple-tree Flea-beetle

** Eating entire leaf. Gray beetle.....Imbricated Snout-beetle

(4.) Not protected by web. With sucking mouth.

* Green, soft-bodied, wingless bugs in colonies......Plant-lice

** Gray, winged bugs on nursery stock......False Chinch-bug

(*b.*) *Solitary or scattered over tree.*

(1.) Protected caterpillars.

* By web over single leaf...............Leaf Skeletonizer

** In tortuous tube..........................Leaf Crumpler

*** In folded leaves. Leaf Rollers.........Several species

**** Cases made from piece of leaf, Resplendent Case-bearers

***** Cases made of silk, leaf-fragments, etc., Apple-tree Case-bearer

****** Case of silk covered with sticks, Basket-worm. Bag-worm

(2.) Unprotected Caterpillars.

* In spring.

† Working in the day-time...................Canker-worms

†† Working in the night.............................Cut-worms

** In summer. Caterpillars.

† Large, green, covered with spiney tubercles, Cecropia Silk-worm

†† Apple green, striped obliquely on sides with white, American Silk-worm

††† Similar to above but with bluish caudal horn, Blind-eyed Sphinx

†††† Green or gray above, pink below,
Larva of Turnus Butterfly

††††† Hairy, long tufts over head and tail,
White-marked Tussock

(3.) Unprotected. Beetles.

* In spring.

† Feeding at night. Large brown..........May-Beetles

†† Feeding at night. Smaller brown,
Other Leaf-beetles

††† Feeding during day. Small gray-brown,
Rose-chafer

†††† Feeding during day. Large whitish,
Goldsmith Beetle

††††† Feeding during day. Small grayish-black,
Dominican Case-bearer

(4.) Jumping insects with sucking mouth.

* Working in axils of leaves............Jumping Plant-lice

** Attacking the foliage promiscuously,
Various tree-hoppers

(5.) Stripping off leaves and gnawing bark from twigs,
Various Grasshoppers

E. ATTACKING THE BLOSSOMS.

(*a.*) *Entering before open and gnawing so as to shrivel*.........Thrips

(*b.*) *Piercing after open and killing* ....Tarnished Plant-bug

F. ATTACKING THE FRUIT.

(*a.*) *Eating channels through it.*

(1.) Channels very irregular and numerous.........Apple Maggot

(2.) Channels chiefly about core, single,
Apple-worm, Codling Moth

(3.) Insect eating into it from outside.............Ash-gray Pinion

(*b.*) *Gouging into it for food or to lay eggs*...............Snout Beetles

(1.) Puncture marked with crescent..................Plum Curculio

(2.) Puncture plain, causing fruit to distort.

* Insect with four humps on wing-covers...Apple Curculio

** Insect without humps on wing-covers........Plum Gouger

*** Small insect living within enlarged cavity...Apple Thrips

(3.) Puncturing ripe fruit with beak for food......Box-elder Bug

(4.) Puncturing with ovipositor. Grasshopper ......Orchelimum

(c.) *Attacking and eating holes in ripe fruit*............Indian Cetonia

THE APPLE-TREE ROOT LOUSE.

(*Schizoneura lanigera* Hausm.)

This plant louse, which appears in two forms, has become quite plentiful in portions of the state within the past few years. One of these forms (Fig. 1) works upon the roots of the tree from one to several inches below the surface, where it does much injury. It is especially destructive to nursery stock where it is permitted to multiply from year to year. The presence of this root form is readily detected by the wart-like swellings which its attacks produce upon the roots; also by the "moldy" appearance of the root and surrounding earth. The lice insert their beaks into the bark of the roots and extract the juices which would otherwise go to nourish the tree. When they are very numerous their injuries cause the roots to gradually decay; and if they continue in their attacks the trees eventually die.

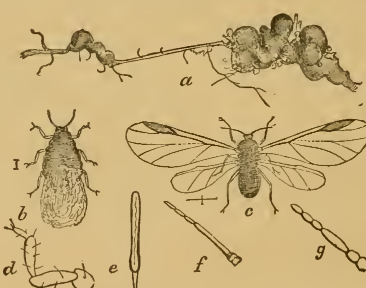


FIG. 1.—The Apple-tree Root Louse; *a*, rootlet showing galls; *b*, wingless or apterous louse; *c*, winged insect; *d*, *e*, *f*, and *g*, parts of louse showing structure. Figs. all magnified except *a*. [After Riley.]

If upon examination you should discover these irregularities upon the finer roots of your apple trees, and at the same time notice the moldy looking spots, you may be sure that this louse is present, and needs looking after. A closer examination will reveal the small pale-yellow lice, which sit concealed beneath their flaky covering in the crevices of the root deformities which their attacks have produced. These are also frequently accompanied by winged individuals of larger size. The wingless lice have their bodies covered with a bluish-white cottony substance, already mentioned as the "moldy" substance, which is secreted from the upper portion of the bodies of the wingless lice and hangs to their bodies in a tuft of filaments which are frequently five or six times the length of the lice themselves. In Fig. 1, *a* represents the affected root, *b* a wingless louse, and *c* one with wings. The size of these insects is indicated by hair lines alongside of the figures.

Saunders speaks of this insect as follows in his work entitled "Insects Injurious to Fruits": "The apple-root plant louse is believed by some entomologists to be a native insect, while others hold to the opinion that it has been imported from Europe. It is nourished by sucking the juices of the tree, piercing the tender roots with its proboscis. In the very young lice this instrument, when at rest and folded under the abdomen, is longer than the body, but in the mature specimens it is only about two-thirds the length of the body. While it usually confines itself to the roots of trees, it is sometimes found on the suckers that spring up around them, and sometimes also about the stump of an amputated branch, but in every instance it may be recognized by the bluish-white cottony matter with which its body is covered. If this cottony covering be forcibly removed, it will be found that in two or three days the insect will have again produced sufficient to envelop itself completely. Occasionally the mature lice crawl up the branches of the trees during the summer, where they also form colonies, and then are known as the Woolly Aphis of the apple." In speaking of this form of the louse now under consideration the same author says: "They are often found about the base of twigs or suckers springing from the trunk, and also about the base of the trunk itself, and around recent wounds in the bark. In autumn they commonly affect the axils of the leaf stalks, towards the ends of twigs, and sometimes multiply to such an extent as to cover the whole under surface of the limbs and also of the trunk, the tree looking as though whitewashed. They are said to affect most those trees which yield sweet fruit. This woolly louse is very common in Europe, especially in Germany, the north of France, and England, where it is more destructive than in this country, and, although generally known there under the name of the 'American blight,' it is believed to be indigenous to Europe, and to have been originally brought from Europe to America. It appears to thrive only in comparatively cold climates, and in this country occurs in this [above ground] form most abundantly in the New England states.

"Under each of the little patches of down there is usually found one large female with her young. When fully grown the female is nearly one-tenth of an inch long, oval in form, with black head and feet, dusky legs and antennæ, and yellowish abdomen. She is covered with a white mealy powder, and has a tuft of white down growing upon the hinder part of her back which is easily detached. During the summer the insects are wingless, and the young are produced alive, but about the middle of October, among the wingless specimens appear a considerable number with wings, and these have but little of the downy substance upon their bodies, which are nearly black and rather plump. The fore wings are large and about twice as long as the narrower hind wings. Late in the autumn the females deposit eggs for another generation the following spring, a fact which should induce fruit growers to take particular pains to destroy these lice wherever found, for the colony that is permitted to establish itself upon some worthless tree, or on the shoots or suckers at its base, will furnish the parents of countless hosts that may establish themselves next year on the choicest trees in the orchard. The insects are extremely hardy and will endure a considerable amount of frost, and it is quite probable that some of them survive the winter in the perfect state in the cracks of the bark of the trees.

"The eggs are so small that they require a magnifying glass to enable one to see them, and are deposited in the crevices of the bark at or near the surface of the ground, especially about the base of suckers, where such are permitted to grow.

"The young, when first hatched, are covered with very fine down, and appear in the spring of the year like little specks of mold on the trees. As the season advances, and the insect increases in size, its cottony coating becomes more distinct, the fibers increasing in length and apparently issuing from all the pores of the skin of the abdomen. This coating is very easily removed, adhering to the fingers when touched. Both young and old derive their nourishment from the sap of the tree, and the constant punctures they make give rise to warts and excrescences on the bark, and openings in it, and, where very numerous, the limbs attacked become sickly, the leaves turn yellow and drop off, and sometimes the tree dies."

This louse was noticed as early as 1848, at which time it was found upon thousands of small trees in such large numbers that the destruction of the trees was necessary. Since that time it has been gradually spreading over the country until it has become quite general, save in isolated localities.

REMEDIES.

Like all other plant lice, the present species is preyed upon by a large number of predaceous and parasitic insects, such as lady-birds, lace-wing flies, syrphus flies, and several very minute hymenopterous parasites. Some of these are shown in Figs. 2 to 8.

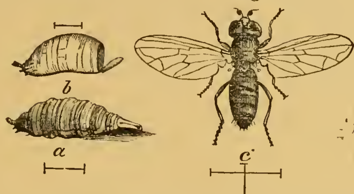


FIG. 2.—The Root-louse Syrphus-fly (*Pipiza radicum*): *a*, larva or maggot; *b*, puparia; *c*, fly. [After Riley.]

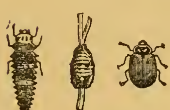


FIG. 3.—*Hippodamia convergens.* [After Riley.]

FIG. 4.—Larva of Lady-bird. [After Riley.]

FIG. 5.—*Hippodamia 13-punctata.* [After Riley.]

FIG. 6.—*Coccinnella 9-notata.* [After Riley.]

FIG. 7.—*Hippodamia maculata.* [After Riley.]

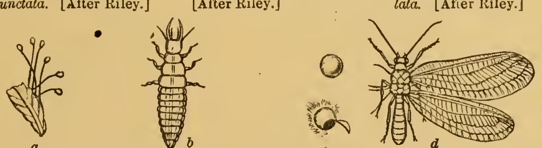


FIG. 8.—Lace-wings: *a*, eggs on leaf; *b*, larva; *c*, *d*, mature insect. [After Riley.]

When artificial means must be employed, and this should be done just as soon as the lice first appear, the "kerosene emulsion" remedy should be applied to the above ground form, while for the root form Saunders writes: "The most successful means yet devised for destroying these root lice is the use of scalding hot water freely poured around the roots of the trees. If the trees are to remain in the soil, the roots may be laid bare, and the water used nearly boiling without injury; but where they have been taken up for the purpose of transplanting, and are to be dipped in the hot water, the temperature should not exceed 150° Fahr.; under these circumstances, from 120° to 150° would suffice for the purpose. A mulch placed around the trees for some time previous to treatment has been found useful in bringing the lice to the surface, where they can be more readily reached by the hot water. Drenching the roots with soap-suds has also been recommended, to be followed by a liberal dressing of ashes on the surface."

THE APPLE-TREE APHIS.

(*Aphis mali* Fabr.)

Recently another plant louse has been doing considerable injury to the apple trees in some portions of eastern and southeastern Nebraska. This latter insect is the one commonly known as the Apple-tree Aphis. It differs considerably from the root louse of the apple in several points, as will be seen by reference to figures 9 and 10, the former representing a wingless and the latter a winged louse. As will be seen in the figures, this louse of both forms is provided with a pair of

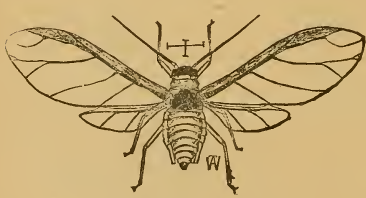


FIG. 9.—The Apple-tree Aphis (*Aphis mali*), winged viviparous female. [Original, drawing by T. A. Williams.]

FIG. 10.—The Apple-tree Aphis (*Aphis mali*), apterous viviparous female. [After Weed.]

honey tubes, which issue from the upper surface of the abdomen near its apex. It also has the body destitute of any covering like that found upon the root louse; and its antennæ or feelers are as long as its body, while the legs are also long and slender. In color the Apple-tree Aphis is green or greenish yellow, the winged specimens, as well as the apterous, being marked to some extent with black.

The presence of this louse in an orchard can be readily detected by the curled appearance of the leaves which it infests. When the insects attack a leaf it curls or twists around so as to shelter them from rain, as well as to afford a partial protection against its natural enemies. The life-history of this plant louse is given briefly as follows by the author already quoted:

"During the winter there may often be found in the crevices and cracks of the bark of twigs of the apple tree, and also about the base of the buds, a number of very minute, oval, shining black eggs. These are the eggs of the Apple-tree Aphis, known also as the Apple-leaf Aphis, *Aphis malifoliæ* Fitch. They are deposited in the autumn, and when first laid are of a light yellow or green color, but gradually become darker, and finally black.

"As soon as the buds begin to expand in the spring, these eggs hatch into tiny lice, which locate themselves upon the swelling buds and the small, tender leaves, and, inserting their beaks, feed on the juices. All the lice thus hatched at this period of the year are [viviparous] females, and reach maturity in ten or twelve days, when they commence to give birth to living young, producing about two daily for two or three weeks, after which the older ones die. The young locate about the parents as closely as they can stow themselves, and they also mature and become mothers in ten or twelve days, and are as prolific as their predecessors. They thus increase so rapidly that as fast as new leaves expand colonies are ready to occupy them. As the season advances, some of the lice acquire wings, and, dispersing, found new colonies on other trees. When cold weather approaches, males as well as females are produced, and the season closes with the deposit of a stock of eggs for the continuance of the species another year."

The habits of this aphis are very similar to that of the Box-elder Plant-louse, mentioned in the report for 1889; and it is usually kept within bounds by the same insect enemies that attack that and other plant lice.

REMEDIES.

The kerosene emulsion, if sprayed over the trees at the time of hatching or afterwards, will kill all the lice that it reaches. If strong soap-suds are sprayed upon the trees at the time the buds are opening, or if weak lye or tobacco water be used instead, many of the young lice will be destroyed. Saunders says: "A frost occurring after a few days of warm weather will kill millions of them; in the egg state the insects can endure any amount of frost, but the young aphides quickly perish when the temperature falls below the freezing-point."

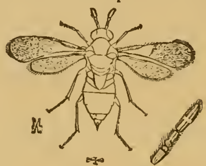


FIG. 11.—The Apple Aphis parasite (*Aphelinus mali*)—enlarged. [After Riley.]

FIG. 12.—The Comely Lady-bird (*Coccinella venusta*) — slightly enlarged. [After Riley.]

The predaceous insects that attack this and other plant lice are shown in Figs. 3 to 8 and also Figs. 11 and 12. All of these are our friends and should become familiar to us so that we can protect and assist them in their good work.

OYSTER-SHELL BARK-LOUSE.

(*Mytilaspis pomorum* Bouché.)

The common Oyster-shell Bark-louse of the apple is too well known by orchardists to require any extended description here. The illustrations of the insect in figures 13 and 14 will at once call to mind the insect which is meant. Unlike the Maple Scale, this insect deposits her eggs during late summer, where they remain concealed beneath the shell during fall and winter. Nor is this scale nearly so prolific as the one just referred to, since but from sixty to seventy-five eggs are laid by each female, whereas the other species is known to deposit from one to two thousand. Aside from this the life-histories of the two insects are near enough alike to need no further mention here. The male alone is winged, and issues during the summer.

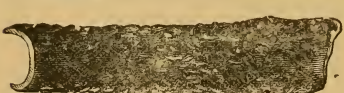


FIG. 13.—Piece of bark containing scales of Oyster-shell Bark-Louse. [After Riley.]

REMEDIES.

The very best direct remedy against this bark louse is the use of kerosene emulsion at the time when the young are hatching and wandering about over the trees. One or two careful sprayings at such

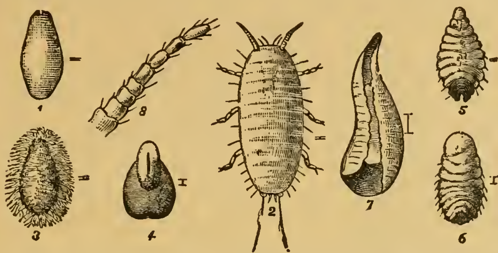


FIG. 14.—Oyster-shell Bark-louse (*Mytilaspis pomorum*): 1, egg; 2, larva when first hatched; 3, larva when forming scale; 4, scale after second plate is formed; 5, 6, forms of louse taken from scale; 7, fully formed scale—all greatly enlarged. [After Riley.]

times will effectually destroy the insects. The use of alkali washes is also strongly recommended as remedies for this and other coccids.

THE SCURFY APPLE-TREE BARK-LOUSE.

(*Chionaspis furfurus* Fitch.)

A second species of scale also works on our apple trees here in the state. It is the one known to the entomologist as *Chionaspis furfurus*. This second Apple-tree Bark-louse can be distinguished from the one just treated, which is brownish, by its dirty white color. Still other species of scale insects are known to attack the apple in other regions. (See list of apple insects on preceding pages.)

REMEDIES.

As a rule these lice are kept pretty well within bounds by a large number of parasites and predaceous insects that prey upon both the young and old. Of these the Twice-wounded Ladybird (*Chilocorus bivulnerus*) is the most important, since it works upon the lice both as old and young; and often occurs in such numbers as to completely dot the infested tree-trunks with their glossy-black bodies. I have counted as many as 200 of this beetle upon a single small limb of a tree that was infested by the Maple-tree Scale. Several other "lady-birds" are also known to destroy these lice. Among the true parasites that infest these insects I have bred at least four or more distinct species from specimens of the Maple Scale taken here in the city of Lincoln.

Whether or not any of these are the same as those mentioned by other writers, I am unable to state, since I have not taken time to look them up or send them away for determination.

THE BUFFALO TREE-HOPPER.

(*Ceresa bubalus* Fabr.)

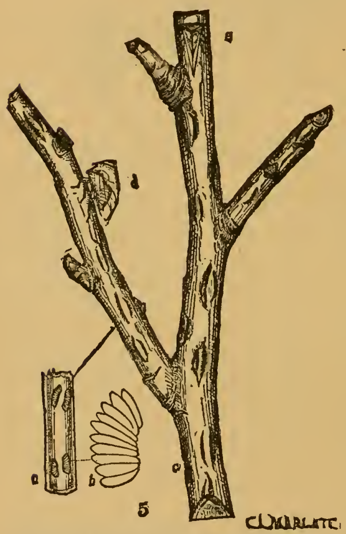


FIG. 15.—*Ceresa bubalus: a*, natural size; *b*, enlarged; *c*, punctures on twig; *d*, adult tree-hopper; *e*, same from above. [After Poponoe.]

One of our most troublesome insect pests here in the west is the one known to the general public by the name of Buffalo Tree-hopper; and to the entomologist as the *Ceresa bubalus.* The insect certainly does bear a striking likeness to the animal for which it is named. (See Fig. 15, *d.*)

The insect may be known by the following brief description: The insect is green in color, is hunchbacked, about one-fourth to one-third of an inch in length, and is a great jumper. In its movements it is very active, and at the appearance of an enemy will very quickly dart around to the opposite side of the twig upon which it is perched. Like all the representatives of the order to which it belongs, it is a sucker, *i. e.*, it takes its nourishment by means of a beak which it inserts into the stems of tender and growing plants. The injury inflicted by this and other tree-hoppers when feeding is sometimes very great; but in this particular case the greatest damage is occasioned by the female in the deposition of its eggs. Professor Riley has described these egg-punctures as follows in his Fifth Missouri Report: "The punctures consist of a row, more or less straight, of little raised slits in the bark, in each of which, upon careful examination, may be found an oval, dark-colored egg. These eggs hatch about the middle of May, and the young are at first brownish, with a formidable row of ten pairs of compound spines, and looking totally unlike the mature insect."

REMEDIES.

Professor Herbert Osborn, of the Iowa Agricultural College, has quite recently treated this insect in the *Orange Judd Farmer*, and in the article under consideration has the following to say about handling it: "The insect is a difficult one to deal with, as it lives by puncturing the plants upon which it feeds with its suctorial mouth-parts, so that it cannot be reached by arsenical applications; and they are scattered over such a variety of plants that the application of kerosene emulsion is not practicable. It often happens that the punctures occur in great numbers on certain trees, or on certain branches of a tree, and in such cases some degree of protection is secured for the following year by trimming off the injured twigs and burning them."

Various other tree-hoppers also frequently attack the apple trees and by their combined efforts do much injury. When these are found upon young trees in the nursery, kerosene emulsion, if sprayed upon them, will do much towards remedying the evil.

THE TARNISH PLANT-BUG.

(*Lygus pratensis* Linn.)

Another of the insects that appears on almost every list of insect enemies is the one figured herewith (Fig. 16). 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.

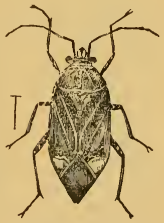


FIG. 16.—Tarnish Plant-bug (*Lygus pratensis*). [After Riley.]

REMEDIES.

Since it breeds on weeds of various kinds in large numbers, clean culture is one of the best preventive measures that we can recommend. The kerosene emulsion, if applied to the trees when the insect is at work, will also prove beneficial.

THE FALSE CHINCH-BUG.

(*Nysius angustatus* Uhl.)


FIG. 17.—*Nysius angustatus.* [After Riley.]

The insect which is shown herewith in Fig. 17, quite frequently becomes very numerous during fall and spring and then gathers upon young trees in the nursery where it does much injury by sucking the sap and killing the new growths. It naturally feeds upon a number of our most common weeds, and therefore is most frequently destructive in localities where these weeds have been allowed to grow up during late summer and fall.

REMEDIES.

Clean culture throughout the summer and fall is, of course, the most sure remedy for this and several other weed-feeding bugs. When present and causing their injury the kerosene emulsion will act as a safeguard.

THE PEAR-TREE PSYLLA.

(*Psylla pyri* Schmidb.)

An insect that sometimes occurs upon the apple tree is shown herewith (See Fig. 18). It is known as the "Pear-tree Psylla" because


FIG. 18.—The Pear-tree Psylla (*Psylla pyri*). [After Saunders.]

t is more frequently found as an enemy of that tree than of the apple. In describing this insect Saunders uses the following language: *

"During the middle of May, when growth is rapid, the smaller limbs and twigs of pear trees are sometimes observed to droop; a close examination reveals copious exudation of sap from about the axils of

*"Insects Injurious to Fruits," by Wm. Saunders. J. B. Lippencott & Co.

the leaves, so abundant that it drops upon the foliage below, and sometimes runs down the branches to the ground. Flies and ants gather around in crowds to sip the sweets, and by their busy bustle draw attention to the mischief progressing. With a magnifying lens the authors of the injury may be observed immersed in the sap about the axils of the leaves."

The insect is "a small, yellow, jumping creature, flattened in form and provided with short legs, a broad head, and sharp beak." Like the Aphididæ this insect lives upon the sap of the tree and when numerous causes it to wither and droop.

REMEDY.

The kerosene emulsion, if applied as directed for other plant lice, will be quite effective in ridding trees of this insect.

THE BOX-ELDER BUG.

(*Leptocoris trivittatus* Say.)

Everyone in this western country is familiar with the insect of which the accompanying figure is an enlarged drawing. However familiar many of us may be with this insect, most of us are undoubtedly ignorant as to its habits, mode of life, enemies, etc. To include all of this here would, of course, occupy too much space. Suffice it at present then for me to give a few of the general points in connection with its life history.

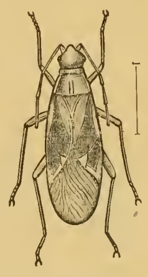


FIG. 19.—The Box-elder Bug (*Leptocoris trivittatus*). [Original.]

This is the dark slate-colored bug, with red border and median line of same color, that is so common about houses and out-buildings during fall, when it frequently becomes a nuisance on account of its habit of crawling over and into different things left standing about the house. In form it is somewhat flattened, about one-third as broad as long. Its length, as will be seen by the hair line at the right of the figure, is about one-half of an inch. When handled or disturbed it emits a pungent or disagreeable odor, adding to its odiousness.

Aside from the box-elder tree, it also frequently gathers upon apples and other fruit which it punctures with its beak and renders unpalatable if it does not destroy them.

REMEDY.

On account of its habit of gathering into great clusters, it is not difficult to wage war against this bug. When thus gathered upon the ground, on walls of buildings, or upon the trunks of trees, it can readily be destroyed by the use of kerosene or boiling water. Birds and other insectivorous animals are not very partial to it, nor to any of the members of the order to which it belongs, all of which are very "odoriferous," and presumably not especially delightful to the taste.

BORING BEETLES.

Very prominent among the insect enemies of the apple tree in this country are a number of kinds of boring beetles. These may be separated into three groups, viz., flat-head, round-head, and bark-borers. These boring beetles belong to several distinct families and work upon the trees which they attack in different ways. Some of them bore directly into the heart of the larger limbs and the trunk, others work immediately under the bark upon the sap wood, while still others work in and destroy the twigs and smaller branches.

FLAT-HEADED WOOD-BORERS.

(*Buprestidæ.*)

Fig. 20—*Chrysobothris femoratus*: beetle and larva. [After Riley.]

Very prominent among these wood boring insects of the apple tree are those known as the flat-headed wood-borers (*Buprestidæ*). This name is given them on account of the structure of their larvæ. One of these is shown in the accompanying illustration (Fig. 20) at the right. All of the larvæ of the representatives of this family are thus characterized, though they vary much in size and general appearance. Several of the others of these flat-headed boring beetles are shown in Figures 21, 22, and 23. All of them are more or less metallic in their colors and sculptured with ridges, lines, and depressions as are shown by the illustrations.

REMEDIES.

Most of these flat-headed borers can be kept in check by washing the trunks of the trees which they infest with a strong soap solution, or by whitewashing them about the time the insects' eggs are laid The borers can also be grubbed out with a sharp knife and destroyed after they have entered the bark. In the woods and away from cities

FIG. 21.—*Chalcophora virginiensis.* [Marx.]

FIG. 22.—*Chalcophora liberata.* [Marx.]

FIG. 23.—*Dicerca divericata.* [Marx.]

and towns they are greatly infested by parasites that kill them off, and they are also eagerly sought out and devoured by the different species of woodpeckers that make this sort of work their special business. Much good can also be done at times in the way of capturing and destroying the mature beetles as they are found basking in the bright sunshine upon their favorite trees.

ROUND-HEADED WOOD-BORERS.

(*Cerambycidæ.*)

Certain others of the wood-boring beetles have been called "Round-headed" as distinguished from the "Flat-headed" borers referred to above. These round-headed borers are the larvæ of the Long-horn

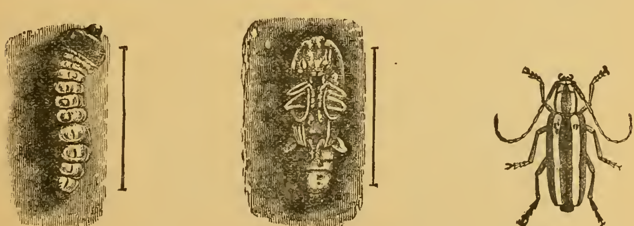


FIG. 24.—Round-headed Apple-tree Borer (*Saperda candida*): 1, larva; 2, pupa; 3, imago. [After Riley.]

beetles of the family *Cerambycidæ.* They are shown in figure 24. These borers usually bore directly into the heart of the wood and there do much injury to the trees which they infest. Some of these borers are described more fully below, where the remedies are given for each.

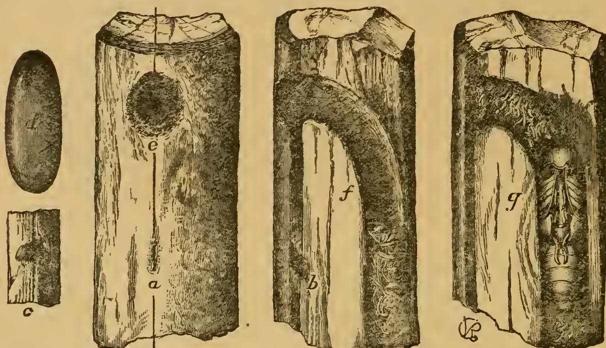


FIG. 25.—Oviposition and exit of the Round-Headed Apple-tree Borer: *a*, wound where egg is deposited; *b*, same, with the wood split lengthwise along the line (*a*, *e*), and turned so as to show an egg in place; *c*, same, with the bark split on the same line and removed to the left, so as to show the manner in which the egg is commonly thrust to one side under the bark; *d*, the egg, enlarged; *e*, hole of exit of beetle; *f*, the same, as it appears from the side when split along the line (*a*, *e*); *g*, the burrow, as it appears while the insect is in the pupa state, and before the bark is perforated. [After Riley.]

TWIG GIRDLER AND TWIG PRUNERS.

Not unfrequently do we find limbs and small branches of our fruit trees lying upon the ground where they have fallen during ordinary wind storms. An examination shows that they have been cut off by something or other, but just what this something has been is a mystery to most of us. A reference to the accompanying illustrations (Figs. 26 and 27), will at once explain the mystery. Both the "Twig Girdler" and several species of the pruners occur within the state where they cause more or less injury. In the case of the girdler (Fig. 26), it appears that the larva must feed upon dead wood, and that this dead wood must be in a special condition. To this end the female beetle punctures the twigs and lays her eggs as shown in the illustration at *b*. She then proceeds to gnaw a groove around the branch below the point where the egg was deposited. The branch dies and the borer has dead wood upon which to feed. The further growth and transformations of the insect take place within the stick upon the ground. With the pruners the eggs of the female insects are laid in the living branches and the cutting off is done by the borers when just about fully grown. They cut off the woody portion, leaving only a small part of the bark intact. The result is that with the fall

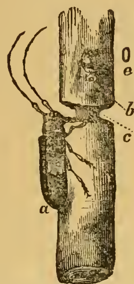


FIG. 26.—The Twig Girdler (*Oncideres cingulata*): *a*, beetle; *b*, puncture showing where the egg is laid; *c*, girdling to cause upper portion to die; *e*, egg. [After Riley.]

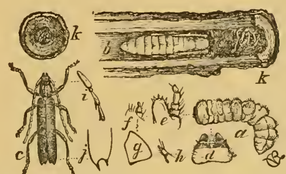


FIG. 27.—Twig Pruner: *a*, larva; *b*, pupa; *c*, beetle. [Riley.]

winds the limbs fall to the ground and the insect finds a shelter among the fallen leaves, as well as protection from birds and parasites. The figure, 27, will explain this sufficiently well.

REMEDIES.

Gather the fallen limbs during fall, winter, or early spring, and burn them.

THE BROAD-NECKED PRIONUS.

(*Prionus laticollis* Drury.)

Among the different species of long-horned boring beetles that attack the apple tree the one herewith illustrated is the largest. It is

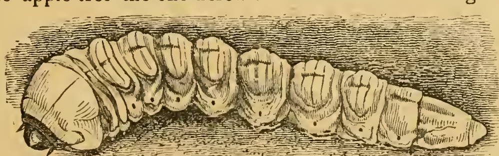


FIG. 28.—The Broad-necked Prionus (*Prionus laticollis*): larva. [After Riley.]

shown in the larva, pupa, and imago stages in Figs 28, 29, and 30, respectively, all natural size. In color the larva is yellowish white, with its small horny head reddish brown. The pupa is also light colored, while the beetle is dark mahogany brown, inclining to black in some specimens.

The larvæ of this and allied species bore in the roots of the plants which they injure; and it is supposed that they are three years in attaining their growth. These borers, although so very large, often work upon roots smaller than their own diameter, and in consequence are often plowed up in breaking prairie.

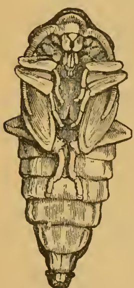


FIG. 29.—The Broad-necked Prionus: pupa. [After Riley.]

FIG. 30.—The Broad-necked Prionus: beetle, female. [After Riley.]

REMEDIES.

These underground borers are the most difficult of all our insect enemies to fight, and must be dealt with singly. In other words each larva must be searched for and and destroyed. Happily for us the insects are not very numerous, and hence rarely become a pest. Their presence can quite readily be detected by the sudden death of the plants which have been attacked. (It also destroys young apple and other trees growing in nursery rows which it follows and takes one after the other.)

THE APPLE-TWIG BORER.

(*Amphicerus bicaudatus* Say.)

The insect that is figured herewith (Fig. 31) in all its stages of growth, is, perhaps, one of the best known insects that attack apple trees here in the west. The beetle, which is shown in the illustration at *a* and *b*, is known by its methods of attack from all other enemies of the tree. In winter it is found in the twigs, where it enters at the axils and bores down the center a half inch or more, and remains over winter. The point beyond the attack usually dies. Although so often found in twigs of the apple and pear trees the insect breeds in other localities. Its life-history has been studied by Prof. Popenoe, of the Kansas Agricultural College.

REMEDIES.

Gathering and burning the twigs containing the insects seems to be about the only remedy that we have for this species. It is also attacked by several parasites that do much towards keeping it in check.

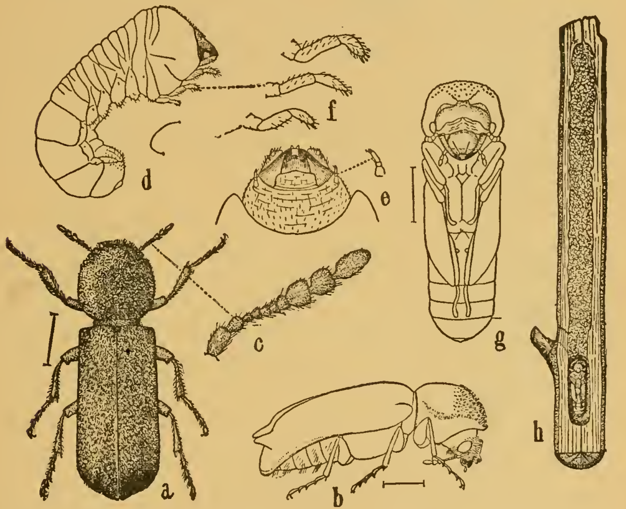


FIG. 31.—The Apple-twig Borer (*Amphicerus bicaudatus*): *a*, female beetle from above; *b*, outline side view of male; *c*, antenna; *d*, full-grown larva; *e*, head and antenna of do.; *f*, right legs of do.; *g*, front view of pupa, in outline; *h*, twig showing, above, the larval burrow packed with castings, and below, the pupa in its cell. The figures, excepting *h*, which is natural size, are enlarged, the hair-lines at the side showing natural size. [After Popenoe—drawings by C. L. Marlatt.]

THE RED-SHOULDERED SINOXYLON.

(*Sinoxylon basilare* Say.)

A not uncommon insect in portions of eastern and middle Nebraska is the one shown in its different stages of larva, pupa, and imago in the accompanying illustration (Fig. 32). As will be noticed by the comparison of the figures, it is related to the beetle so commonly known as the Apple-twig Borer. Like that insect it also attacks the grapevine and various fruit trees in the stems and limbs of which it bores, often doing a vast amount of injury to these plants.

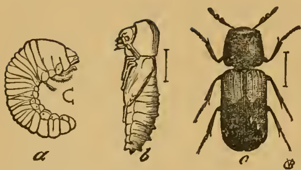


FIG. 32.—The Red-shouldered Sinoxylon (*S. basilare*): *a*, larva; *b*, pupa; *c*, imago—all enlarged. [After Riley.]

The grub, or larva, which is shown at *a* in the illustration, is about three-tenths of an inch in length, of a dirty yellowish-white color, and has the anterior end somewhat enlarged. Its normal position is that shown in the picture, *i. e.*, with the body arched or bowed. The pupa is of the same general color as that of the larva, and is to be found in the burrows made by it. The beetle is of the length of the line at its right in the illustration, and is black in color, with the basal portion of the elytra or wing-covers red.

REMEDIES.

Like the Twig Borer, this beetle is more or less frequently destroyed by several kinds of four-winged parasites, which generally keep the insect within reasonable control. Occasionally, however, it gets a start in an orchard or vineyard; especially is this the case where neglect is the rule of the owner. Then the *heroic* remedy only can be recommended, viz., the pruning and burning of the infested canes and branches along with their contents.

BARK-BORING BEETLES.

(*Scolytidæ.*)

A reference to figures 33 and 34 will show the readers of this paper the appearance and method of attack of another group of boring beetles that occasionally do much harm to trees of various kinds. These insects not only work on trees grown for shade and ornamental purposes, but also upon those in the orchard and forests.

While these insects usually attack dead or dying trees, they sometimes do considerable injury to living trees also. Their mode of attack is as follows: The mature insects bore into the bark until they reach the wood, when they dig a longitudinal burrow between the bark and wood, or rather partly in the bark and partly in the sap-wood. Along the edges of this gallery eggs are laid and the young larvæ begin feeding and growing, digging as they advance lateral galleries of increasing size as shown in the accompanying illustrations (Figs. 34 and 35, *c*). When mature some species of these beetles enter the wood quite deeply, others simply remain between the wood and bark when they transform.

The Fruit Bark-beetle (*Scolytus rugulosus*), which is shown along with its work (See Fig. 35, *a*, *b*, *c*.), has become quite a pest in some

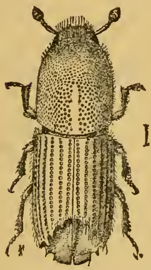


FIG. 33.—*Tomicus caıographus.* [Marx.]

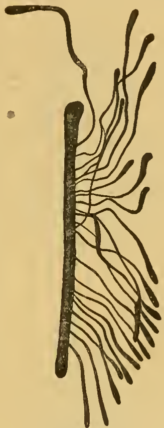


FIG. 34.—Mine of *Scolytus unispinosus.* [After J. B. Smith.]

parts of the United States, and certainly needs to be watched in this state. It is especially liable to attack such of our trees as have suffered from blight.

REMEDIES.

It is quite a difficult matter to fight these bark borers, and we are obliged to depend mostly on their natural enemies for keeping them in check. Professor A. S. Packard, in treating of one of these insects, writes (5th Rept. U. S. Entomological Commission, p. 710) as follows, when speaking of remedies:

"This, and the other bark-beetles of the pine, have numerous insect enemies which wage incessant war upon them. Various species of small beetles pertaining to the families *Staphylinidæ, Histcridæ,* etc., are always to be met with under the loose worm-eaten bark of pines, and M. Perris has ascertained that these insects resort to this situation for the purpose of rearing their young, their larvæ being predaceous and subsisting upon the larvæ and pupæ of the bark beetles."

Aside from the good work that is done by the above mentioned friendly insects in keeping these bark-borers in check, it is a good plan to gather all dead or dying limbs, branches, and even trees that contain these borers and burn them during the winter months.

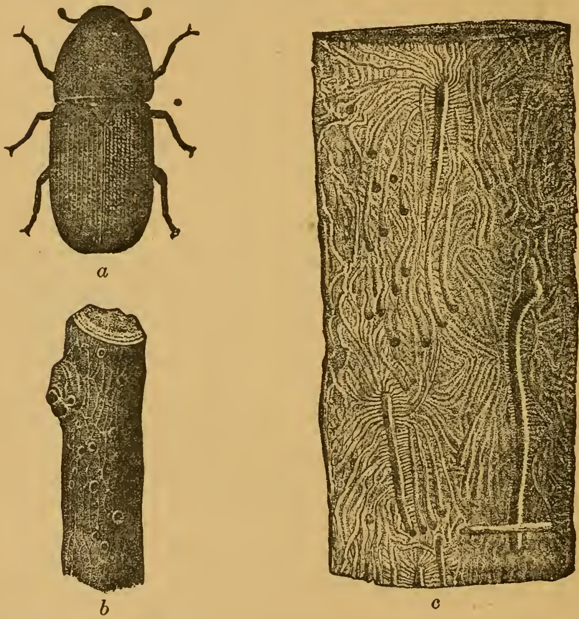


Fig. 35.—*Scolytus rugulosus:* a, beetle, enlarged twenty diameters; b, small branch, showing perforations of bark, natural size; c, denuded branch showing work of insect, natural size. [After Forbes.]

THE NEW YORK WEEVIL.

(*Icthycerus noveborascensis* Forst.)

An insect that frequently occurs in our orchards, and one that sometimes does considerable injury to different fruit-trees, is what has been called the New York Weevil. This insect, as will be seen by reference to the accompanying figure, is a snout-beetle of large size. It is an early arrival in spring, and frequently does much harm by eating the buds and bark of the twigs. It also gnaws into the bases of twigs and causes them to fall, as well as eats off the leaves later in the season. Besides all this, it has the habit of devouring the tender shoots or new growths.

Like the Imbricated Snout Beetle, this weevil is gray. Saunders, in speaking of this insect, in his work entitled "Insects Injurious to Fruits," says, "The beetle is said to be more active at night than in day, and seems to show a preference for the tender, succulent shoots of the apple, although it makes quite free with those of the peach, pear, plum, and cherry. Sometimes it occurs in swarms in nurseries, when it seriously injures the young trees. In the east it is seldom present in sufficient numbers to prove injurious, but it is very common in the valley of the Mississippi. The larva is found in the twigs and tender branches of the bur-oak, and probably also in those of the pig-nut hickory." The female, when about to deposit her egg, first gnaws a slit in the twig, as shown at *a* in the figure. This egg soon hatches, and the larva works in the stem. It is a rather large, yellowish, fleshy, footless grub.

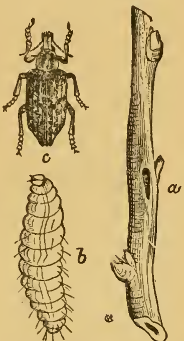


FIG. 36.—The New York Weevil (*Icthycerus noveboracensis*): *a*, twig showing slit for egg; *b*, larva; *c*, beetle—natural size. [After Riley.]

REMEDIES.

The beetles can be jarred from the trees into some sort of a receptacle and then destroyed; or they can be poisoned by spraying with the arsenites.

TREE-CRICKETS.

Few if any of our injurious insects are more widely and generally distributed over the state, and for that matter over North America, than the common Snowy Tree-cricket (*Œcanthus niveus*) which is herewith figured. Figure 37 represents the female and Fig. 38 the male, both natural size. This cricket, as the name implies, is whitish or greenish-white. It is a very common insect, and can readily be recognized by the accompanying illustrations; therefore a description of it is unnecessary here.

While this particular cricket is less injurious to trees and shrubs than are many other indigenous noxious insects, its peculiar mode of attack brings it into notice much more frequently than they. By reference to the accompanying figure (Fig. 39) which is intended to represent a raspberry cane that has been injured by this cricket, its mode

FIG. 37.—Snowy Tree-cricket (*Œcanthus niveus*): female. [After Harris.]

FIG. 38.—Snowy Tree-cricket (*Œcanthus niveus*): male. [After Harris.]

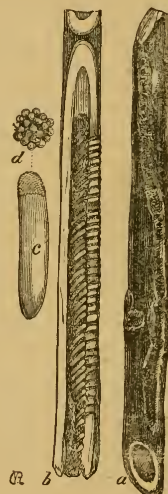


FIG. 39.—Snowy Tree-cricket: *a*, raspberry cane showing egg punctures; *b*, transverse section; *c* and *d*, magnified view of egg. [After Riley.]

of attack can be seen. Instead of destroying the plant by devouring the foliage or twigs, as is usually the case with insect depredators, this species unintentionally becomes an enemy by using the stems of various pithy plants as receptacles for its eggs during the winter—the result being alike favorable for the parent and progeny, whether the twigs or stems die or live.

REMEDIES.

When it is thought necessary to fight this insect its eggs should be gathered and burnt. Usually it is a benefit rather than an injury to the fruit-raiser, since the food of this and allied species is various plant-lice and other small soft-bodied insects.

MOTH WOOD-BORERS.

(*Cossidæ* and *Sesiidæ.*)

Some of our most destructive borers that attack fruit and other trees are those belonging to the order *Lepidoptera.* Of these moth-borers there are two well-defined families, *Sesiidæ* and *Cossidæ.* The cossids are all large-bodied insects, and their larvæ are correspondingly large. It is supposed that they live in the caterpillar stage three years.

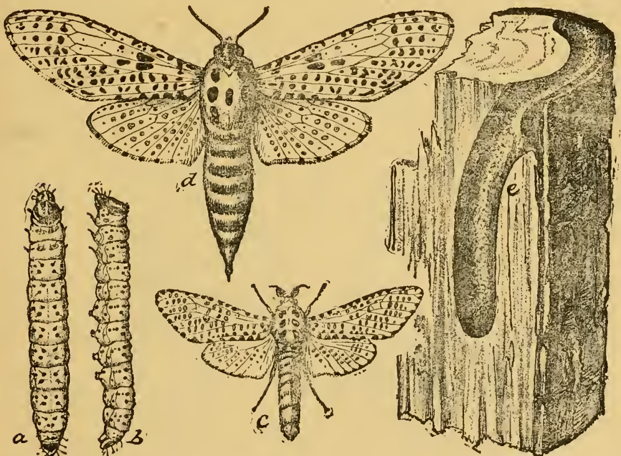


FIG. 40.—The Leopard Moth (*Zeuzera pyrina*): *a*, larva, dorsal view; *b*, larva, side view; *c*, male moth; *d*, female moth; *e*, larval burrow—natural size. [Insect Life.]

The insect shown in figure 40 is an imported one, and is known as the Leopard moth on account of its color—white and black with brown head and abdomen. Scientifically it is known as *Zeuzera pyrina.* It is a very general feeder, having been known to attack maples, mulberry, hackberry, hickory, thorn-apple, sweet gum, tulip tree, oaks, basswood, elms, mountain ash, apple, pear, and even currant bushes. The eggs of this moth are said to be laid near the crotch of a tree in a group, and are covered by a loose, fluffy substance.

REMEDIES.

Where these insects are known to be working in trees they can be destroyed by injecting a small quantity of bisulphide of carbon into each burrow, after which the opening should be closed with clay. The fumes of this will kill the borers, while it is claimed it will not injure the tree.

THE APPLE-TREE CASE-BEARER.

(*Coleophora malivorella* Riley.)

Among the many insect enemies that attack the apple tree in the United States are to be mentioned certain species that are known as "case-bearers," from the fact that the larvæ live within cases or coverings, which they construct for themselves of silk, fragments of leaves and bark, intermingled with their own excrement. One of these case-bearers is shown in the accompanying illustration (Fig. 41).

FIG. 41.—The Apple tree Case-bearer (*Coleophora malivorella*): *a*, apple twig showing case of larvæ, and the work on leaves; *b*, larva; *c*, pupa; *d*, moth—*b*, *c*, and *d* enlarged. [After Riley.]

It is known as the Apple-tree Case-bearer, and has been known to greatly injure this tree in portions of the eastern and middle states. As yet it has not been reported as especially injurious in this or adjoining states, although it is known to occur in all of them, where it has been introduced on nursery stock.

This case-bearing moth lays its eggs upon the leaves during the month of July. The eggs soon hatch and the larvæ feed upon the leaves until they drop, when they migrate to the twigs and fasten their cases to the bark, where they remain during winter. The following spring they feed upon the leaves, which they skeletonize, and when full-fed abandon them and again repair to the twigs, where the case is firmly attached a second time. They now completely reverse their position within their cases and transform to chrysalids. About three weeks later the moths issue through the anal opening.

They are usually kept in check by a minute Chalcid which is parasitic upon them. They can also be destroyed with the arsenites which are so frequently recommended for killing other leaf-feeding insects.

THE RESPLENDENT CASE BEARER.

(*Aspidisca splendoriferella* Clem.)

A second species of these Case-bearing apple tree moths is herewith illustrated in its different stages of growth. Like the preceding, it has also made its appearance within the state, where it has probably been introduced on nursery stock. Although an exceedingly small insect for a moth, it makes up in numbers, as will be seen from the following quotation from the annual report of the U. S. Entomologist for the year 1879: * * "The first brood was quite numerous, but when the second brood began to make their cases, about the end of September, the apple trees were a sorry sight to the orchardist. I have frequently counted from twenty-five to thirty separate mines in a single leaf, from which one can see what a great drain this insect must have caused upon the vitality of the plant. In early October, when permanent hibernating quarters had been taken up, the tree trunks and larger branches were fairly covered with the clustering cases. I have counted forty-seven on a spot of bark not larger than a dime. In the crotches of the limbs, in the crevices of knots, and in similar places, they were particularly abundant. They were also to be found upon the grass and sticks at the base of the tree."

Before transforming to the chrysalis stage, this larva, like that of the preceding species, reverses its position inside the case. There are two broods annually; and it also attacks the pear and thorn-apples, as well as the wild cherry. The larvæ of the first brood transform almost immediately after fastening their cases permanently; but those of the second brood hibernate and transform the following spring.

NATURAL ENEMIES AND REMEDIES.

This little case-bearer is attacked and destroyed by ants and at least two distinct hymenopterous parasites, the one a Microgaster, which is

FIG. 42.—The Resplendent Case Bearer (*Aspidisca splendoriferella*): *a*, leaf of apple showing work; *b*, summer larva; *c*, larva in case traveling; *d*, cases tied up for winter; *e*, hibernating larva; *f*, pupa; *g*, moth; *h*, parasite—all enlarged but *a* and *d*. [After Comstock.]

figured in the illustration (Fig. 42 at *h*), and the other a Chalcid. These evidently keep it pretty well within bounds, but occasionally it may become sufficiently numerous to cause injury. In such a case a spraying of the trees with kerosene emulsion is thought to be an effectual remedy.

THE YELLOW-NECKED APPLE-TREE CATERPILLAR.

(*Datana ministra* Drury.)

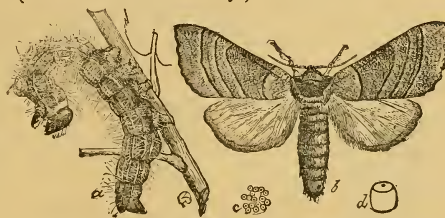


FIG. 43.—The Yellow-necked Apple-tree Caterpillar (*Datana ministra*): *a*, mature larva at rest; *b*, moth; *c*, eggs; *d*, a single egg greatly enlarged. [After Riley.]

The insect shown herewith in figure 43, *a*, larva, *b*, moth, is commonly found in our orchards during late summer and early fall. The caterpillars are rather large, more or less hairy, dark-colored with light stripes, and live in colonies. When about to molt they gather in clusters upon the larger branches or the trunk, where they remain for several days, clinging together by means of webs spun by the individual caterpillars. The position of the caterpillar in the cut is a common one for the insect when disturbed.

REMEDIES.

FIG. 44.—Army-worm Tachina fly; larva, pupa, imago, and front end of Army-worm showing eggs. [After Riley.]

This insect and other web-spinning caterpillars, such as are shown in figures 55 and 56, can very readily be controlled by hand-picking at molting times, and when first hatched, since at such times they are massed together. All the species of this and a couple other genera are very apt to be attacked by several kinds of flesh flies that usually keep the insects within due bounds. One of these flesh flies is shown herewith (Fig. 44).

LEAF-FEEDING CATERPILLARS.

(*Various kinds.*)

FIG. 45.—*Halesidota maculata.* [After Emerton.]

In addition to the several species of lepidopterous larvæ that are treated of at some length in the preceding pages there are a number of others that are always more or less numerous upon our trees. These, while possibly less injurious than the former, when working together do a vast amount of injury. Sometimes there will be a dozen or more kinds working at once upon a single tree. Some of them are figured herewith at Figs. 45–56.

FIG. 46.—White Marked Tussock Moth: *a*, female moth with eggs; *b*, young larva; *c*, female pupa; *d*, male pupa; *e*, male moth. [After Riley.]

Of these a very troublesome one in our state appears to be the White Marked Tussock Moth, which is shown in its different stages in figures 46 and 47. Although the female moths are without wings it

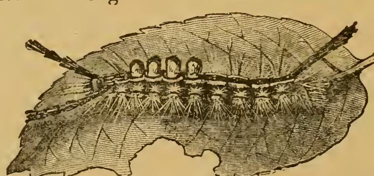


FIG. 47.—Mature larva of White Marked Tussock Moth. [After Riley.]

has managed to spread over the greater part of the country. Another of these wingless moths, the Canker Worm (*Anisopteryx vernata*) is also frequently quite a pest in localities away from the guardianship of the feathered tribe, or at least that portion of it that feeds upon these creeping vermin.

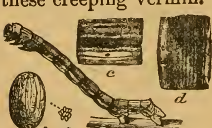


FIG. 48.—Canker Worm. [After Riley.]

FIG. 49.—Canker Worm; *a*, male moth; *b*, female moth. [After Riley.]

REMEDIES.

All of these leaf-feeders are readily kept under control by resorting to the arsenical sprays. They also suffer greatly from the attacks of many predaceous insects and dipterous and hymenopterous parasites.

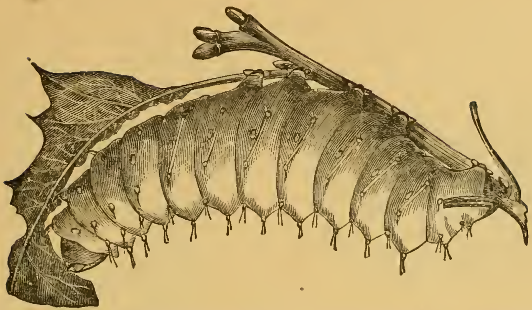


FIG. 50.—Larva of the American Silk-worm moth (*Antherea polyphemus*). [After Riley.]

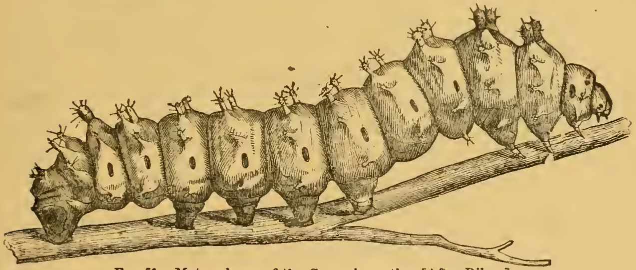


FIG. 51.—Mature larva of the Cecropia moth. [After Riley.]

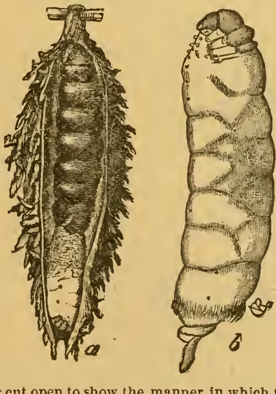


FIG. 52.—Bag-worm: *a*, bag cut open to show the manner in which the female works from her puparium and reaches the end of the bag; *b*, female extracted from her case—enlarged. [After Riley.]

FIG. 53.—The Apple-tree Tent-caterpillar (*Clisiocampa americana*): female moth. [After Riley.]

FIG. 54.—Eggs of Apple-tree Tent-caterpillar. [After Riley.]

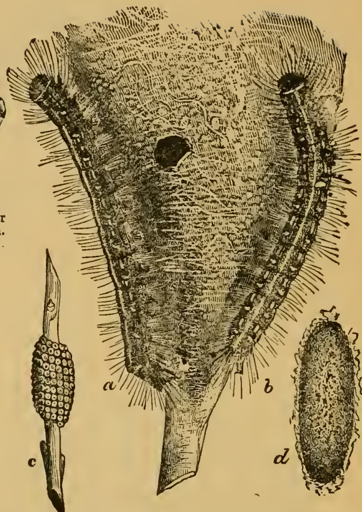


FIG. 55.—Apple-tree Tent-caterpillar; *a*, and *b*, mature larvæ; *c*, twig with eggs; *d*, cocoon. [After Riley.]

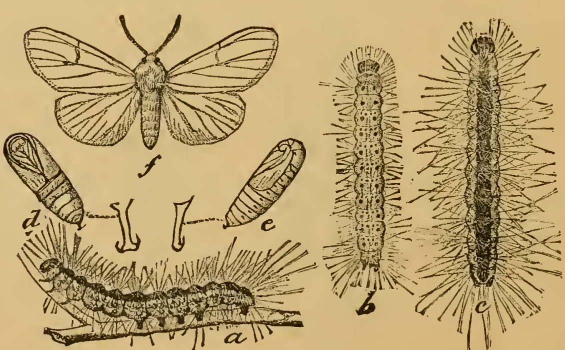


FIG. 56.—The Fall Web-worm (*Hyphantria cunea*): *a*, dark larva from side; *b*, light larva from above; *c*, dark larva from above; *d*, pupa, central view; *e*, pupa, from side; *f*, adult—all slightly enlarged. [After Riley.]

THE LEAF SKELETONIZER.

(*Pempelia hammondi* Riley.)

The insect which is shown in Fig. 57, although not very abundant within the state as yet, has been observed on several occasions at widely separated points. According to Osborn "the moths appear in early summer, and the caterpillars are destructive from early summer till in autumn. They eat only the upper portion of the leaf, leaving the ribs and the under epidermis, though portions of the pulpy part may remain and thus turn a rusty brown, and give the infested trees a burnt appearance. The leaf is covered with a thin web and under this the worm is slightly protected, and here will be found a mass of black excrement."

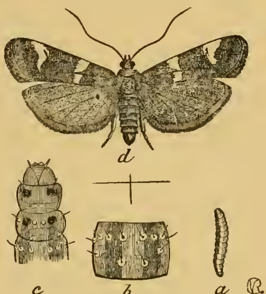


FIG. 57.—The Leaf Skeletonizer (*Pempelia hammondi*). [After Riley.]

REMEDY.

The arsenical sprays are sufficient to destroy the insect.

BUD WORMS.

In most localities apple trees are attacked by one or more species of very small caterpillars that are known as "bud-worms" because of their methods of attack. These insects begin their work very early in the season by eating into the unopened buds. Where very numerous it is evident that much injury can result to the trees. Two species of these insects are moderately common, viz., the Eye-spotted Bud-moth (*Tmetocera ocellana*), and the "Apple-bud Worm" (*Eccopsis malana*). Both of these insects belong to the "leaf-rollers" or family Tortricidæ among the moths, and as caterpillars protect themselves in some way by tying the new or dead leaves with silk.

REMEDIES.

Although the caterpillars begin their work quite early in spring, they continue to feed until after the fruit has formed and spraying has begun. They can usually be kept within bounds by the application of London purple or Paris green when used against the Codling moth and leaf-feeding caterpillars.

"CUT-WORMS."

(*Agrotis*, *Mamestra*, etc.)

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. 58), the illustration showing it as 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 directly bury-

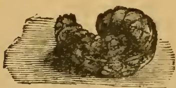


FIG. 58.—The W-marked Cut-Worm (*Agrotis clandestina*): larva. [After Riley.]

FIG. 59.—*Agrotis clandestina*: moth. [After Riley.]

ing 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.

REMEDIES.

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

FIG. 60.—Tachina or Flesh Fly.

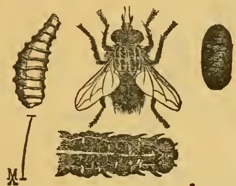


FIG. 61.—Army Worm Tachina fly: larva, pupa, imago, and front end of an Army Worm showing eggs. [After Riley.]

the evening scatter these poisoned baits over the field between the rows of beets, cabbage, etc., and about the bases of trees. 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. 60, and another at Fig. 61.

THE LEAF CRUMPLER.

(*Phycis indigenella* Zeller.)

This is an insect that causes much more injury to the apple and allied trees than is usually admitted by those who suffer loss from its ravages. Much has been written concerning the insect, which was first described in this country by Mr. Walsh. Later, Professor Riley gave a very full account of it along with the admirable figures of the insect and its work (see 4th Missouri Report, p. 38), which are copied herewith—Fig. 62. The following condensed account of the insect, taken chiefly from Riley's report, is copied from Osborn.* "It affects apple, plum, cherry, pear, crab, and other trees. The result of its labors is seen during fall and winter in the blackened, crumpled leaves firmly fastened to the branches. These branches will be found to contain one or more long tortuous tubes, and in these tubes will be found the half-grown worms, which become very destructive in the spring. The bunch of leaves containing tubes is shown in the figure at *b;* a single tube or case with head of worm protruding at *a;* the head of the worm alone at *c*. If these branches are left upon the tree till the following spring, the worms, which are then naturally quite hungry from their winter fast, begin upon the opening foliage, and the damage it is capable of doing at this time is very great. The tube in which it spends most of its time is an excellant protection against birds and other natural enemies, while the crumpled leaves surrounding it serve to deceive the orchardist and induce him not to trouble it. The larva pupates within the tube, and hence remains protected on the tree. The moth issues, and the eggs for the coming generations are laid during the summer. The eggs hatch shortly after being laid, and the worms begin feeding, and also the construction of a tube for their shelter. This is enlarged as occasion requires, and leaves are fastened to the outside, so that by winter time we have the bunch of crumpled dry leaves characteristic of the species."

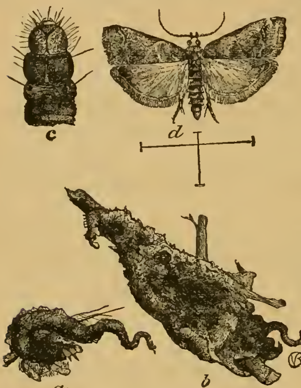


FIG. 62.—*Phycis indigenella: a*, tube, head of larva protruding; *b*, mass of tubes and leaves; *c*, head of larva; *d*, moth. [After Riley.]

REMEDIES.

"It is obvious that the insect can be destroyed by collecting the bunches of crumpled leaves during the winter when they are conspicuous, but probably the remedy that would prove most satisfactory now

* Transactions of the Iowa State Horticultural Society, 1892, p. 109.

would be the use of London purple or Paris green sprayed early in the spring, as soon as the worms begin their work. For this purpose it might be well to spray before the trees blossom. Where spraying is generally practiced for the Codling moth and other insect pests this is not at all likely to become troublesome, as the worms will, for the most part, I think, be killed by the later sprayings, and consequently few adults will appear to deposit eggs in summer."

LEAF-ROLLING CATERPILLARS.

(*Tortricidæ.*)

Under the general heading of "Leaf-Rolling Caterpillars" can be grouped quite a number of species that are more or less partial to the apple tree. The principal character by which these insects are to be recognized is the manner in which the larvæ protect themselves by

FIG. 63.—*Cacœcia rosaceana:* imago, larva, and pupa. [After Forbes.]

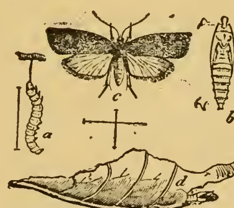


FIG. 64.—Apple-leaf Tyer (*Teras cindrella*): *a*, larva; *b*, pupa; *c*, imago. [After Riley.]

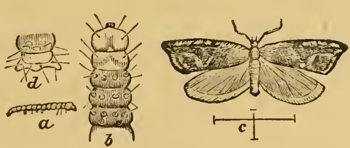


FIG. 65.—The Strawberry Leaf-roller (*Phoxopteris comptana*): *a*, larva, natural size; *b*, magnified; *c*, moth, a little enlarged. [Engraved after cut in Saunders' "Insects Injurious to Fruits."]

constructing tubes of the leaves by rolling or drawing them together by means of a web. Within this protection the larvæ feed or else retreat during day-time. One of these Leaf-rollers (*Cacœcia rosaceana*) is shown herewith as imago, larva, and pupa. It is known as the Oblique-banded Leaf-roller. A second species, the Apple-leaf Tyer (*Teras cindrella*) is also figured herewith (Fig. 64). A third is also shown in the illustration at 65. In addition to these three species a number of others are known to attack the apple.

REMEDIES.

Since these insects are always more or less protected within their leaf burrows they are rather more difficult to handle than is commonly the case with leaf-feeding species. The arsenical sprays will, however, reach many of the caterpillars and keep them from increasing to any great extent. They are also quite subject to the attacks of hymenopterous parasites.

GRASSHOPPERS OR LOCUSTS.

(*Acrididæ.*)

Quite prominent among the insect enemies of the apple tree are to be mentioned certain kinds of locusts or grasshoppers. Of these there are at least a dozen species that at times are especially injurious to the tree by eating off the leaves and even the bark from the smaller branches and twigs. Among these species our commonest are the following: The Differential, Two-lined, American, Large Green, Migratory, Lesser Migratory, Red-legged, and Devastating, some of which are figured herewith. (See Figs. 66 to 71.)

FIG. 66.—*Shistocerca americana:* female. [After Riley.]

FIG. 67.—The Differential Locust (*Melanoplus differentialis*): female. [After Riley.]

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

FIG. 68.—The Red-legged Locust (*Melanoplus femur-rubrum*): female. [After Riley.]

FIG. 69.—Rocky Mountain Locust (*Melanoplus spretus*): male. [After Riley.]

FIG. 70.—*M. devastator.*

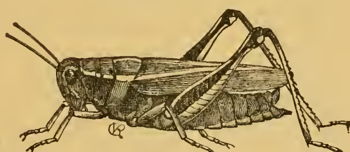


FIG. 71.—The Two-lined Locust (*Melanoplus bivittatus*). [After Riley.]

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." (See Fig. 72.) These latter are shallow sheet-iron pans in which are put coal tar or kerosene oil and drawn over the ground

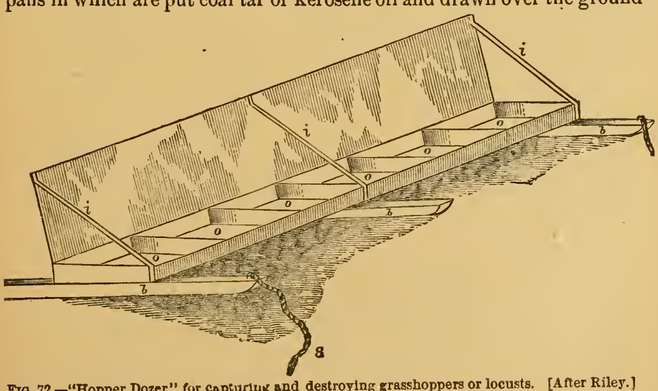


FIG. 72.—"Hopper Dozer" for capturing and destroying grasshoppers or locusts. [After Riley.]

by horses in such a manner that the 'hoppers will hop into the pan and be killed by coming in contact with the oil. This latter remedy has been described very fully in several of the United States Entomological Commission reports, as well as in the reports of the Department of Agriculture.

THE IMBRICATED SNOUT-BEETLE.

(*Epicærus imbricatus* SAY.)

The accompanying figure (Fig. 73) represents one of the weevils or snout-beetles that sometimes attacks various fruit trees, the twigs, fruit, and leaves of which it gnaws. Here in Nebraska this beetle is quite common; and at times, in certain localities, has been known to do considerable injury to these trees as well as to a variety of other plants. Among those plants upon which it feeds, the following have been mentioned by different writers: apple, cherry, gooseberry, onions, radishes, cabbage, beans, watermelons, muskmelons, cucumbers, squashes, beets, and potatoes.

FIG. 73.—Imbricated Snout-beetle (*Epicærus imbricatus*): dorsal and side view. [After Riley.]

Up to the present time its life-history is not known, nor has it been very regular in its arrival at all points within its range each year. It is one of a few of our insect enemies that comes and goes by starts—sometimes appearing in great numbers several years in succession, and then again being almost entirely absent for one or more years—a regular Bohemian, as it were.

REMEDY.

When numerous, an application of Paris green or London purple will effectually check them, if used as for the Colorado potato beetle.

THE ROSE CHAFER.

(*Macrodactylus subspinosus* Fabr.)

A very prominent injurious insect in which the horticulturists are very much interested is the one shown in Figs. 74 and 75, and which

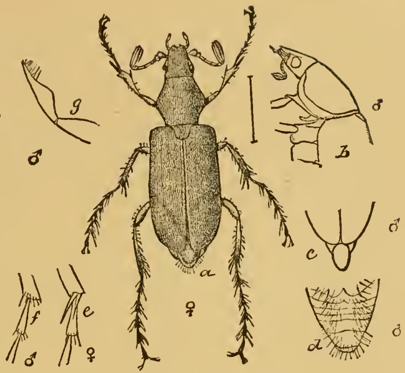


FIG. 74.—The Rose Beetle (*Macrodactylus subspinosus*): *a*, female beetle; *b*, *c*, *d*, *e*, *f*, and *g*, outline figures showing characters of the sexes, etc.—all enlarged. [After Riley.]

is known as the Rose Beetle or Rose Chafer, from the fact that it appears to be especially fond of the various kinds of roses, both wild and cultivated. It is also very fond of most of our fruit trees and shrubs. It also is a grape pest. Prof. C. V. Riley, Entomologist of the United States, published a very complete article on the history of this insect, in which he treated the subject from all standpoints.* He says it is one of the insects most frequently treated in horticultural literature; that it is native to America; and that it has become injurious to cultivated plants within the present century. He also describes the larva and pupa, and shows how the former is also very injurious by feeding upon the roots of various grasses, herbs, and perhaps trees too.

NATURAL HISTORY.

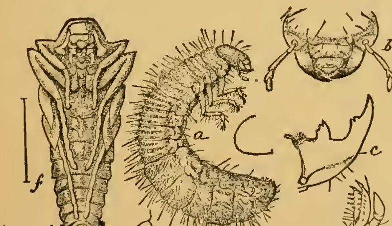


FIG. 75.—The Rose Beetle (*Macrodactylus subspinosus*): *a*, full-grown larva, side view; *b*, head of larva, front view; *c*, left mandible or jaw of larva from below; *f*, pupa, below—all magnified. [After Riley.]

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

* Insect Life, Apr., 1890, pp. 295–302.

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 larvæ 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 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 grapevine." [Riley, l. c.]

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 a one is killed by Carabid beetles.

THE DOMINICAN CASE-BEARER.

(*Coscinoptera dominicana* Fabr.)

While this insect, which is figured below, is not considered one of our injurious fruit pests, it is nevertheless known to feed upon both the apple and plum in addition to a number of our other trees and shrubs. It is, however, included here to show the readers that there are other case-bearers among insects besides those belonging to the Lepidoptera. This beetle, for such it is, belongs to the extensive family of leaf-beetles known to the entomologist as Chrysomelidæ. The case which adorns the back of the larva is composed of mud which it attaches from time to time to the open or lower edge as the growth of its owner requires it. This case is adorned with longitudinal ridges, as shown in the illustration *b*.

The beetle is plain black, and covered with a thin coating of short gray hairs, which give it a sort of a grizzled appearance. The eggs are covered with a coating of excrementitious matter that is worked into the form of cones or seed-pods of some evergreen, and are elevated upon slender thread-like stalks as shown at *e* and *i*.

FIG. 76.—The Dominican Case-bearer (*Coscinoptera dominicana*): *a*, larva removed from case; *b*, same, with case; *c*, beetle showing punctures; *d*, do., natural size; *e*, egg magnified; *i*, cluster of same, natural size; *f*, *g*, *h*, *j*, *k*, *l*, figures showing anatomy of parts. [After Riley.]

There are quite a number of these case-bearing beetles to be met with in any part of our country, and some of them are even quite injurious to the vegetation upon which they feed. When remedies are required against them, they can be destroyed by jarring them off and collecting them in an inverted umbrella, or by spraying the foliage with London purple or Paris green in the proportion so often recommended.

"MAY BEETLES."

(*Lachnosterna.*)

The common May-beetles, *Lachnosterna fusca* and allies, are among the most troublesome of all insect pests with which the tree-grower has to deal. 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 in these new regions than in older ones, because the tree growths in these newly cultivated districts are so scant that a moderate number of the beetles will very quickly entirely strip off the leaves, while they would make but little show if working on the foliage of many trees and those 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 destruction among our fruit, shade, and forest trees.

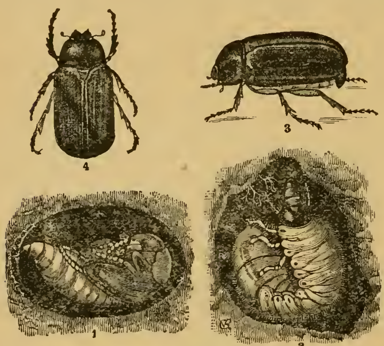


FIG. 77.—The common May beetle (*Lachnosterna fusca*): 1, the pupa; 2, the larva or White grub in its ground cell; 3 and 4, the beetle, side and dorsal view. [After Riley.]

These different species of May and June beetles are usually about the size of the one shown in the accompanying figure (77), 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.

LIFE-HISTORY.

The life-history of these beetles, although differing slightly among themselves, may be summed up practically as follows: Shortly after pairing, the female beetles creep into the earth, especially wherever the soil is rough and loose and more or less covered by vegetation, and after depositing their eggs to the number of forty or fifty, die. These eggs hatch in from three to five weeks, and produce grubs that feed upon the roots of various plants and grow slowly for a little upwards of two years, when they change to the pupa stage within cells in the ground which they construct for themselves. Within these cells the beetles remain during the remainder of the summer, fall, and winter into the following spring, when they crawl to the surface and are ready to take active part in the destruction of all kinds of tree foliage and to prepare for the propagation of future generations.

REMEDIES.

On account of their underground life the larvæ or grubs of the May beetle are very difficult to reach and destroy. They are not without their natural enemies, both vertebrate and invertebrate, and by far the greater 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 its

FIG. 78.—White Grub Parasite: *a*, imago; *b*, head of larva; *c*, larva; *d*, cocoon. [After Riley.]

FIG. 79.—White Grub Fungus. [Aft. Riley]

several stages at Fig. 78. The larva of this black or bluish-black wasp attacks and destroys the grubs, after which it spins a pale brown elongate 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. Last spring, and in fact for several successive years, here in the city of Lincoln these May-beetles were attracted to the electric lights by the thousands, and also along with these, 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 frequently attacked and destroyed by a peculiar whitish fungus. This fungus issues near the head of the grubs and occasionally attains the length of three or four inches, when it has near the appearance of the accompanying illustration (Fig. 79). Another fungus has been experimented with during the past few years with a view to destroying the grubs, but without success, I am sorry to say.

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. In some instances the beetles can also be destroyed by spraying the foliage of trees with either London purple or Paris green.

APPLE-TREE FLEA-BEETLE.

(*Graptodera foliacea* Lec.)

This insect, which is represented in Fig. 81, magnified, can be readily recognized from the following description: In size it is somewhat variable, ranging from four to five millimeters in length; it is oval in its outline, and of a highly polished brassy-green color. Antennæ dull brownish black beyond the three basal joints, which are somewhat obscured by a coating of short fine hairs or gray pubescence. The feet are dull brownish, or reddish brown, and, with the legs and under parts generally, are also somewhat pubescent.

FIG. 80.—The Apple-tree Flea-beetle (*Graptodera foliacea*), showing beetle natural size, and mode of attack. [After Popenoe, drawing by C. L. Marlatt.]

FIG. 81.—Apple-tree Flea-beetle—greatly enlarged. [After Popenoe, drawing by C. L. Marlatt.]

We are indebted to Prof. E. A. Popenoe for a pretty full life history of this beetle,* and in treating of it here I will quote his language largely.

"Throughout its range, so far as noted, it usually occurs upon plants of the evening primrose family (*Onangraceæ*), being especially partial to the silky gaurus (*Gaura parviflora*), and others, the leaves of which are often riddled by it. * * *

"For several years past the beetle in question has attracted attentention on the college grounds (at Manhattan, Kan.) by its attacks during May and June upon the apple tree, the leaves being the portions injured. In orchard trees the lower branches only, near the ground, have suffered, and these but slightly. The greatest injury has been done in the nursery, where the beetle has often completely defoliated the spring-set root-grafts, and the yearling trees, and has seriously injured even two-year-old trees. The insects are most active

* Bulletin No. 3 of the Experimental Station of Kansas Agricultural College, pp. 37-39.

in bright, warm weather, and are then attracted to the trees in great abundance, where they feed upon the parenchyma [green pulp between the veins] of the leaf (Fig. 80), avoiding the veins and midrib, these being sometimes all that remains after a few days' presence of the beetle. It is on the young shoots of the root-grafts that their work is the most injurious. In these they keep the new growth cut so close that the graft sometimes fails to recover. While the injury to yearlings is considerable, yet the trees, though denuded, usually recover and throw out new leaves after the season of attack is past."

REMEDIES.

While this beetle does not appear to be quite as susceptible to the effects of poisons as are some of the other insect enemies of the apple, it can very readily be destroyed by using the arsenites, London purple or Paris green, in the proportions of one pound of the poison to 150 gallons of water.

THE APPLE THRIPS.

(*Thrips tritici* Fitch.)

FIG. 82.—*Thrips tritici.*

The insect which is shown herewith in Fig. 82 is a very minute and slender creature of a light straw-yellow color that sometimes gathers upon apple blossoms in large numbers which it easily enters even before they have opened. When such is the case they often do considerable injury to the blossoms by gnawing the delicate parts and causing them to dry up and fall without producing fruit.

One or more additional species of thrips have also been found to frequent apple blossoms in a similar manner.

REMEDY.

As yet no remedy has been suggested by which to prevent these injuries by thrips.

THE INDIAN CETONIA.

(*Euphoria inda* Linn.)

FIG. 83.—The Indian Cetonia (*Euphoria inda*).

This beetle which is figured herewith is a very common insect in all parts of the country to the eastward of the great plains. It is one of our earliest spring visitors, and may often be seen flying about in sheltered localities before the snow has entirely disappeared from the more open places. It is very frequently seen here in Nebraska during early April, as it skims over the surface a foot or two above the earth, producing a buzzing noise very similar to that produced by a bumble-bee. When flying, this and other members of the sub-family, instead of lifting the elytra, the wings are merely thrust out at the sides.

All of the Cetoniidæ are lovers of flowers, and also of the sweet juices of plants of various kinds. This beetle is, therefore, quite injurious to different kinds of ripe fruit upon which it gathers in large numbers, often entirely devouring apples, peaches, and pears. It is also a corn insect here in the west, feeding upon the ends of the ears while still soft. I have also taken many of the beetles upon the trunks of apple and other fruit trees, where they had gathered about "bleeding" wounds produced by wind-breaks or pruning. Just what the larval habits of this beetle are I do not know; but I have taken the beetle on several occasions from ants' nests in company with *Eu. hirtipes* which I have never taken anywhere else.

REMEDY.

The beetle should be gathered and destroyed at all times and places; for should its larval habits be such as to permit of its increase in great numbers it can become a dangerous pest.

THE CODLING MOTH.

(*Carpocapsa pomonella* Linn.)

All fruit growers, and especially those who have apple orchards, know the insect only too well to make it necessary for me to describe it here. In Nebraska the insect is double brooded—*i. e.*, there are two broods annually, the first being that of early spring, resulting from the eggs deposited in the forming fruit during May and very early June. These first worms are only about four weeks in attaining their growth after the eggs have hatched. When full-grown they gnaw to the surface, crawl out, and seek some refuge upon the trunk of the tree, or other favorable position, in which to spin their slight cocoon, in which to transform. In about two weeks more these first pupæ of the year have issued as moths, and soon commence the deposition of eggs for the second generation. Each female deposits about fifty eggs during her egg-laying season, which usually is extended over a period of a week or ten days. The eggs for this second generation are placed indiscriminately over different parts of the fruit, although the calyx end offers the best location, and receives by far the greater per cent of them. These last larvæ usually hibernate as such, especially northward—some in the orchard, others in storerooms, barns, cellars, and barrels, where they have been carried in the fruit from the orchards, this being the chief manner in which the insect has become so widely disseminated over the civilized world.

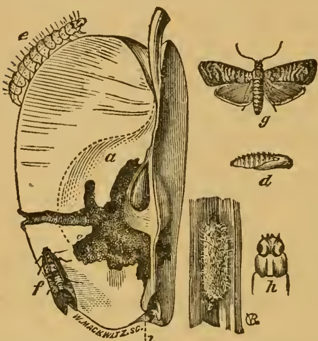


FIG. 84.—The Codling Moth (*Carpocapsa pomonella*): *a*, fruit showing mine of larva; *b*, place of entrance; *c*, mine or burrow; *d*, pupa; *e*, larva; *f*, moth, wings closed; *g*, same, wings spread; *h*, magnified view of head of larva; *i*, pupa cocoon. [After Riley.]

Although confined principally to the apple, the Codling moth also breeds in a variety of other fruits—peaches, apricots, plums, and allied stone fruits sometimes suffering greatly from its attacks; but its principal haunts, outside of the apple, are among the seeded fruits of the *Rosaceæ*, as the pear, quince, hawthorn, and perhaps the seed buds of roses.

REMEDIES.

On account of the miscellaneous food habits of the Codling moth, there is no single remedy that will suffice to keep in check and prevent its injuries to our apple crop. We must, therefore, adapt our remedies to the habits of the insect by meeting it on all sides, and at different seasons of the year. The best remedy now known, and the only one by which the first brood is killed and a large per cent of the fruit saved from their ravages, is the use of one or the other of the arsenical sprays, composed of London purple or Paris green, with water. These are to be applied just after the fruit has "set" and before it has become heavy enough to droop or the calyx end to turn downward. One or two thorough sprayings at this time will, it has been proved, save at least seventy per cent of the loss otherwise experienced. The ratio of these poisons best adapted for the purpose has not been definitely ascertained, since this varies with conditions of climate, latitude, etc. About four ounces of the Paris green and three of the London purple to the barrel of water will probably be sufficiently strong to kill the worms and at the same time not injure or kill the foliage during ordinary weather at this time of year.

Such other remedies as the gathering of "wind falls," and destroying them, or turning hogs and sheep into the orchard to either feed upon or trample upon the creeping worms; the jarring or picking of infested fruit from the trees; the gathering and destruction of the cocoons containing larvæ and chrysalids from the trunks and branches of trees; the killing of moths in various ways; and the trapping of the larvæ by using bandages, shingles, etc.; all of these remedies with which every fruit grower is more or less familiar, through personal experience, do of course come in play as the opportunities permit during the year, and combined, do much good.

FIG. 85.—The Banded-legged Pimpla (*Pimpla annulipes*)—enlarged. [After Riley.]

Like all other injurious insects, the Codling moth is preyed upon by certain of the birds, and also has certain true parasites that destroy many of the worms, which otherwise would be permitted to mature. Quite a number of the predaceous beetles are also known to feed upon the worms while the latter are creeping about preparatory to spinning in, as well as afterward.

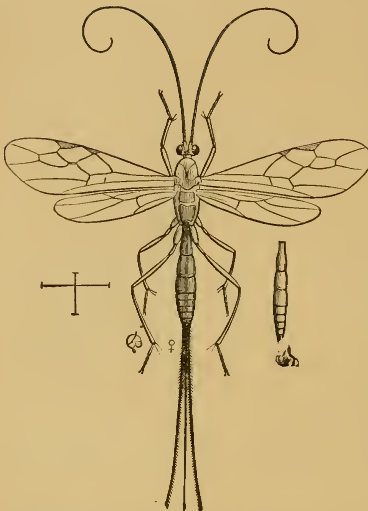


FIG. 86.—The Delicate Long-sting (*Macrocentrus delicatulus*)—enlarged. [After Riley.]

But do not let us stop here, even if we know that a dozen or more species of friendly insects are aiding to destroy this moth. Let us lend a hand by doing our "share of destruction."

Two of the hymenopterous parasites that attack and kill the larva of the Codling moth are shown herewith. They are known as the Ring-legged or Banded-legged Pimpla (Fig. 85), and the Delicate Long-sting (*Macrocentrus delicatulus*), Fig. 86. The larvæ of several of the Lampyridæ or Fire-flies are known also to aid in this good work.

THE APPLE GOUGER OR CURCULIO.

(*Anthonomus quadrigibbus* Say.)

Until quite recently the insect known as the four-humped Curculio, or Gouger, has been absent from the state, as an injurious species at least. During the past three or four years, however, it has been quite a pest in the older orchards of the southeastern part. In writing of this insect Professor Osborn says, "Apples are often very much stunted in growth and distorted in form by the attacks of this insect, and it may be considered one of the serious apple pests. The beetle is recognized by the four sharp humps on the back portion of the wing-covers (see Fig. 89). The beak is long and the body enlarges toward the posterior end."

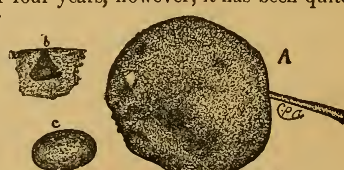


FIG. 87.—A, Apple infested by Apple Curculio; *b*, egg-cavity, natural size; *c*, egg, much enlarged. [After Gillette.]

The method of attack and injury is shown in the above illustration at Fig. 87. The insect punctures the fruit with its beak both in feed-

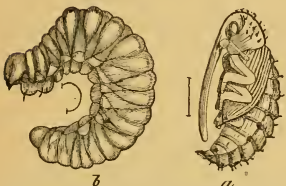


Fig. 88.—*Anthonomus quadrigibbus:* b, larva; a, pupa. [After Riley.]

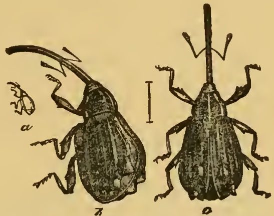


Fig. 89. — *Anthonomus quadrigibbus:* beetle, *a*, natural size; *b*, side view; *c*, top view. [After Riley.]

ing and when laying its eggs. When the apples thus injured do not fall from the tree they become greatly distorted as seen in the picture; but most of the fruit injured drops.

REMEDY.

Spray with the arsenites as directed for Codling moth and leaf-feeding caterpillars during time of egg-laying.

THE PLUM CURCULIO.

(*Conotrachelus nenuphar* Herbst.)

While this insect is essentially a plum, peach, and cherry enemy, it also frequently confers its attention to the apple. When this is the case it is the cause of some injury, as can be seen by reference to the illustration as presented in Fig. 91. This illustration shows simply the punctures made by the insect while feeding. Its egg punctures are always further indicated by the crescent mark which partly surrounds them.

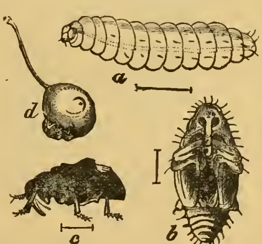


Fig. 90.—Plum curculio: *a*, larva; *b*, pupa; *c*, beetle; *d*, young plum showing puncture and crescent. [After Riley.]

THE PLUM GOUGER.

(*Coccotorus prunicida* Walsh.)

In addition to the two insects named above as apple enemies, the Plum Gouger, which is shown in Fig. 92, has also been known to attack apples in a similar manner with the above. Whether or no it ever breeds here I have not learned; but, judging from its habit of entering the pit of the plum as a larva, I imagine that it does not.

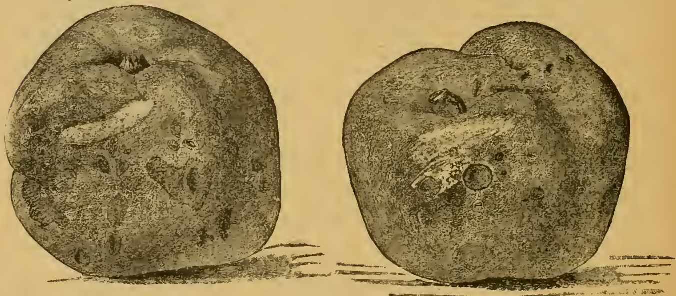


FIG. 91.—Apples showing Plum Curculio punctures—natural size. [From Insect Life.]

Fig. 93 represents still another species of these gougers that may in future be found to attack the apple, viz., the Sand-cherry Gouger.

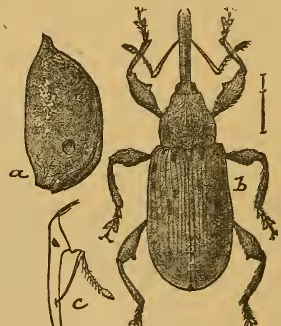


FIG. 92.—Plum Gouger. [Insect Life.]

FIG. 93.—Sand-cherry Gouger. [Insect Life.]

REMEDY.

The remedy suggested for the Apple Gouger will apply equally well for fighting both the curculio and gouger of the plum when they are found attacking the apple.

THE APPLE-MAGGOT.

(*Trypeta pomonella* Walsh.)

Possibly one of the most troublesome apple pests that the orchardist has to deal with is the one known as the Apple Maggot. Although not reported from the state thus far, it can be but a matter of time when it will be with us and require our attention. It is now pretty well distributed over the states further east and south, and could very readily be introduced in shipments of fruit from such localities. Osborn has given us a very condensed account of this insect in the Transactions of the Iowa Horticultural Society for 1892, and Prof. F. L. Harvey, of the Maine Experiment Station, a very full treatise upon it in a bulletin from that station. For our present purposes the condensed account by Osborn will answer best. The illustrations used here are those used by Harvey.

"The flies that deposit the eggs from which the maggots are developed appear in June, and from that time on till late in fall. The eggs are deposited by puncturing the skin of the fruit.

FIG. 94.—*Trypeta pomonella*, pupa. [After Harvey.]

"The eggs are deposited in all parts of the apple, but most commonly upon the cheeks and less on the calyx and stem ends. They hatch in four or five days, and the maggots begin at once to work in the pulp of the fruit, and, as they grow, fill it full of channels and burrows, and as these are extended they coalesce and reduce the pulp to a series of cavities. This work does not show on the outside perceptibly, and the fruit may be shipped as good, but soon rots and gives up its horde of larvæ. These enter the ground to become pupæ, and in this stage the insect remains over winter to emerge the following season sometime between May and autumn.

REMEDIES.

"The remedies most strongly recommended are the immediate destruction of the wind-falls in infested orchards, which can be done by gathering tnem every day and feeding them to swine, or throwing them into pits, that should be covered with a foot or two of earth after the season is over. Or, where it can be done, hogs or sheep may be

Fig. 1

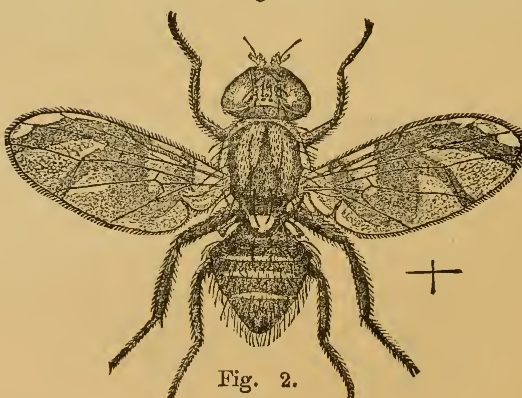


Fig. 2.

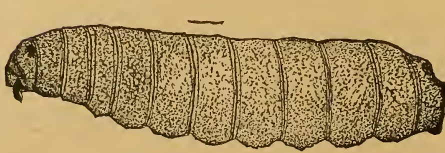


Fig. 3.

FIG. 95.—*Trypeta pomonella:* 1, female; 2 male; 3 maggot. [After Harvey.]

allowed to range for a time each day in the orchard to gather up the wind-falls, and if enough to collect them thoroughly this would be the most feasible plan.

"A matter requiring special attention here is to prevent their introduction from other localities, and particularly states further south, from which we get a large supply of early apples."

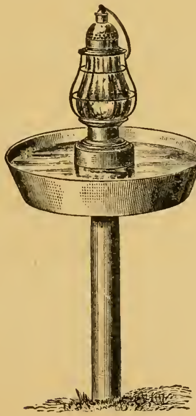


FIG. 96.

THE INSECT

ENEMIES OF SMALL GRAINS.

Extracted from the Annual Report of the Nebraska State Board of Agriculture for 1892.—pp. 360-466.

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 sinilis* 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 pygmæus* 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.)
Læmophlæus 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 Diabrotiba (*Diabrotica 12-punctata* Oliv.)
Chætocnemis confinis Cr.
Chætocnemis pulicaria Mels.
Psylliodes insterstitialis 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.)
False 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.
Dræocoris rapidus Say.
Podisus——Sp?

Sub-Order Homopetra.

Jassus inimicus Say.
Black-Fronted Leaf-Hopper (*Cicadula nigrifons* 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 atlanis* 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 (*Camnula 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.

(*Ceadomyia destructor* Say.)

The Hessian Fly is possibly quite as important an insect enemy of the small grains as the Chinch Bug. Certainly it has occupiéd 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. Expr. 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.

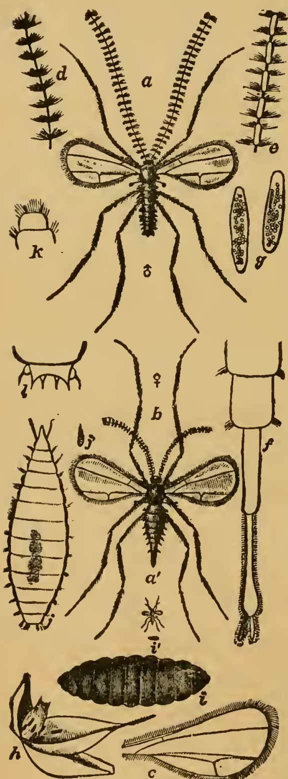


FIG. 2.—The Wheat Midge: *a*, male; *b*, female; *h*, flower of wheat showing larva on kernal. Other figures showing various parts of insect more highly magnified. [After Fitch.]

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, obliges 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 consider able 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 larvæ 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 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

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

* 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,

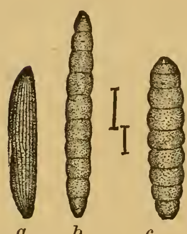


FIG. 6. — *Meromyza americana; a*, egg; *b*, larva; *c*, puparia—enlarged.—[After Forbes]

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 Jointworm 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 figureswill show the difference between these two little flies, so no description will be necessary.

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

REMEDIES.

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.

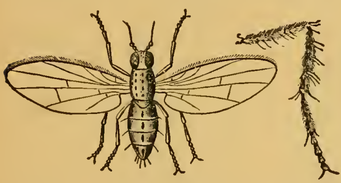


FIG. 11.—*Hylemyia deceptiva*—enlarged about four times, with a hind leg still more enlarged.—[After Fitch.]

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

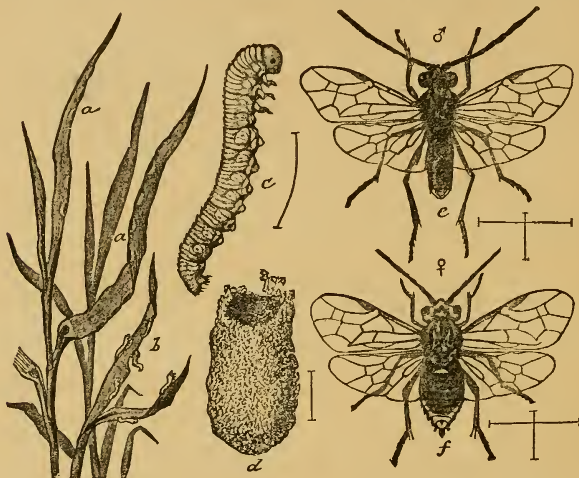


Fig. 12.—*Nematus marylandicus: a a*, eggs in wheat blades; *b*, young larvæ; *c*, full-grown larva; *d*, cocoon from which fly has escaped: *e* and *f*, adult insects—*e*, male; *f*, female; *a* and *b*, nat. size; *c* to *f*, enlarged. [Insect Life.]

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

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

Other species of saw-flies 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 pygmæus* Linn.)

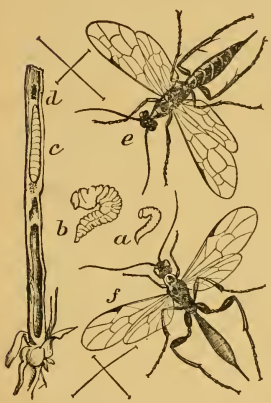


Fig. 14.—*Cephus pygmæus*: *a*, outline of larva—nat. size; *b*, larva enlarged; *c*, larva in wheat stalk—nat. size; *e*, adult female; *f*, female parasite—enlarged. [After Curtis.]

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.

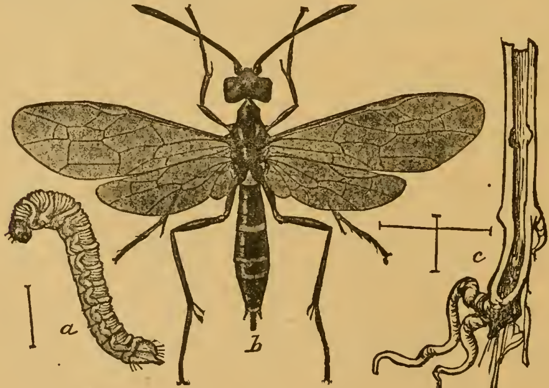


FIG. 15.—*Cephus occidentalis:* *a*, larva; *b*, imago, female; *c*, base of grass stalk showing excavation of larva—all enlarged. [Insect Life.]

THE WHEAT JOINT-WORM.

(*Isosoma hordei* Harr.)

By refereuce to figure 16 the reader will see illustrated a small 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.

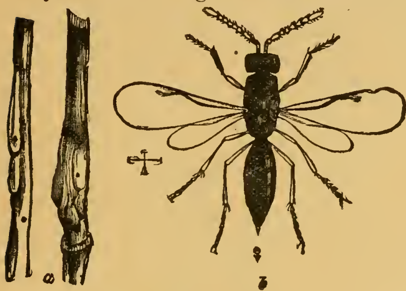


FIG. 16.—*Isosoma hordei: a*, wheat straws showing injury; *b*, female insect.—[After Riley.]

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

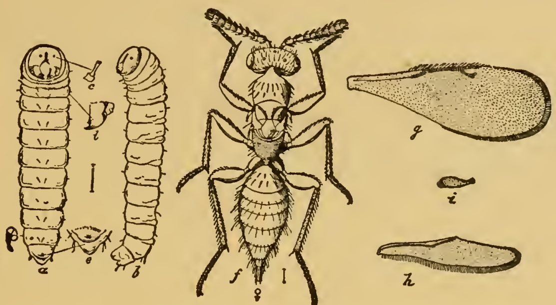


FIG. 19.—*Isosoma tritici; a, b,* larva; *f,* adult female; *g,* fore wing; *h,* hind wing.—[Riley.]

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."

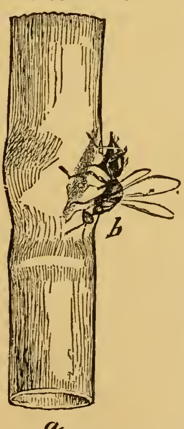


FIG. 20.— *Isosoma grande.*—[After Riley.]

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

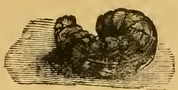


FIG. 21.—The W-marked Cut-Worm (*Agrotis clandestina*); larva.—[After Riley.]

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* Huebn.)
THE CLAY-COLORED CUT-WORM. (*Agrotis Morrisoniana* Riley).
THE BRONZY CUT-WORM. (*Nephelodes violans* Guené.)

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.]

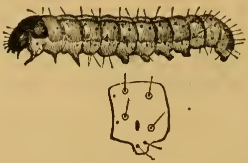


FIG. 24.—*Hadena devastatrix:* larva. [After Riley.]

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

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

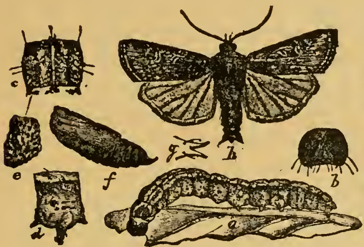


FIG. 27.—The Granulated Cut-worm (*Agrotis annexa*): *a*, larva; *f*, pupa; *h*, moth. [After Riley.]

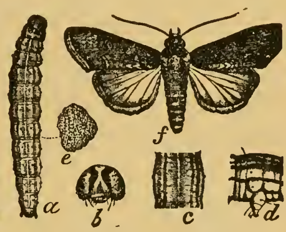


FIG. 28.—The Shagreened Cut-worm (*Agrotis malefida*): *a*, larva; *f*, moth. [After Riley.]

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.]

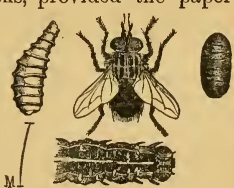


FIG. 30.—Army Worm Tachina fly: larva, pupa, imago, and front end of the Army Worm showing eggs. [After Riley.]

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 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.

FIG. 31.—Tachina or Flesh Fly.

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.

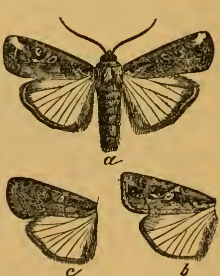


FIG. 32.—*Laphygma frugiperda:* moth, showing variations. [After Riley.]

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."

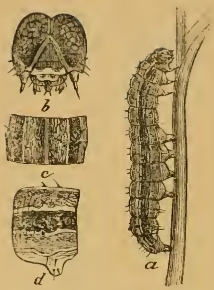


FIG. 33.—*Laphygma frugiperda: a*, larva; *b*, head of same. [After Riley.]

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 ascendency. 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 allurement 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 xylina* 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.

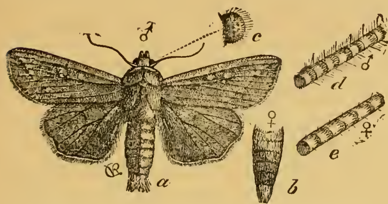


FIG. 35.—The Army Worm (*Leucania unipuncta: a*, male moth; *b*, abdomen of female, natural size; *c*, eye; *d*, antennal joints of male; *e*, do. of female, enlarged. [After Riley.]

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

Here in Nebraska the larva of a species of saw-fly is sometimes "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.

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

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.—*Colsoma 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

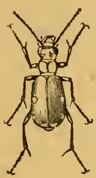


FIG. 39.—*Cicindela 6-guttata.* [After Riley.]

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

FIG. 41.—*Exorista leucaniæ.* [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.)

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

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 related 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 stigmated 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 vertebrates 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 *Pyralidæ*, 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 synonomy.

In referring to the distribution of this insect that author writes as follows: "*Eurycreon rantalis* † 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. 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 xylina*). The characteristic 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 (*crinisalis*) the anterior line and inner portion of posterior line may be lacking."

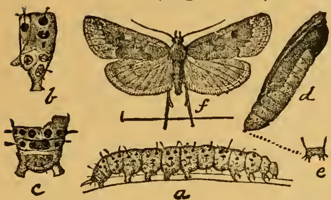


FIG. 44.—Garden Web-Worm (*Loxostege*): *a*, larva; *d*, pupa; *f*, moth—all slightly enlarged. [After Riley.]

"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.—*Colsoma 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 outbuildings, 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.

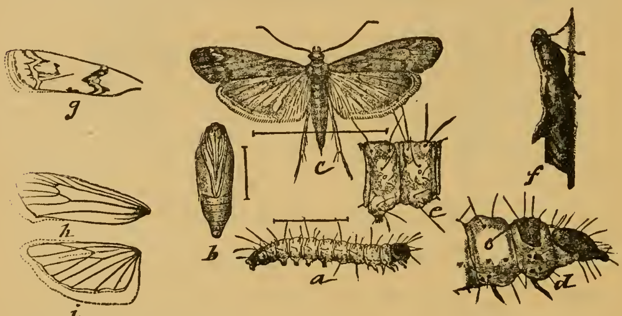


FIG. 48.—*Ephestia kuhniella: a*, larva; *b*, pupa; *c*, imago—enlarged; *d*, head and thoracic joints of larva; *e*, abdominal joints of same more enlarged; *f*, moth from side, resting; *g*, front wing, showing more important markings; *h*, venation of fore-wing; *i*, venation of hind-wing—somewhat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

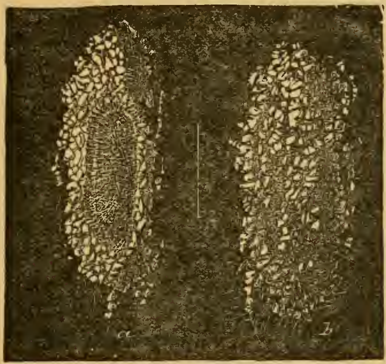


FIG. 49.—*Ephestia kuhniella:* *a*, cocoon from below, showing pupa through the thin silk attaching the cocoon to a beam; *b*, same from above—enlarged. [Insect Life.]

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 Ephestia 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.

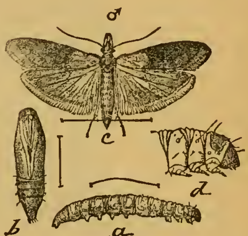


FIG. 50.—*Ephestia interpunctella:* *a*, larva; *b*, pupa; *c*, imago—enlarged; *d*, head and thoracic joints of larva still more enlarged.—[Insect Life.]

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.

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 *Crambidæ*—it may be of interest to state that they

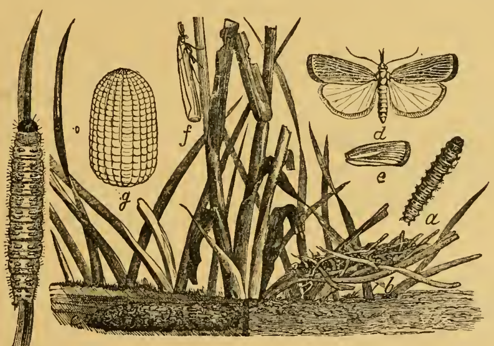


FIG. 51.—*Crambus vulgivagellus:* *a*, larva; *b*, web of same; *c*, cocoon; *d*, moth, wings expanded; *f*, same, wings closed; *g*, egg—greatly enlarged. [After Riley.] Larva more highly magnified at left. [After Linter.]

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 arcanella* 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.)

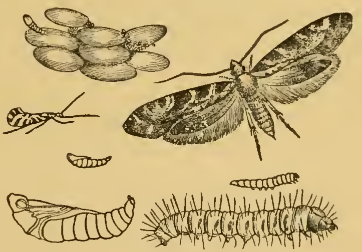


FIG. 52.—*Tinea granella:* larva, pupa, imago, natural size and enlarged; also grain fastened together by web of larva. [After Packard.]

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.

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 statement 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-

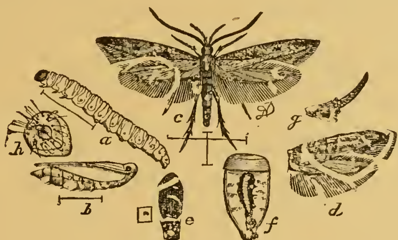


FIG. 53.—*Gelechia cerealella; a*, larva; *b*, pupa; *c*, moth; *f*, mode of attack. [After Riley.]

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 impreceptible 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.

LÆMOPHLÆUS 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.

Tenebrioides dubia Mels.

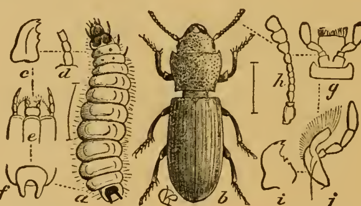


Fig. 55.—*Tenebrioides corticalis: a*, larva; *b*, beetle. [After Riley.]

WIRE WORMS.

Fig. 56.—Wire Worm, Nat. Size.

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

Agriostes 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.

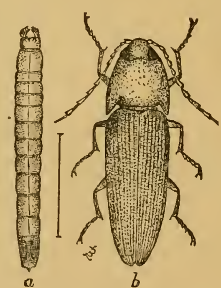


Fig. 58.—The common Snapping-beetle (*Melanotus communis*): *a*, larva; *b*, beetle. [Original.]

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

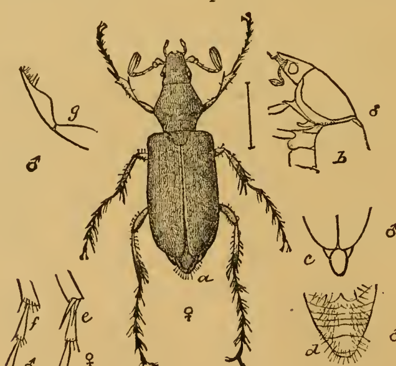


FIG. 59.—The Rose Beetle (*Macrodactylus subspinosus*): *a*, female beetle; *b*, *c*, *d*, *e*, *f*, and *g*, outline figures showing character of the sexes, etc.—all enlarged. [After Riley.[

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

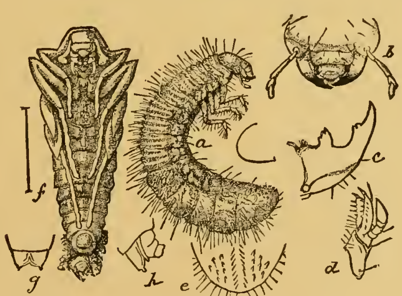


FIG. 60.—The Rose Beetle (*Macrodactylus subspinosus*): *a*, full grown larva, side view; *b*, head of larva, front view; *e*, left mandible of jaw of larva from below; *f*, pupa, below—all magnified. [After Riley.]

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 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.

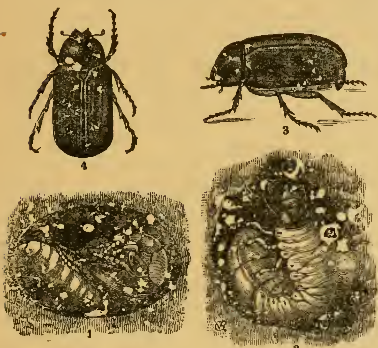


FIG. 61.—The Common May-beetle (*Lachnosterna fusca*): 1, the pupa; 2, the larva or white grub in its ground cell; 3 and 4, the beetle, side and dorsal views. [After Riley.]

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 loss 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 following 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,

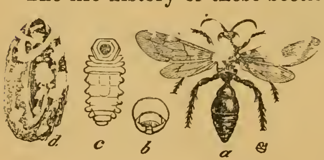


FIG. 62.—White Grub Parasite: *a*, imago; *b*, head of larva; *c*, larva; *d*, cocoon. [After Riley.]

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

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

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 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* Oliv.)

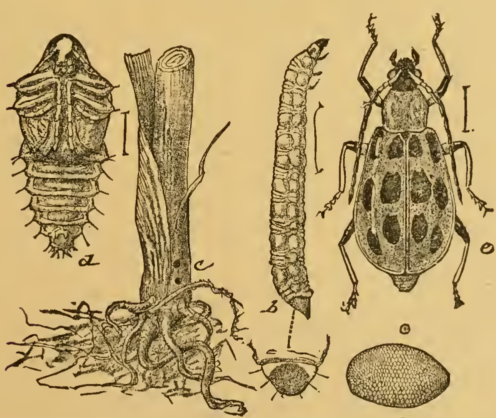


FIG. 64.—The 12-Spotted Diabrotica. [Insect Life.]

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.

(*Chœtocnemis and Psylliodes.*)

The insect which is shown in the accompanying ilustration (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

Fig. 65.—The Pale Flea-beetle (*Sysiena blanda.*) [Original.]

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.

THE EUROPEAN MEAL WORM.

(*Tenebrio molitor* Linn.)

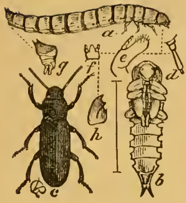


FIG. 66. — *Tenebrio obscurus*; *a*, larva; *b*, pupa; *c*, beetle, natural size. [After Riley.]

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.)

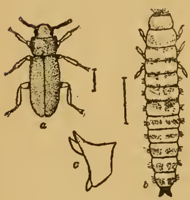


FIG. 67. — *Tribolium ferrugineum: a*, beetle; *b*, larva; *c*, tip of abdomen of larva—enlarged. [F. Clements.]

The little beetle that is illustrated herewith (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, clambering 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 chest nut-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.)

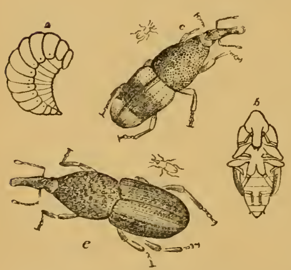


FIG. 68.—*Calandra oryzæ: a*, larva; *b*, pupa; *c*, *Calandra granaria*—all enlarged. [After Packard.]

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 oryzæ* 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 remotepunctta* 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 RHYNCOPHORID

(*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 cucopterus*, 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.]

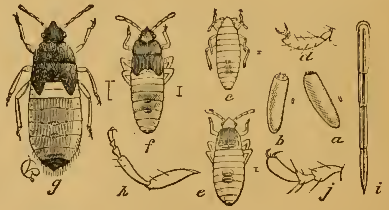


FIG. 73.—Chinch-bug: *a*, *b*, eggs; *c*, larva just hatched; *e*, and *f*, same, more advanced; *g*, pupa; *h*, *d*, and *j*, legs of bug—all enlarged. [After Riley.]

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, papæ, 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

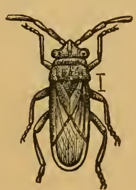


FIG. 74.—False Chinch-bug (*Nysius angustatus*): mature insect, enl'r'd. [After Riley.]

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

FIG. 76. — Negro-bug (*Corimelæna 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 (*Corimelœna 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 Chich-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 artificially 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. 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."

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

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 aimless y 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 numerously 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 caues the bugs to bunch. These bunches vary in size from that of a walnut to a teacupful, and, according to some few reports, stiil 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 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 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 mentioned 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. *Corimelæna 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.

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

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.

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 inimicus.* [Osborn.]

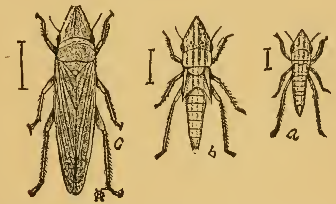


FIG. 82.—*Diedrocephala mollipes.* [After Osborn.]

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

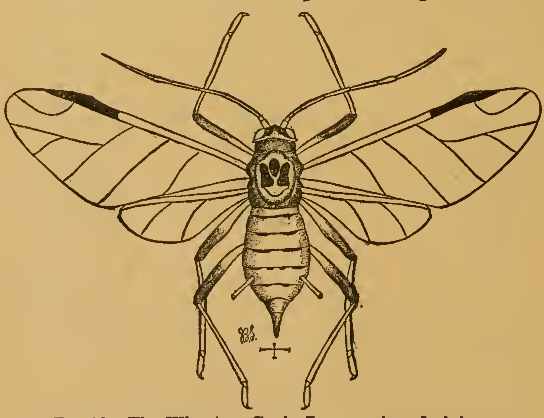


Fig. 86.—The Wheat or Grain Louse, winged viviparous female. [After Smith.]

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."

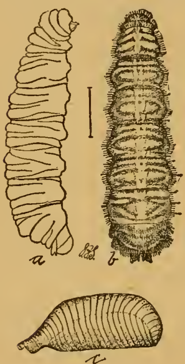


FIG. 88.—Larva of *Syrphus torvus*: *a*, *b*, larva; *c*, pupa. [After Smith.]

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 Lady-bird. [After Riley.]

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

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

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

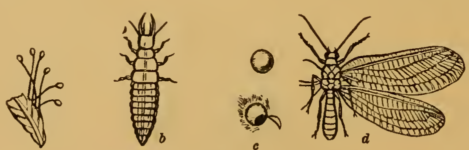


FIG. 95.—Lace-wing: *a*, eggs on leaf; *b*, larva; *c*, *d*, mature insect. [After Riley.]

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.)

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.

FIG. 96—*Thrips tritici*. [Original.]

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. (*Melanaplus atlanis* 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 or 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 *atlanis* 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

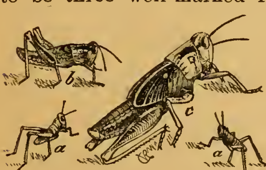


FIG. 99.—R. M. Locust: different stages of growth of young. [After Riley.]

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 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.

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

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 acccompanying 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

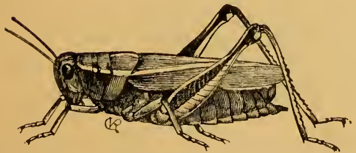


FIG. 104.—*Melanoplus bivittatus*: female. [After Riley.]

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

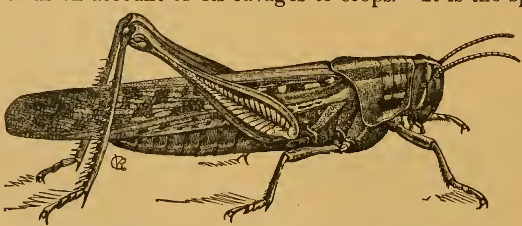


FIG. 106.—*Shistocerca americana:* female. [After Riley.]

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 inself. 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. (*Smynthurus 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.)

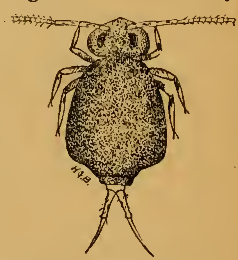


FIG. 109.—*Smynthurus hortensis.* [H. G. Barber.]

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 insect 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. (*Smynthurus elegans* Fitch.)

THE MARKED GROUND FLEA. (*Smynthurus 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.

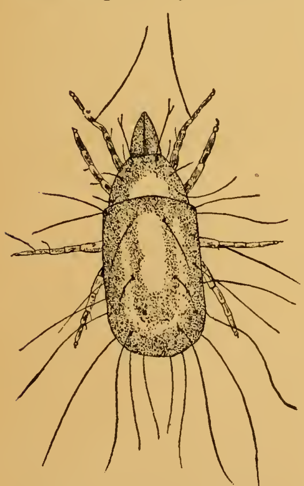


FIG. 110.—*Tyroglyphus longior.* [After Murray's Fig.]

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.

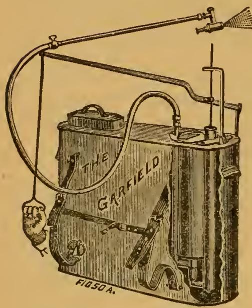
FIG. 111—*Tetranychus telarius*, enlarged. [Griffiths.]

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

INDEX

INDEX.

The Garfield Knapsack Sprayer



FOR VINEYARDS, NURSERIES, FRUIT ORCHARDS, AND POTATO FIELDS—CONCAVED TO FIT THE BACK.

This machine consists of a copper tank holding five gallons. The pump is made entirely of brass and copper, and cannot corrode or rust. There is a large air chamber placed inside the tank for convenience, which has sufficient capacity to keep up the pressure and continue to discharge the spray for nearly one minute after the operator stops pumping. A brass pipe 15 inches long with a stop cock is furnished with each machine. The nozzle is our combination Vermorel, so highly recommended by Prof. Riley, and gives universal satisfaction. The Vermorel attachment throws a fine, misty, vapor spray, but on account of its fineness cannot be thrown more than 15 feet. Weight, empty, 14 lbs.; full, 60 lbs.

Price - - - - $10.50
With Automatic Agitator 12.00

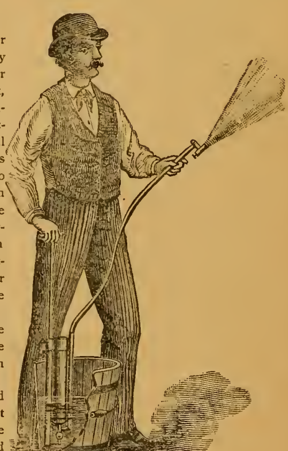
THE "LITTLE GEM" SPRAYING PUMP.

It Stirs the Liquid Automatically.

This pump is made entirely of brass, except the rubber hose and valve packing, making it practical for using any of the insecticides, emulsions, arsenites, fungicides, or ammoniacal mixtures, now in common use for saving fruit, foliage, and flowers from destruction by insects and fungus. It is supplied with our "Combination Vermorel Nozzle," which throws a fine, misty spray, using only a small amount of liquid to cover a large space; and by a brass needle point, operated by a spring, may be condensed to spray a single plant without spraying the ground between the plants, and this needle point also serves to clear the nozzle of any obstruction that might lodge in the aperture. It has two feet of vulcanized rubber hose, to which is attached a brass hand tube, with the solid stream nozzle firmly fastened, to which the Vermorel is attached or detached by a screw connection at the pleasure of the operator.

When it is desired to throw water to a greater distance than can be done with the Vermorel nozzle, unscrew the Vermorel attachment and the water can then be thrown 40 to 50 feet.

This pump is neat in design, very compact, strong, and durable, nothing liable to get out of repair or wear out that could not be replaced at a cost of a few cents. The entire weight of the pump complete is 4 lbs; when boxed ready for shipment, 7 lbs.



Price, including Vermorel Nozzle, two feet of hose, and foot stirrup - - - - - $4.00

This pump is fitted with metal valves. Additional hose at 12 cents per foot.

Address for either machine

FIELD FORCE PUMP CO.,

Lockport, New York.