



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

### **Usage guidelines**

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

### **About Google Book Search**

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

SCIENCE  
LIBRARY

QL  
463  
.M98

B 485707

INES

OF

NOV 20 1900

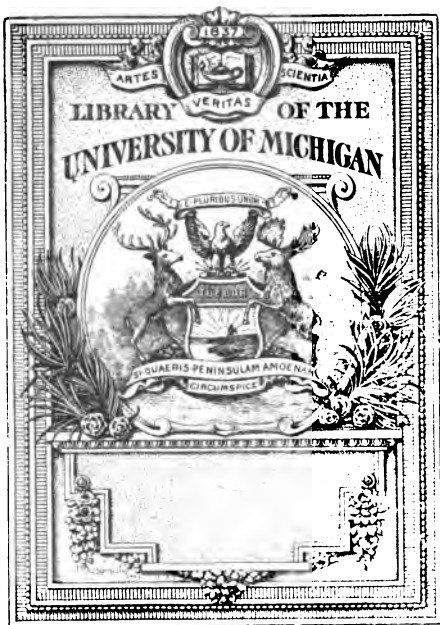
# ENTOMOLOGY.

PREPARED FOR THE USE OF FARMERS AND HORTICULTURISTS.

AT THE REQUEST OF THE SECRETARY OF THE STATE BOARD OF AGRICULTURE  
AND THE STATE HORTICULTURAL SOCIETY OF MISSOURI.

BY MARY E. MURTFELDT.  
KIRKWOOD, MISSOURI.

JEFFERSON CITY, MO.:  
EMBURE PRINTING COMPANY, STATE PRINTERS AND BINDERS.  
1891.

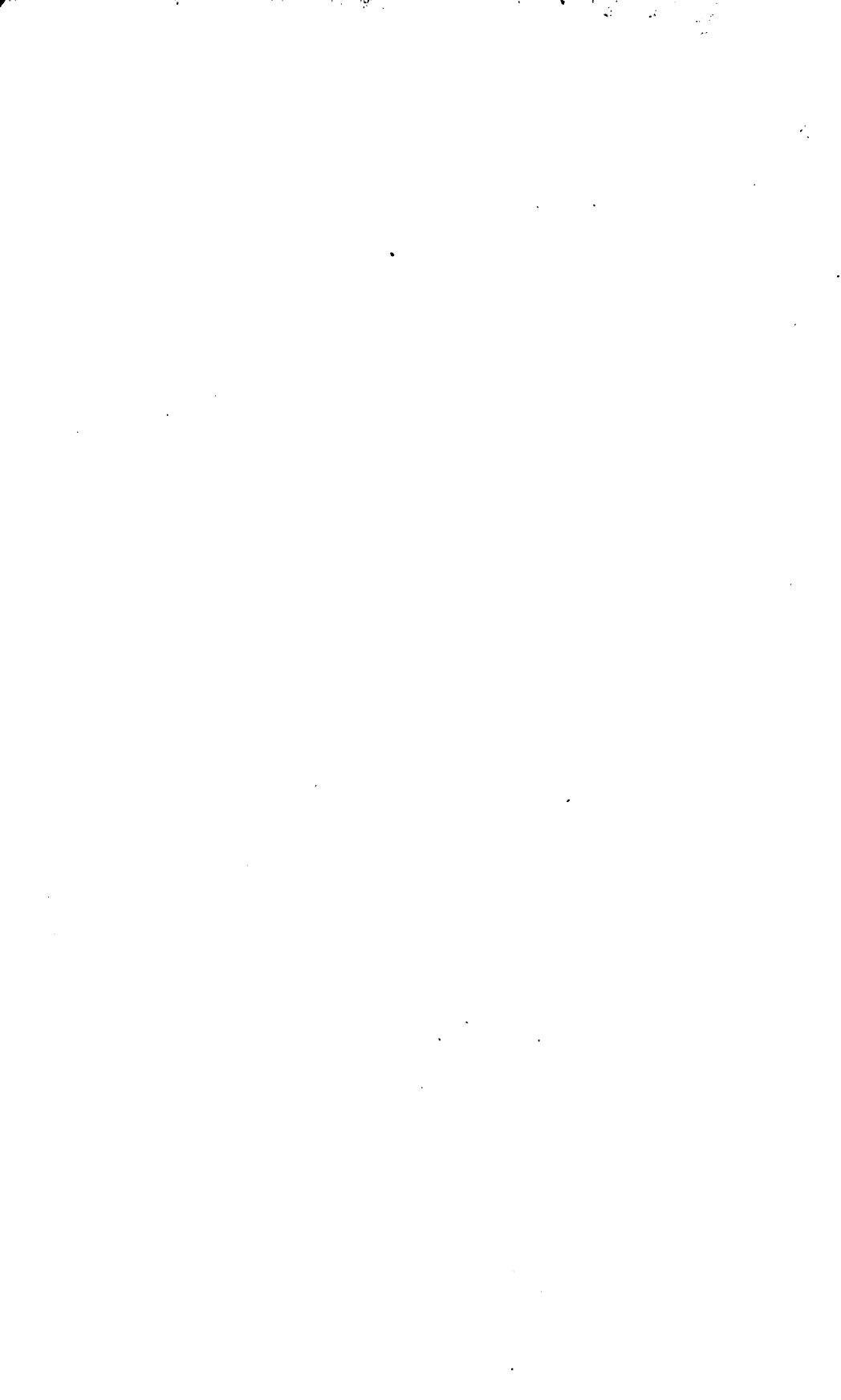


29

SCIENCE LIBRARY

QL  
463  
.M98

1852



OUTLINES  
OF  
ENTOMOLOGY.

---

PREPARED FOR THE USE OF FARMERS AND HORTICULTURISTS,

AT THE REQUEST OF THE SECRETARY OF THE STATE BOARD OF AGRICULTURE AND  
THE STATE HORTICULTURAL SOCIETY OF MISSOURI.

---

BY MARY E. <sup>the</sup>MURTFELDT.  
KIRKWOOD, MISSOURI.

---

JEFFERSON CITY, MO.:  
TRIBUNE PRINTING COMPANY, STATE PRINTERS AND BINDERS.  
1891.

---

Copyrighted by M. E. Murtfeldt.  
1891.

---

032092.5.  
0

## PREFACE.

---

Rec 1855 7-12-38  
mjd

In preparing the following pages, as an introduction to the science of Entomology, the primary object has been to supply a need of the farmer and horticulturist. For while the ravages of noxious insects have an indirect effect upon the prosperity and convenience of every one, it is to the agriculturist more directly that their absence or prevalence brings financial success or failure. It is true that there are already almost innumerable publications, many of them of great value, on the subject of economic entomology, as well as those of more strictly scientific importance, all of which are accessible to any inquirer; but it is undeniable that a lack of some general knowledge of the life histories of insects, and an unfamiliarity with many of the terms used in description, deprive those for whom they are prepared of a large share of the benefit they might derive from them.

I do not ignore the fact that this want has been realized by many of our most distinguished entomologists, and that several text-books have been prepared to meet it; but the objective to these is, that the authors have gone into the subject too thoroughly, have dwelt upon points of structure that the business man has neither time nor skill to trace out, have discussed phenomena that are chiefly interesting to the philosopher, and which make the study seem too abstruse.

The following pages are an attempt at something more elementary, remembering that there are those who have yet to learn the difference between a beetle and a bug, or between a moth and a butterfly; to whom the transformations of insects offer a puzzle which they cannot solve, and who are completely daunted and discouraged by a half-dozen successive technical terms. This little introduction aims to help the beginner over some of the first difficulties he is liable to encumber in taking up the subject systematically, and the author hopes it will be the means of attracting him to the study of the more exact and comprehensive treatises of Dr. Packard, Prof. Comstock and others.

Incomplete and simple as this work is, it is hoped, however, that the definitions are sufficiently explicit to enable the student to place all



the more common insects in their proper order, and in most cases to find the family with which they correspond in structure and habit. So far as possible, throughout the work technical terms and scientific names have been subordinated to popular ones, although for the sake of precision and to accustom the reader to their use, the former are nearly always given. While the illustrations are not so numerous as could be wished, the objects themselves are so easily obtained that the reader can supply the deficiency from the pages of nature, and it is most earnestly recommended that he will in all cases try to do so. Insects need no especial preparation for study, except to kill them with the fumes of chloroform or by immersion in alcohol or gasoline. Butterflies and moths and the two-winged flies cannot be placed in fluids without injury, but all the other sorts are unharmed by the process. A hand lens, a bit of cork and a few needles and pins are all the appliances needed for a study of the superficial structure of the large or medium-sized species with which it is best to begin.

If the writer shall succeed in introducing this delightful branch of natural history to even a few of those who are surrounded by the beautiful and interesting objects discussed, and if in these pages the victim of insect depredations obtains a few hints concerning the vulnerable stages in the lives of his tiny but collectively potent foes, the work will not have been done in vain.

In conclusion, I must acknowledge my great indebtedness to the works of Dr. C. V. Riley, U. S. Entomologist, Dr. A. S. Packard, whose "Guide" and *Entomology for Beginners* are so admirably adapted to the use of those desiring a thorough knowledge of the structure of insect forms, and to Prof. Comstock's more technical and elaborate "Introduction."

Among other authors from whose works I have obtained much assistance are Professors Fernald, Cook, French, Osborne, the Rev. Dr. McCook, Messrs. Howard, Henshaw and Saunders.

The illustrations used are mostly from electrotypes purchased from Dr. C. V. Riley, and from drawings done by Mr. Joseph Bridgham, of Providence, R. I., who also supervised the heliotyping of the same. Fig. 32 was engraved by the Gast Bank Note Lithographing company of St. Louis, and Fig. 44 is from an electrotype presented by the Rural World.

MARY E. MURTFELDT.

Kirkwood, Missouri.

# OUTLINES OF ENTOMOLOGY.

---

## GENERAL STRUCTURE OF INSECTS.

*Illustrated by electrotypes from drawings by Prof. C. V. Riley, Washington, D. C., and zinc process work done under the supervision of Mr. Joseph Bridgham, of Providence, R. I.*

---

### CHAPTER I.

#### INTRODUCTION.

What is an insect? This does not seem like a question difficult to answer, and yet how few either of grown persons or children would be able to define an insect otherwise than as "some sort of a bug." Now it is true that all bugs, properly so called, are *insects*; but it by no means follows that all insects are *bugs*. On the contrary, genuine bugs form but a small proportion of the fluttering, buzzing, crawling myriads to which the term is generally applied.

Insects are among the most familiar of natural objects. They are met with in all climates and situations, and in greater or less numbers at all seasons of the year. They claim our attention in a thousand different ways. We admire the beauty of form and color in some, and shrink from the grotesque ugliness of others. Many species injure and annoy us personally or damage or destroy our property, while on the other hand a few, like the honey-bee, the silk-worm and the cochineal insect, produce some of our choicest luxuries. Is it not well then for us to endeavor to learn something of the structure, habits and differences of a class of animals with which we unavoidably have so much to do?

How few people realize that there are as wide differences between insects and some of the animals that are usually classed with them—for example, spiders, millepedes and earth-worms—as there are between cows and chickens and serpents; and there are far greater distinctions between butterflies and beetles and grasshoppers than exist between

horses, cows and sheep. This may seem strange to one who has given the subject no attention, but a little careful observation will convince him of its truth.

It is impossible to obtain a definite idea of the structure of insects, and their place in the scale of being, without comparing them critically with other kinds of animals and noting the points in which they differ. To obtain this knowledge without the aid of books would involve a wide field of observation and a great deal of labor in systematizing the information gained. Therefore, to aid and direct the observations of the student, we will glance hastily over the outlines of the classification of the animal kingdom as arranged by the great French naturalist, Cuvier, after whom it is called the "Cuvierian system." According to this system all the animals, on or in the earth, monstrous or minute, are arranged in the *four* following Sub-kingdoms :

I. **BACKBONE** animals (Sub-kingdom **VERTEBRA**), such as have an internal bony frame termed a *skeleton*, the axis of which is a spinal column composed of a number of peculiar joints called *vertebræ*. Examples—Man, Birds, Fishes and Reptiles.

II. **RINGED** or **ARTICULATE** animals (Sub-kingdom **ARTICULATA**), having an external tough or horny framework composed of rings or articulations enclosing the muscles and other soft tissues. Examples—Insects, Spiders, Millepeds, Crabs.

III. **MOLLUSKS** (Sub-kingdom **MOLLUSCA**), soft-bodied animals usually enclosed in shells. Examples—Snails, Slugs, Oysters.

IV. **STAR** or **RADIATE** animals (Sub-kingdom **RADIATA**). These are formed somewhat upon the plan of a star or asterisk, with all the members branching out from a common center. Examples—Star-fish, Sea Urchin, Coral animal. This division includes mostly marine animals.

Each of these Sub-kingdoms is divided into several very distinct *classes*. Passing over the classes of **BACKBONE** animals, we will confine our attention to the **ARTICULATA**, in which insects, although by no means the largest representatives, occupy, on account of their more specialized structure, the highest rank. The classes of **ARTICULATA** are *five* in number, viz. : \* Insects (*Insecta*), Thousand-legged worms or Millepeds (*Myriapoda*), Spiders (*Arachnida*), Lobsters and Crabs (*Crustacea*), and True Worms (*Annelida*).

---

\* According to Cuvier, whose plans will answer our present purpose.

For convenience this classification may be tabulated thus :

Animal Kingdom.	{	Vertebra.	{	Insecta.
		Articulata. ....		Myriapoda.
		Mollusca.		Arachnida.
		Radiata.		Crustacea.
				Annelida.

In proceeding to separate true insects from the other members of their sub-kingdom, the most obvious distinction is that they alone among articulates ever possess *wings*. There are, however, some insects, mostly of the worst repute, such as fleas, bed-bugs, lice and a few others, that never acquire wings. We have, therefore, to seek in some other organ, or set of organs, a characteristic by which we can distinguish *any* insect from other articulates, and one which will, if possible, have a peculiar development in each of the classes. Such a distinction is found in the *number of the legs*. Thus insects, in their perfect or adult state, always have *six* legs, neither more nor less—although in some butterflies the front pair of legs, not being used, are of diminished size, and are tucked up out of the way. Millepedes, as the name denotes, have *numerous* legs, from thirty to four hundred; spiders and mites have *eight* legs; crustaceans from *ten* to *fourteen* legs, while the true worms have *no legs* at all in any stage of their existence. We have, therefore, only to count the legs of an articulate animal to find out in which of the preceding classes it belongs.\*

The term "insect," which is derived from two Latin words, *in* and *seco*—*cut into*—in reference to the ring-jointed or *insected* body, was, by some of the earlier writers on natural history, applied to the entire group of the articulates, and the various classes were distinguished as "six-legged insects," "eight-legged insects," "many-legged insects," and so forth. But as the structure of these animals was more thoroughly studied, they were found to be more widely separated than was at first supposed. The term "insect" was restricted to the six-legged class, and other names, more suitable, applied to the remaining classes. Insects are further distinguished from other articulates in having the external framework composed apparently of *thirteen* or *fourteen* rings or joints, which are separated into *three* regions, the first joint forming the *head*, the succeeding three the *thorax*, and the remaining nine or ten the *abdomen* and its appendages.

In the millepedes the number of rings varies from *ten* to *two hundred*, and the head alone is distinct from the abdomen. In the spiders the joints are so closely consolidated that *two* only can be perceived, the first forming the combined head and thorax (*cephalo thorax*) and the second the abdomen. In the crustaceans the number of joints is

---

\*Except in the case of the young of some Mites, which also have only six legs.

variable, and in some species the division is into three regions, as in insects, while others bear some resemblance to spiders in the arrangement of the joints. In the framework of the worms we find numerous joints, but no distinct head, thorax or hind body.

Another and very interesting peculiarity of insects is found in their *transformations* or *metamorphoses*. Insect life begins with an embryo contained in an *egg*. From this egg hatches the first active form, which is called a *larva* (plural *larvæ*), the term signifying a *mask*, because the true form of the insect is considered to be *masked* or *concealed* at this stage of life. All caterpillars, grubs and maggots are larvæ. When the larva is full grown it changes, in most cases, to a very different object, and is then termed a *pupa* (plural *pupæ*), from a word meaning a *doll* or *mummy*, in reference to its quiescence and the swathed or bandaged appearance of its members. From the pupa in due time emerges the *perfect insect* or *imago* (plural *imagines*), which is the final form and the one in which it possesses wings, unless it belongs to the few wingless species.

The chief office of the perfect insect is to develop and lay the eggs from which another generation of larvæ will hatch, and, in the case of some species, to provide food for their young.

To briefly recapitulate, in answer to our opening question: An insect is an articulate animal having the external skeleton composed of a number of rings or joints, which are separated into three groups to form a distinct *head*, *thorax* and *abdomen*. It has *six legs*, and, in its perfect state, has *two* or *four wings*, and is further characterized by changes of form and habit called *metamorphoses*.

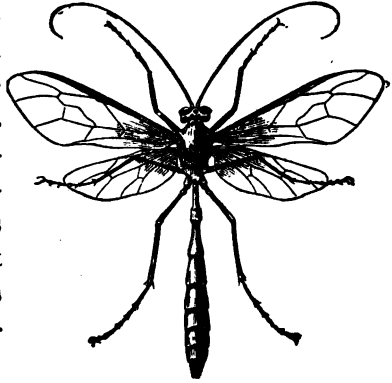
The science which treats of the structure, habits and classification of insects is called *Entomology*, a term composed of two Greek words which signify a "discourse on insects."

*Economic Entomology* has for its object the investigation of the habits of injurious insects, with a view to the better preservation of our persons and property from their attacks. It also includes experiments with such species as are or may prove to be valuable for their products or properties, and endeavors to ascertain which are indirectly useful to man on account of their parasitic and cannibalistic habits.

## CHAPTER II.

## EXTERNAL STRUCTURE OF INSECTS.

In our introductory chapter were noted some of the differences between insects and vertebrate animals, and also between insects and other articulates. Now in order to comprehend these distinctions still more clearly, and to understand how the various parts and organs are modified to produce the almost innumerable diverse forms, it becomes necessary to examine the general structure still more critically.



Ichneumon fly (*Ophion macrurum*, L.)  
after Riley.

The external crust or skeleton of an insect forms a many-jointed tube in which, as has already been mentioned, are enclosed and protected all the softer vital parts, such as the muscles, nerves, the air and blood vessels, etc. The most common form of this tube is more or less cylindrical, but in some insects it is shortened and flattened so that the outline is oblong, oval or nearly circular. This body-wall is composed of fourteen ring-like sections or segments which are more or less closely connected. Of these joints the first, forming the head,\* is most distinct. The three joints forming the thorax have the appearance of being firmly soldered together, and it is often difficult to trace the divisions. In the abdominal region, on the contrary, the rings are loosely connected by a flexible and elastic membrane, which allows them to move freely in any direction. Two or three of the terminal joints of the abdomen are changed from their original shape to form and support stings, piercers, forceps, and the like, so that we are seldom able to distinguish more than six or seven distinct rings in this part of the body.

It must not be supposed that the fourteen joints are the only divisions of the insect skeleton. If this were the case we should never have occasion to admire the grace of the butterfly's flight or the surprising agility of various beetles and bugs. The fact is that each joint, although it may appear like a simple ring, is composed of from six to nine variously shaped pieces, each piece, however closely fitted to the others, being capable of independent motion by the muscles within. Otherwise an insect would never be able to move a wing or leg or other organ

\* Dr. Packard considers the head as composed of four joints.

separately. On the thorax of many smooth, hard-shelled insects, like wasps and beetles, we can readily trace the divisions of each joint by means of fine impressed lines.

The insect crust varies greatly in texture and thickness. In some insects, and especially in many larvæ, it is very thin, easily bent and easily broken; in others it is hard and brittle like shell, or dense and impenetrable like metal. Examples of the shelly texture are found in the pupæ—termed *chrysalides*—of butterflies and moths, while the metal-like covering may be seen in the cases of the beautiful Brazilian beetles, often used by jewelers in the place of gems, which are so hard that they can only be pierced by a drill.

The majority of insects have the head separated from the thorax and the thorax from the abdomen by deep incisions, or the contraction of the connecting joints. This will be understood by a glance at the illustration at the head of this chapter, or better still by examining the body of a bee, a butterfly or a fly.

The back or upper surface of the body of an insect is termed the *dorsum* or dorsal surface, or *tergum*, the sides the *pleurites* or lateral surfaces, while the under side is the *venter* or ventral surface. The top of the thorax is sometimes further distinguished as the *notum*, the under side, or breast, being correspondingly termed the *sternum*.

In exact scientific description a number of other terms are used to indicate the various divisions of a segment, or to refer to precise localities on the body, but these are not necessary to a general apprehension of the structure, and would only confuse and discourage a beginner.

## CHAPTER III.

### THE HEAD AND ITS APPENDAGES.

As with the higher animals, the head of an insect is more especially the *sensorial* region, because it contains the organs of *sight*, *touch*, *taste*, *smell*, and possibly in some species, of *hearing* also. The sense of feeling is not, of course, confined to the appendages used by the insect for touching objects—which in this sense correspond to the human hand—but extends over the entire surface of the body.

Certain localities on the head are frequently referred to in descriptions of insects. The more important of these are :



Fig 2.  
Head of Wasp: a, occiput; b, epicranium; c, ocelli; d, compound eyes; e, jaws.

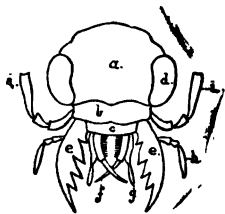
the *Occiput*, which is the back upper part (Fig. 2, *a*); the *epicranium*, the front upper part (Fig. 2, *b*), and the *Olypeus*, which occupies the space between the epicranium and the mouth. The top of the head is also sometimes called the *Vertex*; the front, the *face* or *Frons*; the sides, the *cheeks* or *Genæ*. The manner in which these parts are developed varies greatly in different insects.

The principal appendages or organs of the head are the *Mouth*, the *Eyes* and the *Antennæ*.

The mouth presents a variety of forms, being adapted in different insects to the kind of food upon which they subsist, and also to the various offices, besides those of mastication or suction, which are performed by it.

All the variations in structure, however seemingly diverse, are made upon *two* plans, viz.: *jaws* for biting and *beaks* or tubes for sucking.

Fig 3.



Head of Tiger beetle: *a*, frons; *b*, epistoma; *c*, labrum; *d*, eye; *e*, mandibles; *f*, maxillæ; *g*, maxillary palpi; *h*, labial palpi; *t*, antennæ.

The mouth of a biting insect consists of *six* distinct parts, collectively called *Trophi*. These parts are the lips—upper and under—and two pairs of strong, horny organs which form the jaws and move from side to side and not up and down like the jaws of the higher animals. The upper lip is called the *Labrum* (Fig. 3, *c*), and the under lip (not shown in the illustration), the *Labium*. These parts are subject to great changes in shape, and seldom bear much resemblance to the lips of Vertebrates. The upper or principal jaws are termed *Mandibles* (Fig. 3, *ee*).

They are strong and sharply toothed, and are the chief instruments for seizing and tearing the food.

The lower jaws (Fig. 3, *ff*) are called the *Maxillæ* (sing. *maxilla*), and are usually more slender and flexible than the mandibles and terminate in a point.

Besides these six principal mouth parts, most insects have from *one* to *three*, generally *two* pairs of slender-jointed organs, called *Palpi* (sing. *palpus*) or *mouth-feelers*. One pair is attached to the lower jaws, and are termed the *maxillary palpi* (Fig. 3, *g*), the other pair, connected with the lower lip, are the *labial palpi* (Fig. 3, *h*). Their office seems to be to aid in the selection of food and to brush impurities from the face and antennæ.

The sucking or *haustellate* insects have the same number of mouth parts, but they are developed on an entirely different plan. In some species, such as the true Bugs, most of the parts are united to form a stiff, jointed *beak*, with which the leaves of plants or the skins of ani-



mals are punctured and the juices or blood extracted. In others, like the Butterflies and Moths, the combined parts form a long, flexible tube, usually called a *tongue*, through which the nectar of flowers and similar fluids may be drawn. In others still, the lower lip and the maxillæ together form a sort of tongue for collecting sweets, while the mandibles are not altered. Bees and Wasps have this kind of mouth.

The organs of vision are situated upon the epicranium in front or near the top of the head.

They consist of a pair of prominent *compound* eyes (see Figs. 2 and 3, *dd*), composed of a great number of six-sided lenses. In shape these compound eyes are round, oblong or reniform (kidney-shaped). In addition to these, many insects are provided with three small single eyes, called *ocelli* (sing. *ocellus*), situated upon or near the apex of the head, in a triangle, as shown in Fig. 2, *c*.

All these eyes are fixed in their sockets, but protrude so much that some of the lenses face in each direction, and the insect has no need to turn its eyes to obtain warning of approaching danger, or in its search for food. It has been suggested that the compound eyes serve the ordinary purposes of vision, while the ocelli are used upon objects that are near and minute; but this is mere conjecture. Some of the best observers and most careful investigators assert that with all the provision that has apparently been made for sight in insects their vision would seem to be very imperfect, especially for objects at a distance.

Black and brown are the colors most commonly seen in the eyes of insects, but many species have eyes that gleam with the tints and brilliancy of jewels, and add not a little to the beauty of the species.

The most striking appendages of the head of an insect are the *Feelers* or *Antennæ* (sing. *antenna*). These are many-jointed organs in which the sense of touch is thought chiefly to reside. Many experiments go to show that they are also the organs of smell. They are of a great variety of forms, a few of which are represented in Fig. 4. The different shapes are distinguished as *knobbed*, *capitate*, *lamine*, *pectinate*, *filiform*, etc. They are usually attached a little below and between the eyes, as shown in figures 2 and 3.

A knowledge of the form and position of the antennæ is very important in the classification of insects, especially in such orders as the *Coleoptera* (beetles).

All the functions of the antennæ are probably not yet known; but it has been ascertained that besides serving the purposes already mentioned, they are also indispensable in guiding the flight of all winged

Fig 4.



Antennae of insects, adapted from authors. 1 and 3, lamellate ant. of beetle; 2, capitata ant. of beetle; 4, pectinate ant. of beetle; 5 and 6, filiform ant. of beetle; 7, bristle tipped ant. of fly; 8, knobbed ant. of butterfly; 9, feathered ant. of moth.

species, and are, to a large extent, the instruments of communication between individuals of the same kind, as among ants, and no doubt aid the perception of insects in many ways that are beyond our comprehension.

The sense of hearing in insects is not considered to be as generally developed as in the higher animals. Yet unquestionably many insects do hear, although the special organs of this sense have been located in comparatively few species. Such ears as have been discovered are not found on the head, but on the front legs and at the base of the abdomen. These will be more particularly described in a succeeding chapter.

## CHAPTER IV.

### THE THORAX AND ABDOMEN.

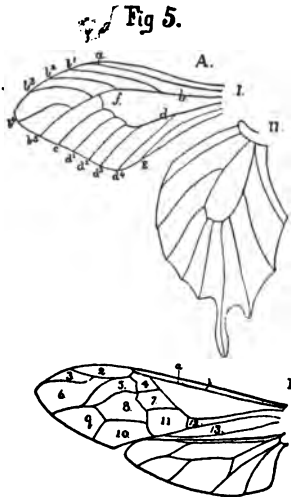
The three segments immediately back of the head constitute the *Thorax* or chest of an insect. This division of the body is very compact and usually somewhat globular, or barrel-shaped. Each of the segments or joints composing it has received a special name; the anterior one—next the head—is termed the *Prothorax*; the middle one, the *Mesothorax*, and the third or posterior one the *Metathorax*. Each of these divisions, though apparently entire, is in reality, as has already been observed, made up of several irregularly shaped pieces, which are connected in such a way as to afford free play to the strong muscles within.

The appendages of the thorax are the wings and legs. The wings of insects are their most conspicuous members, upon which the beauty and, in a great measure, the safety and enjoyment of most species depend.

In their adult and perfect state nearly all insects possess these organs, the only exceptions being the members of a few small groups, such as fleas, bed-bugs, lice, some of the ants, and the females of a few moths and beetles.

In their general structure the wings of insects show a number of very distinct plans or types, which have been made the basis for the system of classification commonly adopted.

The wings are attached to the mesothorax and metathorax, and where present are always four in number, except in the order of the two-winged flies (*Diptera*), where only the upper pair are fully developed, the lower pair being represented by little hammer-like organs, called *Halteres* or *Poisers*.



A, 1 and II, upper and under wings of a butterfly; B, upper and under wings of wasp, adapted from authors.

*Posteriors* or *Secondaries*. Many of the best writers use the simple terms of *fore* and *hind* wings.

These organs exhibit an almost endless variety of outline, texture and ornamentation. The wings of butterflies and moths, for example, are broad and of rather frail texture, and are covered with minute scales and hairs of rich and varied colors. The upper wings of beetles

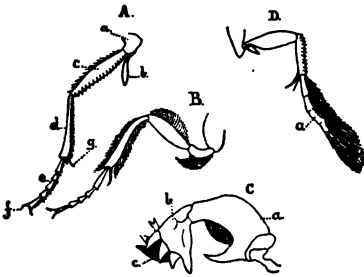
Wings are composed of membrane, more or less transparent, stretched over a framework of horny tubes, termed *veins* or *nerves*. The number and arrangement of these tubes constitute the *Venation* or *Neuration* of the wings, to which frequent reference is made in descriptions of insects. There are usually from three to five principal veins in each wing. These branch and intersect very differently in the types of different families. The spaces between the veins are called *cells*, which are also named and numbered in regular order.\*

The first or upper wings are variously designated as the *Anteriors*, the *Superiors* or the *Primaries*, while to the lower or under pair are applied the opposite terms of

\* The outline and venation of the wings of insects are made great use of in classification, and for the convenience of any that may be interested, I append the terms applied to margins, veins and cells as follows: On the wing of an insect the upper edge, from where it is joined to the body to the most distant point, is the *costa* or *costal edge*. The extreme point is the *apex*. (In the figure A, just above  $b^4$ .) The outer edge extends from the apex to the *inner angle* at  $d^4$ , and the *inner edge* from this point to the insertion of the wing. The veins are the *costal vein*, just below  $a$ ;  $b$ , *sub-costal vein*;  $d$ , *median vein*;  $b^1$ ,  $b^2$ ,  $b^3$ ,  $b^4$  and  $b^5$ , *sub-costal veinlets*;  $d^1$ ,  $d^2$ ,  $d^3$  and  $d^4$ , *median veinlets*;  $e$ , *internal vein*;  $f$ , *discal cell*. The other cells bear the names of the veins which enclose them and are numbered from the costal vein. In, B  $a$  is the *costal vein*; 1, 2, 3, *costal cells*; 4, 5, 6, *sub-costal cells*; 7, 8, 9, *median cells*; 10, 11, 12, *sub-median cells*; 13, *internal cell*. The veins and cells in the under wings correspond to the principal ones in the upper.

are comparatively small, being modified into simple sheaths, often of metallic hardness and luster, beneath which the longer and broader membraneous lower wings are compactly folded, except during flight. In the majority of other insects the wings are translucent or transparent, more closely veined, and not clothed with scales or hairs. The other organs of locomotion are the legs. In fully developed insects these are invariably six in number. Some of our most conspicuous butterflies, it is true, seem to have but four, but the absence of the front pair is only apparent, and close examination will reveal them folded close against the breast and perfectly formed, though small and useless. The legs of insects are modified in many ways to adapt them for running, leaping, burrowing and swimming, according to the habit of the species. Each leg consists of six parts: a large flattened joint called the *coxa*, which is attached to the body; this is succeeded by a joint which is very variable in form, usually small, but in some species large, and having the appearance of an ornamental appendage, and is termed the *trochanter* (plural *trochanters*); next to this is a long and often very stout *thigh* or *femur* (plural *femora*), succeeded by the *shank* or *tibia* (plural *tibæ*), to which is attached the *foot* or *tarsus* (plural *tarsi*), consisting of from two to five small joints, and in many species terminating in a pair of sharp claws, sometimes with a pad-like cushion, termed a *pulvillus*, between them.

Fig 6.



Legs, original and adapted; A, leg of predaceous beetle; a, coxa; b, trochanter; c, femur; d, tibia; e, tarsus; f, tarsal claws; g, tibial spur; B, leg of bee, clothed with hair for collecting pollen; C, front leg of mole cricket, fitted for burrowing in the earth; a, femur; b, tibia; c, tarsus; D, leg of water beetle adapted to swimming.

The *abdomen* in insects is composed of ten remaining segments. In most species, however, the hindmost rings are modified into the apparatus for reproduction and are drawn more or less within the body, so that only from five to seven joints can be clearly distinguished. It is in this part of the body that the form of the typical ring can be traced with greater accuracy than in any other region, as the segments are not apparently consolidated as in the thorax, but are held together quite loosely with elastic membrane.

Along each side of the body is a row of more or less conspicuous orifices. These are the openings through which the insect breathes, and are termed *stomata* or *stigmata* or *spiracles*. They conduct to air-tubes, to which more particular reference will be made in a succeeding

chapter. There are nine or ten, sometimes eleven pairs of them, two on the thorax and the others on the abdomen.

The only appendages of the abdomen are the *organs of reproduction*, which, in some species, as the bee and the wasp, are connected with those of defense, in the form of *stings*. They consist, externally, of various sorts of *forceps* or *claspers* in the male, and of *saws*, *augers*, *swords*, and more commonly, *piercers* and *stings* in the female. All of these instruments are very ingenious in their construction and admirably adapted to the work for which they are designed. They will be described in detail when the species to which they pertain are under consideration.

---

## CHAPTER V.

### INTERNAL STRUCTURE OF INSECTS.

The internal structure of insects consists of the *Muscular*, *Nervous* and *Circulatory* systems, together with the organs of *Respiration*, *Nutrition* and *Secretion*.

The examination of these parts is a work of great difficulty, owing to their extreme delicacy and minuteness. Much of it requires a high power of microscope and the skill of a hand experienced in dissecting; consequently the descriptions—as with the characters of external structure—cannot be easily verified by the observations of the tyro. Only a brief account, therefore, will be attempted in this chapter.

*The Muscular system* lies just within the external crust, or body-wall, to which it is closely attached. Its use is to hold the segments and their various appendages in place, and to move them according to the pleasure or necessity of the insect. It consists of a great number of distinct fibers, not gathered into bundles like those of higher animals, but spread out in thin layers over the parts requiring their action. In their arrangement the muscles correspond to the jointed structure of the body. Each segment has muscles that stretch from its front edge to the front edge of the one succeeding it, and others that in like manner connect the hinder edges. There are also bands of muscular fibers passing around the body and others still that extend obliquely from one joint to another. The muscles of insects are a pale yellow color and of a soft, jelly-like consistence. But, although so delicate in texture, their contractile power is surprising. Thus, many insects, of which the flea is a good example, are enabled to leap more than one hundred

times their own height, or to sustain, without injury, weights several hundred times that of their own. The lofty and long-continued flights of some species, the capacities of others for running, burrowing, boring into hard substances, and for carrying or dragging heavy burdens, all attest the wonderful strength and elasticity of their muscles.

*The Nervous system* consists of two delicate cords which extend longitudinally, the one above the other, along the ventral side of the body. Insects have no brain, properly so called, but the lower or external cord has a series of swellings or nerve knots called *ganglia*, varying in number from two to ten, from which nerve fibers are distributed in various directions. The ganglion in the head is, in many species, larger than the others, but does not differ from them in any other particular. Next to that the ganglia of the thorax are most developed, especially in perfect insects, since from them the supply of nerve-force for the wings and legs must be derived. The upper or internal cord is a simple thread without nerve knots or branches. It lies very close to but scarcely in contact with the ganglionic cord. We find in this nearly equal distribution of nerve force the reason why many insects can live for a considerable time after a part of the body has been crushed or severed, and why the separated parts seem to be alike endowed with vitality.

*The Circulatory system* of insects is as yet but imperfectly understood. The blood is cold and colorless, or with a slight yellowish tint. It does not flow through tubes corresponding to our arteries and veins, but seems to bathe the other tissues without being confined to special channels. There is, however, a long, narrow membranous sac, situated near the upper surface of the body, which forms a sort of *heart*, the pulsations of which can be distinctly seen in many thin-skinned insects, especially in larvæ. This tube is called the *dorsal vessel*, and is divided into several chambers by valves which permit the blood to pass only in a forward direction. The blood enters the dorsal vessel through openings in its sides, and, flowing toward the head, is expelled through a large artery called the *aorta*, from whence its course can no longer be traced. In its progress it is aerified by contact with the air vessels and mixed with chyle from the stomach, and is thus prepared to nourish the organism. It is scant in quantity compared with the blood of vertebrates, and the circulation seems to be slow.

*Respiration* or breathing in insects is performed, not through a single trachea or air-pipe communicating with a pair of lungs, as in most of the higher animals, but through a series of delicate tubes which divide and subdivide so as to permeate all parts of the body. The openings to these tubes are in most insects on the sides of the seg-

ments, and are termed the *spiracles* or *stigmata*. They vary in number from two in some water insects to eleven, usually nine, pairs, and are often quite conspicuous, especially in larvæ. In their perfect state insects breathe mainly through the first four or five pairs of orifices, and consequently most species may be easily suffocated and killed by a sharp pinch or continued pressure on the thorax. Many insects have large vesicles connected with the trachea which they inflate when about to fly, thus lessening their specific gravity and enabling them to continue long on the wing with less muscular exertion than would otherwise be necessary. The breathing organs of aquatic insects are termed *branchia*. They are analogous to the gills of fishes and present many very singular forms.

The organs of *Nutrition* are few in number and simple in structure. They consist principally of the mouth, already described, by which the food is seized and masticated, and, internally, of a large, long tube in which digestion takes place. This tube is the alimentary canal, and occupies a central position in the body of the insect. In the more lowly species it is simply a straight duct or sac extending the whole length of the body; but in the highly organized forms it is contracted at intervals so as to form several chambers, each of which has a distinct function. It terminates in a convolution of minute tubes that are supposed to represent the liver and the small intestines of higher animals. The *œsophagus* or gullet opens into the first chamber or cavity of the central canal, which is analogous to the crop. This in turn communicates with a smaller cavity, which is ridged internally or covered with hard, tooth-like points, and performs the office of a gizzard, from which the food passes into the largest alimentary division, representing the true stomach. In the latter are secreted the gastric and pancreatic fluids, which, mingling with the comminuted food, prepare it to nourish the system. The digestive powers of insects are enormous in proportion to their size, many species of herbivorous larvæ being capable of digesting more than twice their own weight of leaves in the course of a day.

The organs of secretion, aside from those that elaborate the fluids necessary to digestion, consist mainly of the *salivary*, *odoriferous* and *poison* glands. The salivary glands, so called, are greatly developed in such insects as the silk-worm, and the bee and wasp. They consist of two tubes, running parallel to the anterior portion of the alimentary canal. In the silk-worm and other larvæ of the same family these glands secrete the gum which, when drawn out through a little pointed tube beneath the mouth, becomes the beautiful and valuable fiber known as *silk*.

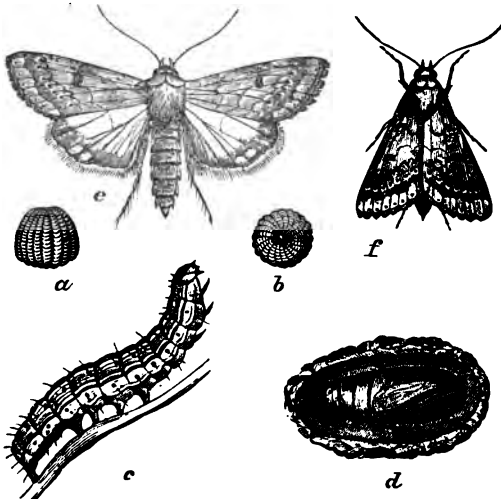
The salivary fluid is used by the bee and wasp to moisten and cement the particles of sap and wood from which the brood and honey cells are made.

The odoriferous organs are of various construction, and are located in some species in one part of the body, and in others in another. They are designed in some cases as a means of attraction between the sexes; in others to repel the attacks of their enemies.

The poison glands are situated sometimes in the mouth, but more frequently at the tip of the abdomen. The poison is of the nature of an acid, and is injected into wounds made by the jaws or by the piercer or sting. Its use is to ward off or revenge the attacks of foes and to paralyze or kill the prey required by the insect for its own food or as food for its young.

## CHAPTER VI.

### TRANSFORMATION OF INSECTS.



Transformations of a lepidopterous insect, the corn worm or boll worm (*Heliothis armigera*), after Riley; *a, b*, egg, magnified; *c*, larvæ; *d*, pupa; *e, f*, imago or moth.

The *transformations* or *metamorphoses* of insects have been already alluded to as one of their most peculiar and interesting characteristics. These are certain changes of form and habit by which the life of every insect, after hatching, is divided into three more or less distinct periods or stages.

Transformation may be either *complete* or *partial*. It is *complete* when the appearance and general habit of the insect is so different at each stage of its existence, that only experience enables us to recognize the various forms as pertaining to the same individual; and *partial* when the insect retains essentially the same form and habit during life, its



successive stages of development being marked only by the acquisition of certain organs and appendages.

The most familiar example of complete transformation is afforded by an insect which in its first active state is a sluggish, worm-like caterpillar, feeding voraciously on herbage, and changing in due time to the inactive, casket-like chrysalis, which bears as little resemblance to the larvæ that preceded it as to the imago that shall ultimately escape from it, viz., the broad-winged, bright-hued butterfly, instinct with graceful activity, as it hovers over the flowers from which it sips its sole nourishment, a dainty draught of nectar. Examples of partial transformation are found in such insects as grasshoppers, locusts, true bugs, etc.

The life of an insect begins with the embryo contained in an egg. Instinct guides the parent insect in the placing of her eggs, so that her progeny, as soon as hatched, find themselves surrounded with the kind of food they require. The eggs of insects are of various forms—round, oval, conical or disk-like. They are deposited singly or in clusters; sometimes openly exposed on the surfaces of leaves or stems, sometimes concealed with the utmost ingenuity. Those of many species are beautifully colored or elegantly sculptured. The eggs of some small insects which produce but few are proportionately large, while on the other hand many large insects lay very minute eggs, but make up in number what is lacking in size.

The insect in hatching from the egg enters on its larval stage of existence. This is the form in which all actual growth takes place, and in which, as a consequence, the insect requires most food. It may, in succeeding stages of development, assume different forms and acquire additional members, but it never really increases in bulk.

The larvæ of the various kinds of insects differ so much in appearance, and in many other respects, that it is difficult to give a list of characters that are common to all. The typical form is more or less worm-like: *i. e.*, cylindrical and elongate; but the variations from this type are exceedingly numerous, even among insects whose transformations are complete; while those that undergo only partial transformation do not conform to it at all.

In the majority of larvæ the thorax and abdomen are not distinct, except that the first mentioned region is often provided with the rudiments of legs. The latter are of a shelly texture, small and pointed at the extremity, with three or four joints. They are six in number, and are termed the *true* or *thoracic* legs, to distinguish them from the fleshy disks called *false legs* or *prolegs*, which in many species support the hinder part of the body.

Many larvæ, such as those of bees, flies and some species of beetles, have neither legs nor prolegs—their movements, in consequence of this lack, being much restricted.

In their habits larvæ are either *active* or *inactive*. The former—including by far the larger proportion of the young of insects—are capable of sufficient exertion to enable them to provide for their own necessities.

Inactive or sedentary larvæ, on the contrary, are hatched in cells or chambers, which they never leave, and subsist upon food previously stored for their use, or, as in the case of bees and ants, they are the objects of constant attention from the mature insects.

In the course of their growth all larvæ *molt* or shed their skins several times. This singular process becomes necessary at intervals, because the external covering will only admit of stretching to a limited extent. A new skin is constantly forming under the outer one, and when the latter becomes too tight it is—after some preliminary fasting and other preparation—ruptured and cast off, and the larvæ appears in a new and for a time, more elastic dress. The usual number of molts is four or five. A few insects of the lower orders molt but twice, while others, especially certain aquatic species and others whose larval life is long, molt from ten to twenty times. Sedentary larvæ shed their skins in shreds and by degrees.

The length of larval life varies with the different species. Many complete their growth in a very short time, often within a week, while some continue to grow from one to several years. The average length of larval life among herbivorous insects is about four weeks.

When the limit of growth is reached the larva ceases to feed, and, guided by instinct, prepares for its first transformation. Inactive larvæ spin a slight web around their delicate bodies, and some kinds are sealed up in their cells by the mature insects.

Active larvæ take various measures to secure themselves from observation and injury during the time when they shall be powerless to escape from or defend themselves against their enemies. Some creep into crevices of stones or bark, or hide ingeniously among crumpled leaves. A large proportion burrow into the earth; others spin for their protection thick, silken or parchment-like cocoons, while some require nothing more than a retired nook in which to suspend themselves by slender but strong cables of silk. After a longer or shorter rest in their various retreats, the larval skins are cast off for the last time, and each insect appears in a new and entirely different form and is termed a *pupa*.

In the pupa state most insects are quiescent and apparently lifeless, and while it continues are incapable of taking food or performing any of the active functions of life. Pupæ that are enclosed in cocoons or cells are termed *folliculate*. A pupa destined to give forth a butterfly is designated a *chrysalis*, from a Greek word meaning *golden*, in reference to the gilded ornamentation of many chrysalides.

There are two forms of quiescent pupæ, the *obtectæ* and the *coarctate*. In the first mentioned form the legs, wings and antennæ of the future imago are shown, each enclosed in a separate sheath. The pupæ of bees, wasps, beetles, etc., are obtectæ. In coarctate pupæ a continuous shell encloses the members as well as the body of the insect.

The pupæ of insects not subject to complete metamorphosis are *active*, and do not differ much either in form or habit from the full-grown larvæ, except in the greater development of the rudimentary wings.

After a certain time, varying with the nature of the insect and with the season of the year, the second transformation takes place and the insect issues from the pupa shell in its mature or *perfect* form.

In this stage of its existence it is, with a few exceptions, characterized by the possession of fully developed wings. It has also large, compound eyes, conspicuous antennæ and various other organs which did not appear in its preceding forms. The head, thorax and abdomen are now well-defined regions, and the sexes can usually be distinguished with ease. In most species the females are larger than the males, and the latter, besides being more slender in body, are often more gaily colored and have the antennæ longer or more ornamental than those of the female.

The abdomen of the female is furnished with an ingenious instrument called an *ovipositor*, through which the eggs are conducted to such situations as will be most favorable to the future larvæ. It serves not only to place the eggs, but is used by many insects to drill holes or saw slits or otherwise prepare suitable receptacles for them. In such species the ovipositor is usually a very conspicuous appendage. In others it is, when not in use, drawn entirely within the body.

As previously remarked, after insects have acquired their wings *they never grow*. Thus the idea that little flies or gnats develop into "house-flies" or "blue-bottles," as some people suppose, or that *little* beetles or bugs or butterflies ever grow to be *large* beetles or bugs or butterflies, is seen to be entirely erroneous.

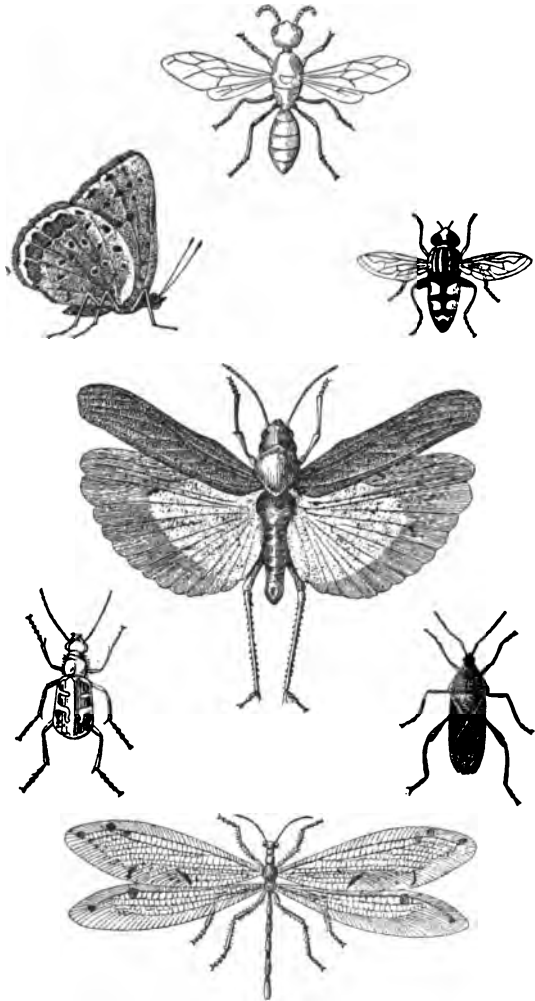
Since perfect insects do not grow, it follows that they require but little food; some are incapable of taking even a sip of dew or nectar.

Others, like the butterfly and wasp, have a very different diet from that upon which they subsisted as larvæ. Some species, however, such as locusts, leaf-eating beetles, etc., retain their voracious propensities throughout life.

*Hyper-metamorphosis*, which attends the development of a few species of parasitic beetles and some flies of the Ephemera family, is the assumption of more than the usual number of forms in the process of growth. The transformations of such species are not invariably from a lower to a higher organization, but some of the intermediate stages are often of a retrograde character. This anomalous mode of development will be illustrated in succeeding chapters in connection with the history of the Blister beetles, Bee parasites and Nerve-winged flies.

Such is an outline of the history, continually repeated, of all insect life; but the number of species is so vast, and their forms and habits so different, that the careful observer finds an infinite variety of detail which gives continual novelty and interest to the subject.

## ILLUSTRATIONS OF THE SEVEN PRINCIPAL ORDERS OF INSECTS.



Butterfly, Order III.

Beetle, Order II.

Wood-boring Wasp, Order I.

Locust, Order VI.

Ant-Lion, Order VII.

Syrphus fly, Order IV.

Bug, Order V.

## CHAPTER VII.

## CLASSIFICATION AND NAMES OF INSECTS.

Having in preceding chapters considered the characters by which insects are distinguished from all other animals, we shall now proceed to notice those by which they may be distinguished from each other.

As a preliminary to such observation it will be a good plan for the student to collect for an hour or two in various situations—field, wood and water-courses— all the insects that he can find. When these are examined he will perceive at a glance that they are not all alike—that they differ in form, size, color, and in many points of structure. He may then proceed to assort them, placing together those that appear to be exactly alike. The next step will be to compare the different lots, when it will be found that several of these closely resemble one or more of the other lots, and such may be arranged side by side. Still other combinations may be made with these compound groups, until finally the entire collection will be embraced in a few comprehensive assemblages. These groups may be considered to represent *Species*, *Genera*, *Families* and *Orders*.

Classification consists in a systematic arrangement of specimens according to their place in each division, thus showing their near and their remote relationships. By means of it we are enabled to consider a multitude of organic forms under a few general heads.

A *Species* comprises all individuals that are supposed to have had a common parentage, and are exactly alike in all essential points of structure and habit.

A *Genus* (plural *genera*) is an assemblage of species that are not the same in all particulars, but have more points of resemblance than of difference.

The characters upon which genera are based are different in the different families of insects, and even concerning insects in the same family the opinions of entomologists differ as to what constitutes a character of generic value.

A *Family* includes all the genera that have in common a few important peculiarities of form and habit.

A *Tribe* is an assemblage of families whose relationship, though remote, is inferred from the similar structure of a few organs.

An *Order* includes all these groups and is founded upon agreement in general structure and mode of development.

With insects, as with all other organic beings, the *species* is the *root* of classification—the only group defined by nature. All other associations of forms, though based upon natural affinities, have been devised by man, and, being in a sense artificial, are liable to rearrangement, restriction or extension whenever new discoveries, or the adoption of new theories of classification, make such changes seem desirable.

In classifying insects we first group them according to their general structure: *i. e.*, arrange them in their proper Order, Tribe, Family etc., which is ordinarily quite easy, after which we proceed to look up the more difficult matters of genus and species.

The first step, then, is to determine in which Order a given specimen belongs. This can usually be decided without difficulty by an examination of the *wings*, for in the system of classification most generally adopted, the Orders—*seven* in number—are mainly founded upon the character of these conspicuous and important organs, and the names of these Orders are Greek compounds of which the termination *ptera* means *wings*, while the prefix describes the *kind* of wing.

There is some difference of opinion among writers as to the relative rank of the Orders, but the following arrangement seems most in harmony with the development of the insects included in each Order, and has the sanction of a majority of the best authorities:

- I. HYMENOPTERA (membrane-wings), bees, wasps, ants, etc.
- II. COLEOPTERA (sheath-wings), beetles.
- III. LEPIDOPTERA (scale-wings), butterflies and moths.
- IV. DIPTERA (two wings), house-flies, mosquitoes, gnats, etc.
- V. HEMIPTERA (half-wings), true bugs, cicadas, plant lice, etc.
- VI. ORTHOPTERA (straight-wings), grasshoppers, katy-dids, crickets, etc.
- VII. NEUROPTERA (nerve-wings), dragon-flies, lace-wing flies, etc.

Two of these orders, COLEOPTERA and DIPTERA, were defined according to the type of wing, by the Greek philosopher Aristotle, more than three hundred years before the Christian era. Thus it will be seen that entomology is one of the most ancient of the natural sciences, although for many centuries it made little or no true progress.

Adopting the idea of Aristotle, Linnæus (or Linne), a Swedish naturalist, and the most celebrated one of the eighteenth century, proposed five additional orders. In his system, however, the ORTHOPTERA were included with the HEMIPTERA, and the seventh order APTERA was devised to contain all insects which, in their perfect state, lacked wings. But as it was long since discovered that wingless species and wingless females exist in each of the orders, from which it would be extremely inconvenient to separate them, the order APTERA was dropped and its number made good by a very necessary separation of the ORTHOPTERA from the HEMIPTERA.

Recent authors have multiplied and rearranged the orders of insects on various other plans, founded in many cases on very obvious natural distinctions, but the arrangement here presented forms a very good basis for subdivision, and meets with continued favor from a majority of our naturalists.

In science the name of every animal and plant is a double one: First, the name of the genus to which it belongs, called the *generic* name; and second, the name of the species which it represents, called the *specific* name. These scientific names are usually derived from the Greek and Latin or have their terminations from those languages.

The names of tribes often refer to the style of that particular organ in which all the species included in them agree. The names of families are usually adapted from that of the leading genus. The generic name may refer to some prominent characteristic of the typical species, or may be entirely fanciful. It is always a proper noun and should be written with a capital.

The specific name is sometimes from some attribute of the species, or from the plant or other substance on which it feeds, sometimes from a resemblance it bears to some other object, and not infrequently from the name of the discoverer or some person whom the describer wishes to compliment. It is either an adjective or a noun in the possessive case, and is now seldom written with a capital, not even when it is derived from the name of a person.

It often happens that the same species is described by two or more authors, and although the name first published is considered to be the correct one, it is not always easy to discover which this is. To prevent confusion, therefore, as well as to give each author credit for his work, it is customary to add after the name of the insect that of the author who bestowed it, thus: *Dynastes tityrus* of Linnæus, or *Papilio asterias*, Cramer. The names of the authors are commonly abbreviated as Linn. for Linnæus, Cram. for Cramer, Fabr. for Fabricius, etc.

Besides their scientific names, many insects have common or popular names. For instance, in this country we have the "Red Admiral" butterfly, the "Devil's riding horse," the "May beetle or June bug," the "Chinch bug," the "Weevil," and many others. Some of these names are known and correctly applied everywhere; others are very local, and in other sections of the country people would not know to what insect they pertained.

Another advantage in the use of the scientific name is that it is perfectly intelligible to educated people in all countries, and, when given in accordance with established rules, there is seldom any question



as to the species designated. Whenever, therefore, exactness is required, the scientific name should accompany the popular one, and in these cases it is enclosed in parenthesis. For example: The Golden Tortoise beetles (*Cassida aurichalcea*, Fabr).

---

## CHAPTER VIII.

### Order I. HYMENOPTERA.

[Fig. 9.]



Bald-faced Hornet (*Vespa maculata*),  
after Riley.

This Order includes the Bees, Wasps, Ants, Ichneumon flies and other four-winged parasites, Gall flies, Saw flies, and a few Wood borers. These are not by any means the largest or most conspicuous of insects, but they occupy the highest rank on account of their perfection of form and the remarkable intelligence which many of them display. The three leading groups have from time immemorial attracted the attention of man by their interesting social relations, their industry, their mechanical skill, and their tender care for their young—in these respects displaying a wonderful analogy to the traits and enterprises of the human race.

Another reason for giving this Order precedence is that among its members we find the most complete metamorphosis—the larvæ being far more helpless and dependent on the personal care or the most painstaking prevision of the mature insects than is the case of the young of other Orders. In this, also, there is an interesting correspondence to man, who in infancy is utterly incapable of taking care of himself, far more so than any of the lower animals.

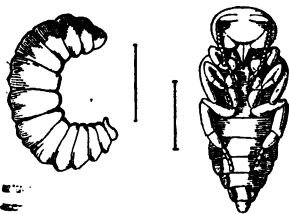
The frame of hymenopterous insects is, in most of the species, very hard and compact, especially on the thorax. The surface is, in some, smooth and polished, and often brilliantly colored; in others it is densely clothed with short hairs, giving it a resemblance to plush or velvet.

The head is comparatively large, and is attached, vertically, to the thorax by a short, slender neck, upon which it can be freely turned in any direction. The mouth is provided with apparatus for both bit-

ing and sucking, but the upper jaws (mandibles), though large and sharply toothed, are but little used in mastication, but serve instead as tools, of which very skillful and effective use is made in various mechanical enterprises. The lower jaws (maxillæ) and lower lips (labii) are greatly changed from the typical form, to adapt them for taking up liquid nourishment, upon which the perfect insects mainly subsist. The compound eyes cover a considerable portion of the head, and are either round, oblong or kidney-shaped (reniform). Upon the top of the head three small simple eyes (ocelli) can in most species be plainly seen. The antennæ are short and stout or long and slender (filiform), or flail-shaped: *i. e.*, bent in the middle and thickened more or less toward the tips.

The first joint of the thorax (the pro-thorax) is very narrow and on top crowded down almost or quite out of sight; but the second and third joints (the meso-thorax and meta-thorax) are large, and together form a compact and nearly globular division of the body. The legs vary considerably in form in the different groups, but are usually long and rather slender, and terminate in five-jointed feet (tarsi). The wings are composed of glassy or mica-like membrane, supported by a few strong veins. In a majority of the species they are quite narrow, the under pair being smaller than the upper, and during flight are attached to the latter by the row of minute hooks which may be seen on their upper (costal) edges, which catch into a ridge made for that purpose on the lower (inner) margin of the upper pair. In a great number of species of Hymenoptera the abdomen swells out in the middle, tapering to a point at the posterior end, and in the opposite direction to a slender joint, of greater or less length, called the *pedicel* or *petiole*, by which it is attached to the thorax. From six to eight rings or segments only can be distinguished in the abdomen. Each of these appears to be composed of *two* plates, an upper and a lower (a dorsal and a ventral), the former overlapping the latter on the sides. The tip of the abdomen of the female is always modified into an *ovipositor*. If this organ is connected with a poison gland and drawn within the body when not in use, it is called a *sting*; but if it is a conspicuous appendage and not capable of emitting poison, it is termed a *piercer*.

[Figs. 10 and 11,]



Larva and pupa of Wasp.

The larvæ of the higher Hymenoptera are, for the most part, soft, fleshy, footless grubs, confined during the whole of the growing period to the cells of wax, paper or mud in which they are hatched. Some species subsist upon food stored in their cells at the time the eggs from which they hatch are laid; others require constant feeding and care from the mature in-

sects that have them in charge. The larvæ of some of the lower families in the Order are more independent. The mother insect having placed her eggs upon the leaves or in the wood on which her instinct teaches her her young will thrive, the latter are, upon hatching, able to provide for themselves.

When full grown most of these larvæ spin a thin, oblong, silken cocoon, within which, after a short rest, they change to pupæ. The pupæ are quiescent and of the obtected form, each leg, wing and antenna being enclosed in its own sheath, which fits it as neatly as a glove finger fits a finger of the human hand.

All the members are closely applied to the body and remain immovable until the time of the second transformation. As a rule, eight or ten days only are passed in the pupa state. Then the membranous covering splits on the top of the thorax, the head, legs and embryo wings are drawn out of their coverings, and the insect gnaws open the end of its cocoon and lifts the covering to its cell—unless the latter is opened for it by one of the mature “worker” insects—and after a period of hardening and general preparation, varying from an hour or two to one or two days, it lifts itself by its strong new wings and sails away into the sunshine. The Hymenoptera are mostly diurnal insects, and are seldom seen upon the wing, except during warm, pleasant weather. The primary division of the Order, founded upon peculiarities of structure and habit, is into two sections:

1. *Stinging Insects* (ACULEATA), comprising the Bees, Wasps and Ants.

2. *Piercing Insects* (TERRIBANTIA), comprising several families of Parasitic Flies, Gall-flies, Saw-flies and Wood-borers. In the first section the sexes are distinguished by a difference in the number of the joints of the antennæ and the abdomen—the antennæ of the males having *thirteen* joints and the abdomen *seven* apparent segments, while the antennæ of the females have but *twelve* joints and the abdomen only *six* distinguishable segments. All the females belonging in this section have the ovipositor (the organ by which the eggs are placed) connected with two poison glands; and whenever this instrument is used as a *weapon*, a minute portion of the acrid fluid is forced into the wound made by its point and causes a burning and stinging pain.

This poison is used by certain wasps to paralyze other insects and spiders which they collect and store in cells as food for their young. In this case it does not *kill*, but produces in the victims a state of helpless torpor in which they continue until devoured by the wasp larvæ.

The Stinging Hymenoptera are separated into four very distinct tribes :

- 1st. Bees (*Anthophila*—flower-lovers).
- 2d. True Wasps (*Diploptera*—double-wings).
- 3d. Wood and Sand Wasps (*Fossores*—diggers).
- 4th. Ants (*Heterogyna*—different females).

Each of these tribes includes several families, the peculiarities of which will be noticed in succeeding chapters. The Piercing insects composing the second division of the Order are distinguished chiefly by the absence of the poison gland. In the higher families the form of the body and the venation of the wings are much like those of bees and wasps, the most obvious difference being the more lengthened abdomen and the *exserted* and often conspicuous ovipositor. The more lowly forms of the Piercing species have the abdomen joined to the thorax by a wide base instead of a slender pedicel, the wings are more net-veined, and in their immature stages they approach certain groups of the Lepidoptera. The section is subdivided into two comprehensive tribes :

- 1st. Four-winged Parasites (*Entomophaga*—insect-eaters).
- 2d. Saw-flies and Wood-borers (*Phytophaga*—plant-eaters).

The Plant-eaters include almost all the insects in the Order that are seriously injurious. All the others are either beneficial—some of them in a very high degree—or neutral in their relations to man.

---

## CHAPTER IX.

### Order HYMENOPTERA. Section ACULEATA.

#### BEES (*Anthophila*).

[Fig. 12.]



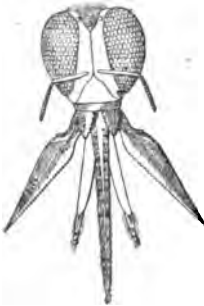
Honey Bee.

The Bees are very appropriately termed the "Flower-lovers," since they are, in all stages of their lives, wholly dependent upon the floral products, nectar and pollen, for their food. And in the economy of nature this dependence is, to a great extent, mutual ; for while the Bees are seeking sustenance for themselves and their young from flower to flower, they are at the same time unconsciously assisting the latter to produce good seed as a result of cross-fertilization, the pollen from the stamens of one plant or blossom being carried by them to the pistils of another.

Thus we see that while Bees could not live without flowers, many flowering plants would soon cease to exist but for the agency of Bees in assisting them to a vigorous development.

It is said there are over two thousand species of bees, the majority of which are small-sized and plainly-colored insects. They are distinguished from other Hymenoptera by the structure of the mouth and legs, which are peculiarly adapted for collecting and conveying nectar and pollen. The mouth of the Honey Bee, for example, is quite differ-

[Fig. 13.]



Head of Bee.

ent from that of other biting insects. To the naked eye it appears like a bundle of flat, pointed bristles, but when examined under the microscope these take the forms represented in Fig. 13. The outer jaws are large and strong, adapted for use as tools, such as scissors, knives, trowels, and so forth. The inner or lower jaws (maxillæ), of which there are two pairs, consist of long, slender jointed blades, which are used for piercing and probing, while the under lip (labium) is prolonged into a sort of hairy tongue, very flexible, with which the nectar of flowers is lapped up, and with the aid of the maxillæ drawn back and deposited in the "honey crop" or *proventriculus* where, by some mysterious chemical process, the crude nectar is transformed into the delicious substance known as honey. Such proportion of it as is required by the insect for food passes onward through the digestive tubes, while the surplus is regurgitated into cells and stored for food for itself or the young of which it has the care.

When not in use, all these lengthened mouth parts are drawn close together and bent under the chin.

The modification of the legs, especially of the hinder pair, is to adapt them to the work of gathering and carrying pollen. The shank (tibia) is broad and somewhat hollowed out on the inner surface, and has a rim of stiff hairs, thus forming a sort of basket in which the pollen is piled when it has been gathered by the feet, the basal joints of which are enlarged and otherwise especially adapted for the purpose, and when also it has been brushed by the front and middle legs from other parts of the hairy body on which it has accumulated in the repeated divings of the insect into the cup of flowers.

The sting is a slender tube formed of three blades, which may be protruded from the abdomen, the tip of which has a needle-like point and in some species is barbed. It serves not only as an ovipositor, but at the will of the insect, as a weapon, in the latter case conveying into the wound made by it a minute portion of an acrid fluid—the pediceled



abdomen enabling the insect to thrust its sting with considerable force. The poison is of an acid nature and may be neutralized with an alkali. An important secretion of many bees is the product known as *wax*. This is an exudation from the under surface of the abdomen, which Prof. Cook describes as "a solid unctuous substance and is, as shown by its chemical composition, a fat-like material. \* \* \* It is formed by the secreting membrane, and there are four "wax pockets" on each side."

[Fig. 14.]



The front legs of honey bees are provided with an ingenious contrivance for dressing the antennæ. It is a movable spur at the end of the thigh which closes over a notch in the base of the tibia, the antennæ being drawn through the aperture thus formed. Several other functions for this contrivance have been suggested.

In consideration of a difference in the length of the mouth parts, the bees are separated into two families:

APIDÆ—long-tongued bees; and

ANDEENIDÆ—short-tongued bees.

Front Leg of Honey Bee

They are further distinguished, according to their relations with each other, as *Social*, *Solitary* and *Parasitic* or *Ouckoo* bees.

In this country there are but two genera of social bees, namely, the genus *Apis*, which contains but one species—*melifica*, the well-known Hive or Honey bee, and the genus *Bombus*, containing about fifty species of the almost equally well-known Humble or Bumble bees.

All social bees, as well as other insects of the same habit, live together in larger or smaller communities, and have a regular system of government and labor—a sort of ideal communism—in which no individual is independent, but each performs certain duties for the common good. Among the bees each colony contains three sorts of individuals: one or more perfect females, or *queens*, which are the mothers of the swarm; a considerable number of males or *drones*, only permitted or developed in the hive or nest at certain seasons, and a great number of smaller, imperfect females, most appropriately termed "*workers*," since upon them devolve all the labors of the colony.

The typical species of this group is the Hive bee, celebrated from time immemorial in sacred as well as classic literature, for the delicious and useful products of its industry, honey and wax; for its intelligence and mechanical skill, and its various peculiar developments and adaptations. Although an introduced species, it is now thoroughly natural-

ized in this country, and is often found wild in forests, where it inhabits hollow trees. It is said, however, that it never occurs far from the habitations of men, which fact caused the Indians, in earlier times, to call it the "white man's fly." It may be considered, indeed, like the silk-worm, a thoroughly domesticated insect; and though so familiar to us, the study of its habits has never lost its fascination nor its reward in the discovery of some remarkable attribute or power.

The form of the worker bee, with its compact, hairy body, its strong wings, its large but widely separated eyes, its long proboscis, and its sharp sting—which has the peculiarity of being barbed, and of causing the death of its user by its loss, if thrust too vigorously into the skin of the offender—is familiar to every one who has ever walked in field or garden. The queen bee is less frequently seen, even by the careful observer, although, where glass hives are used, she can occasionally be noticed in her promenades among the brood cells. She has a much longer body than the worker, and her proboscis and the pollen baskets on the hinder tibiæ are not so well developed. But one perfect queen mother is permitted in a hive at one time, and when the colony grows too large for its quarters, the mature queen goes with the migrating swarm, and her place and office in the hive is assumed by one of the young queens, of which, in the swarming season, there are always a number at the point of development. At this season, too, the males or *drones* are found in the hive in greatest numbers. These are stouter bodied than the worker bees, and have the mouth parts and legs less perfectly developed, while the eyes are larger and almost meet at the top of the head. They are hatched from unimpregnated eggs laid by an occasional fertile worker, or by an unmated queen, or, most remarkable of all, by a fertile queen, when she chooses to allow an egg to pass through the oviduct without contact with the sperm cells stored, after pairing, in her *spermatheca*. In view of this we learn that the queen bee possesses a power not shared, so far as known, by any other animal, viz.: that of controlling the sex of her offspring at will. The queen cells are more than twice the size of those built for the rearing of workers, and are placed here and there on the edges of the brood comb and at right angles to the worker cells. The egg and embryo are of the same nature as those designed to produce workers, and the queens or perfect females result from their more spacious cells and the more nitrogenized food called "royal jelly" on which they are fed. The average life of the queen is from two to three years, and instances are on record of her attaining the age of five years. During the ordinary period of life she lays between one and two millions of eggs. The life of the worker seldom exceeds eight or nine months and that of the drone two or three.



The period of development, from the laying of the egg until the capping of the cells by the workers, when the larvæ are full grown, is said to be eight days. During this time they are regularly fed and attended by the younger workers, on which devolves the office of nurses. After the cell is covered the larva spins around itself a very delicate cocoon of silk, within which it transforms to pupa. The latter has all the members and the form of the mature insect, but all in a very soft state and closely appressed to the body. After a repose of about three weeks the young bees emerge, but remain in the hive for a few days, until the wings and other members are sufficiently hardened to be ready for duty. The hive bee is not torpid during winter, although many of its activities are suspended. It appropriates large quantities of honey and generates heat in proportion to the degree of atmospheric cold. On the other hand, in every hot weather in summer, the bees, by the vibrations of their wings, are able to cool and ventilate their hives.

Next in popular interest to the Honey bee, although they do not contribute directly to our luxuries, are the large, clumsy, noisy Humble bees. They are the largest insects in their tribe. In color they are black or black banded with yellow, and the entire body is densely covered with short, stiff hair. The wings, instead of being transparent, are of a purplish or smoky hue. The tongue and maxillæ are longer than those of the Honey bee, but constructed on the same plan, and the added length enables these insects to extract the nectar from and thus be the means of cross-fertilizing many flowers—among them the red clover—in which the sweets are inaccessible to the former species. The jaws are broad and strong, adapted for digging in the earth. The nests of the largest species, *Bombus pennsylvanicus*, De Geer, are usually, if not invariably, made underground, sometimes in little caves made for the purpose, but often in the deserted burrows of field mice or similar cavities for the sake of economizing labor. Only the queens or fertile females live over winter, and in the spring each one of these founds a separate colony. Her mode of procedure is as follows: After she has selected and prepared her home, she gathers a quantity of pollen and honey, which she kneads into a mass, and upon which she deposits a number of eggs. From these the larvæ hatch in a few days and eat their way into the ball of bee-bread in different directions, growing, meantime, very rapidly. The rude cells thus formed are from time to time strengthened and extended with wax by the mother bee, until the larvæ are sealed up for transformation. The first brood are all workers, and as they mature the queen relinquishes her outside labors to them, and devotes herself exclusively to increasing the numbers of the colony. About the middle of the season drone and queen



cells are built, and upon the emergence of the occupants the two sexes take their marriage flight together, after which, upon the approach of cold weather, the colony disbands, and all except the perfect females soon perish. The latter seek shelter about buildings, in hollows of trees, and possibly some return to the nest and remain dormant through the winter, reviving when spring returns to repeat the annual process of founding new colonies and reproducing the species.

The Humble bees are far less skillful and exact in their mechanical efforts than the Honey bee. The cells are oval instead of hexagonal, and very irregularly placed, and honey and brood-comb are intermixed without much order. The honey is very sweet, but somewhat rank-flavored, and in many persons produces headache, while the wax is dark, coarse-grained and doughy.

The economy of the Solitary bees, belonging in the family APIDÆ is quite different from that of the social species. Each pair, or more properly each female, builds and provisions a separate nest, which consists of from a half-dozen to a great number of cells. A quantity of food, prepared mainly from pollen, is stored in each cell, in which a single egg is also deposited. The cell is then closed and the mother insect takes no further care for her young.

The most interesting and conspicuous of the Solitary species are the Carpenter, the Mason, the Upholsterer and the Leaf-cutter bees.

The Carpenter bees (genus *Xylocopa*) contain a few species which rival the Humble bee in size, and in many other respects closely resemble them. They may, however, be distinguished from the latter at a glance by the smooth top of the abdomen, which is entirely of a glossy black. Upon closer examination, the jaws (mandibles) are found to be very powerful and sharply toothed. The basal joint of the hind feet is very long and clothed with long stiff hairs, appearing much like a bottle brush.

These bees bore holes in solid, but not growing, wood, being often found at work in the cornices of houses and other buildings, in which they make tunnels a foot or more in length. The entrance, for the depth of an inch or more, is cut direct across the grain of the wood, but the tunnel proper is at right angles to this, with the grain of the wood. In this, numerous cells are partitioned off, the walls being built from the chips or raspings, cemented with a sticky fluid from the mouth of the little artisan. Beginning at the end farthest from the entrance, each cell is finished, provided with a quantity of the usual bee food, and the egg laid, before the partition wall is put up. It follows that there is a considerable interval of time between the com-

pletion of the first and last cells, and whether the first laid eggs are last to hatch, or whether, upon development, the young bees in the more remote cells, remain quiet until those nearest the entrance open a passage-way, has not been ascertained; but at all events, they do not emerge until their younger brothers and sisters have passed out before them.

The Mason bees (*genus Osmia*) are a group of small, handsome bees of a metallic bluish or green color. They derive their name from their habit of using clay, or a peculiar mortar which they prepare from fine gravel, in the construction of their variously shaped cells. These may often be found plastered against the sides of buildings, upon the branches of trees, and sometimes even upon leaves, or within oak-galls, separately, or in small groups. They are rough on the outside but smooth and polished within. A few species belonging to this genus are said to excavate tunnels in soft or decayed wood in which to protect their cells. Dr. Riley says of *Anthopora sponsa*, an allied species, that it "builds mostly in steeply inclined or perpendicular clay-banks, and, in addition, extends a tube of clay from the entrance. The burrow has usually two branches, which decline about an inch from the surface of the bank, and (in them) six or eight cells are arranged end to end. By means of saliva the inside of the cell is rendered impervious to the moisture of the honey and bee-bread stored in it for the young."

The Upholsterer bees (*genus Ceratina*) resemble the Mason bees in form and color. They build their nests on a plan very similar to that of the Carpenter bees, but instead of boring into solid wood they select that which is soft from decay, or confine themselves to the pithy stems of such shrubs as the elder or blackberry, or the stalks of the more robust weeds. The walls of the cells are lined and the partitions made of a delicate silken web—the "upholstery" from which they derive their popular name.

The Leaf-cutter or Taylor bees (*genus Megachile*), also in most instances excavate the pithy stems of shrubs in which to build their nests. In other cases they select tough leaves, which they contrive to roll into cylinders and fasten firmly for the protection of the cells. Within these tunnels they prepare a number of cells, forming the partitions and covering the walls with sections of delicate leaves or of the petals of flowers. One species, *M. centuncularis*, is a serious pest to the flower garden, always, with rare good taste, selecting the most delicately colored of the roses, geraniums and other choice flowers for her curtains and coverlets. This is a rather stout, short-bodied bee of a dull black color, banded with yellowish gray. The head is broad and the scissors-like jaws are very strong, and the swiftness

with which they cut out the circular pieces of leaf or petal is something astonishing. The cells are over half an inch in length, nine or ten in a row, placed end to end. As, in the latitude of St. Louis, these bees may be seen at work from May until September, there are doubtless several broods in a season.

Bees belonging in the family *Andrenidæ* are distinguished by having the tongue short and rather broad, and the most characteristic genus (*Andrena*) can be recognized by a lock of long curled hair on each trocater. The colors are dark, banded with dull red. This family of bees includes a large number of small, prettily colored insects which make their nests in tunnels excavated horizontally in banks or perpendicularly in level ground. The tunnels commonly consist of a straight gallery into which the separate cells open on all sides.

Many species of both *Apidæ* and *Andrenidæ* are sorely annoyed by Parasitic or Cuckoo bees. These build no nests for themselves, but when one of them discovers a Carpenter or Mason or other bee at work, she constantly hovers about the spot, and as fast as the cells are completed she slips in and deposits her eggs, always choosing her time when the builder is absent. The larvæ from these eggs usually kill the rightful tenants of the cells, or the latter perish from starvation because the intruder has devoured the lion's share of the food. A few of the Cuckoo bees are rather guests than parasites, living very amicably with their hosts, on whose bounty their young are reared. This is the case especially with those that choose their homes with the social species. A certain large species of *Apathus* is said to live in this way in the nests of Humble bees, and the mature insects, which are similar in appearance, are often seen together, harmoniously sipping nectar from adjoining flowers.

The habits of all wild bees are extremely interesting subjects for study, and have not by any means been thoroughly investigated.

## CHAPTER X.

## Order HYMENOPTERA. Section ACULEATA.

## TRUE WASPS AND DIGGER WASPS.

[Fig. 15.]

Digger-wasp, *stigus spectosus*.

The True wasps are termed **DIPLOPTERA** (double wings), because when not flying the upper wings are always longitudinally folded. This manner of carrying the wings is the most obvious structural distinction between this group and the Fossorial or Digging wasps. In this tribe of insects the body wall, or external envelope, is harder, and, as a rule, smoother, than that of bees, although some species have parts of the body clothed with a velvety pubescence. The neck is very short and the head wide at the top, giving a somewhat triangular shape to the face. The jaws are broad and strong, with sharp teeth, while the inner jaws and tongue, though shorter than those of bees, are not so flexible, still admit of the extraction of nectar from the more open flower cups. Both pairs of palpi are well developed, and on each side of the tongue is a similar supplementary organ called a *parraglossa*.

The eyes are large and hollowed out in the middle (see Fig 2, pt. 1st), and the ocelli are unusually prominent. The legs are mostly smooth and cylindrical, but the shanks are provided with long, thorn-like spurs, and the joints of the feet are also spiny. The females have a formidable sting, but the males, as with nearly all other insects, are unarmed.

The larvæ are much like those of bees, except that they are somewhat larger on the anterior end. They are reared in cells of paper or mud, for wasps are incapable of excreting wax, and are fed mainly on animal food—such as the soft bodies of flies, larvæ, bits of fresh meat and the like—few, if any, being fed on the honey and pollen that form the sole nourishment of the mature insects.

Like the bees, this tribe of wasps has its social and its solitary species.

The best representative of the former is the Bald-faced Hornet (*Vespa maculata*, Linn.) an insect with whose large gray paper nests—often eight or ten inches in diameter—and whose fierce sting every school-boy is familiar. The habits of this species are much like those of the Humble bees. The perfect females, only, hibernate, and when the spring is well advanced each one forms a few cells, mainly from a glutinous secretion from the mouth, but apparently mingled with a little woody fiber. These are attached by a slender pedicel, with the opening downward, to a branch of some low tree or similar and secluded support. The eggs are glued into the cells, and the young larvæ, with heads down, are at first fastened in the same manner, but as they grow the swelling of the segments next the head serves to keep them in position.

These first larvæ speedily develop into workers and release the queen from her labors. The tier of cells is added to on all sides, and over it is built an umbrella-like roof, the materials being mainly fibers of weather-beaten wood, collected from old fences and unpainted buildings. This is masticated and mingled with the fluids from the mouth, and when thinly spread dries into a strong water-proof paper.

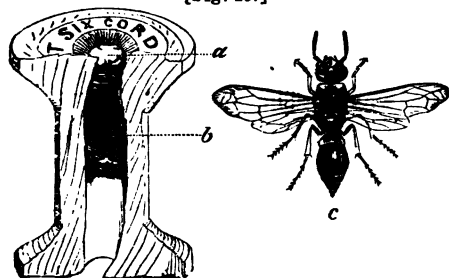
As the season advances and workers increase, successive tiers of cells are built, attached by strong silken pillars to those above, with galleries between, through which the wasps can easily move when caring for the young. The outer envelope too is enlarged and brought down at the sides, and finally made to completely enclose the nest. Late in summer a brood of perfect males and females is produced, and upon the approach of cold weather the ingenious little home is deserted, the mature insects, it is said, first stinging to death any larvæ or pupæ that remain, dragging them ruthlessly from their cells and casting them to the ground.

Some species of the genus *Vespa*—for example, the smaller and more brightly colored “Yellow jackets”—have their homes, like the Humble bees, underground.

The nests of the species belonging to the genus *Polistes* consist of a single tier of from ten to twenty or thirty cells, built in some sheltered situation and without any external enclosing wall. The species are more slender in form than the hornets, and are mostly of rust-red or brown colors. From their habit of attaching their clusters of open, gray paper cells under the cornices or window sills of our dwellings,

and from the familiarity with which they enter our rooms, especially in the autumn when the colonies are disbanding, scarcely any one can fail to have more or less knowledge of their appearance and habits.

[Fig. 16.]



Potter wasp—after Riley. Colors black and yellow; a, clay cover to cell; b, larva; c, wasp.

cell, seals it up and leaves the larva to develop without any material supervision or care.

Among the most interesting of these is a small species, of a black color, banded and ornamented with pale yellow, which has a great partiality for building its mud cells (for these solitary species do not make paper, but are all masons) in key-holes and crevices indoors. On one occasion which came under my observation, one of these wasps took possession of some spools of thread standing on the sill of an open window, and built her cells in the spindle holes, as figured above. As fast as one spool was filled another was supplied, and in the course of three days nine spools, averaging three cells to a spool, had been completed. The food stored consisted of various small caterpillars, including several larvæ of the Codling moth, which had been stung with sufficient severity to produce paralysis but not death.

The cells were scarcely more than half an inch in depth, but into this small space six or seven or more larvæ would be crowded, packed with a deftness that was impossible of imitation by human fingers. The wasp larvæ developed rapidly, the young wasps appearing in less than two weeks.

The Digging wasps (tribe Fossores) contain the largest and most beautiful insects in the Order. (See Fig. 15.) Most of the species are easily distinguished from the True wasps by their spiny legs, their oval or roundish eyes, and especially by the wings not being folded in repose. All the species are solitary in their habits, and as a matter of course only males and perfect females are developed. A few of the species bore holes in dry or decayed wood, or excavate the stems of pithy plants, in which to construct their cells, while others, like the Mud-dauber (*Pelopæus*), build a cluster of pipe-like cells plastered against a beam in some shed or out-building. The great majority, how-

The few solitary species belonging to the group of "Double-wings" differ more in habit than in structure from the social species. No so-called "neuters" or workers exist among them. Each mother wasp builds her own series of cells, stores each with the requisite amount of food, carefully places her egg on the side of the

ever, burrow into the earth, especially in sandy or gravelly situations, loosening the soil with their strong jaws and scrabbling it out with incredible rapidity with their spiny legs.

A separate hole is dug, six or seven or more inches deep, for each egg, at the bottom of which the latter is laid, after the nest has been provisioned with one large or several smaller insects or spiders reduced to torpor by the poisoned lance of the wasp. The shaft is then filled up, the earth smoothed over, and even bits of gravel so placed as to completely obliterate all trace of the excavation.

The Wood wasps (family CRABRONIDÆ), which bore into wood, feed their larvæ on plant lice, a great number of these tiny insects being required to provision a single cell. Species of the genus *Ammophila*—easily recognized by the very spiny legs and the long, slender pedicel gradually widening backward into the rather small abdomen—provide each nest with but one large caterpillar.

The elegant wasp known as the "Handsome Digger" (*Stizus speciosus*, Drury), represented in Fig. 15, a very large species of a black color gaily banded and otherwise marked with yellow, provisions its nest with harvest flies (Cicadas), making use of the seventeen-year species when they appear, as well as of the annual "drummers." A still larger species (*Pompilus formosus*, Say), of a dark blue color, common in the Southwestern States, is called the "Tarantula-killer," because it makes the large and venomous Tarantula, the most formidable of our spiders, its especial prey. The Digger wasps are a great terror to the insects upon which they prey, the latter seeming to recognize them instinctively as enemies from which there is no escape. Observers have noticed that even the Tarantula above mentioned, large and savage as it is, is seized with a violent tremor and appears to lose all courage as soon as it finds itself pursued by the fierce *Pompilus*.

A small black wasp belonging in the genus *Tiphia*, common in the north and west, is distinguished as one of the few insect enemies of the destructive White grub, its tough, brown, silken cocoons being frequently turned out by the plow in the spring from meadows and corn land.

All wasps, whether social or solitary, may be considered among beneficial species, for although the perfect insects feed only on honey and pollen, yet in providing for their young they destroy vast numbers of leaf and fruit-feeding larvæ as well as various grasshoppers, cicadas and flies. In preparing these insects to nourish their young the attending wasps of the social species thoroughly masticate and partly digest them before they regurgitate the pulp into the open mouths of the larvæ. The Solitary species, as we have seen, have a provision for

rendering the insects upon which their young are to feed helpless to escape or resist, and yet not fatally injured so that they would spoil before being required for food.

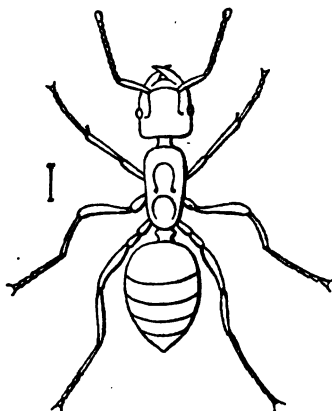
---

## CHAPTER XI.

### Order HYMENOPTERA. Section ACULEATA.

#### ANTS.

[Fig. 17.]



Worker Ant. *Formica*.

All the typical ants (composing the tribe HETEROGYNA) are social insects which rank next to and in some respects exceed the bees in their manifestations of ingenuity and intelligence.

A colony—termed a *formicarium*—as in the case of other social insects, always contains *three* and occasionally *four* distinct forms, males, females, workers, and sometimes *soldiers* or some other distinct class. The males and females at a certain period in their development acquire wings and arise from the nest. After sporting together for a time in the open air the females return to the nest or perhaps originate new colonies, and divest themselves of their wings, as these appendages in the retired life they henceforth lead, would be not only useless but cumbersome. The male ants, which are much smaller than the females, having once left the nest never return to it, and are usually short-lived. The workers and soldiers, which are imperfectly developed females, never acquire wings, and differ from the perfect individuals in having the joints of the thorax less compactly united, and the basal and sometimes the succeeding joint of the abdomen formed on top, into a sort of scale or node. The head is generally more or less triangular, the antennæ are long and elbowed, and seem to be the organs of communication



between the individuals of a colony. The jaws are strong and sharply notched, except in the slave-making species, in which they become almost useless as tools.

Some species are armed with a sting, and all secrete a peculiar acid, called *formic acid*, which has very characteristic properties, and produces a slight burning sensation upon the skin. This acid is attractive to certain insects which penetrate to the ants' nests to obtain it from their bodies. It is thought to have medicinal qualities, and in Switzerland a highly prized vinegar is made from it by boiling the insects in water. It is said that the lumbermen in our northern forests, in the event of a failure of their fruit supply, use these acid insects as a substitute.

Ants build their *formicaries* in various ways, according to their species. Some erect conical dwellings above ground from mortar of clay or sand; others, including a majority of the species, burrow into the earth; while others still inhabit hollow trees or excavate decayed stumps and logs. The nests are marvels of mechanical art, containing store-rooms, nurseries, galleries and other compartments, and are sometimes several stories in height, each story being supported upon pillars, arches and cross-beams.

Not only are these little creatures skillful artisans, but they seem to have quite complex social and governmental systems. When about to make war on a neighboring colony, they sally forth in regular columns, and appear to have a corps of officers who take turns in directing the movements. Several species of red and yellow ants capture and enslave various black species. The slaves are obtained by making war on the "negro ants;" and after the victory which they gain in a majority of the battles, they carry off the pupæ of the vanquished colony and rear them in their own nurseries. When the captives are mature, they do not attempt to escape, but seem entirely willing to procure food for their owners and to serve them in any capacity required.

The larvæ of ants are short, white cylindrical grubs, with small heads which are bent forward. These larvæ receive the most assiduous care from the workers. They are daily carried about to those parts of the nest where the temperature will best promote their growth. When the weather is pleasant, they are brought in the morning to the upper apartments, that they may receive the benefit of the sun's rays, and at evening they are again removed to the lower chambers where there is less exposure and more warmth. The food with which they are supplied must first be chewed and submitted to a process of partial digestion by the nurses before it is fed to them, and in all other ways they are the objects of the tenderest interest and attention.

In case of an accident to the nest, the safety of the larvæ and pupæ seems to be the first consideration, and the workers may be seen running hither and thither in great distress with their delicate white charges in their jaws, and which they will sacrifice their lives in the effort to protect.

Ants feed upon a variety of animal and vegetable substances, and while very fond of sweets, are not, like bees and wasps, restricted in their mature state, to a diet of pollen and nectar. Some species are quite valuable as scavengers, rapidly disposing of carrion.

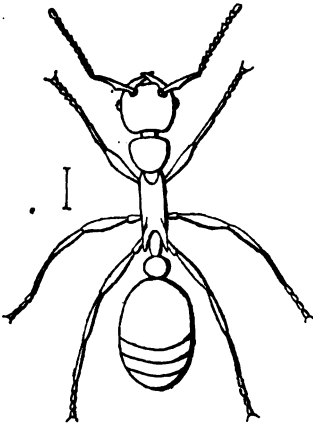
A very good way of obtaining a perfectly clean skeleton of a bird or other small animal is to place it near a large ants' nest. Every particle of flesh will soon be removed in the neatest manner. There are no species injurious to vegetation north of Florida, but in that State a certain species (*Solonopsis Xyloni*, McC) is said by Mr. Henry Hubbard to "seriously injure the orange by gnawing away the bark and causing an exudation of gum which seems, at certain seasons of the year, to become one of its principal sources of food supply." In other sections of the South this species makes reparation for such injuries by its attacks on the cotton-worm, of which there is no room to doubt that it kills great numbers.

The Leaf cutters are mainly Mexican and South American species, and are often very destructive to the foliage of the orange and other valuable trees. Among these appears the singular form of workers, distinguished as "soldiers," with enormously large heads and other peculiar adaptations. These are the protectors of the nest in time of danger, and take no part in other labors. Dr. McCook has also described most entertainingly the habits of the Agricultural ant, which clears the ground around its nest, sows it to a sort of grass which it in due time harvests, storing the seeds in its nest. In Texas and Mexico also occurs another very interesting species whose habits were investigated and published by the same gentleman, viz., the Honey ant. In the formicaries of this species, certain workers have the power of secreting honey from their food. This collects in the abdomen until the latter becomes enormously enlarged and the insect is incapable of dragging the heavy weight, and has to be fed by the less distended workers. This honey is not disgorged into cells, but is taken direct from the insect by the other inmates of the nest, and when the secretion is entirely exhausted the creature perishes.

Instead depending on members of their own colony for their sweets, some of our indigenous species domesticate in their nests certain root-feeding plant lice (*Aphides*), which have been called the "ants' cows," because of the sweet fluid which they yield from their nectar tubes when caressed by the ant's antennæ. Indeed, all these nectar-

yielding aphids are great favorites with the ants, which take various measures for their protection, even when they cannot transport them to their nests.

The great majority of our ants belong in the genus *Formica*. These have no sting, but will sometimes bite severely if they have access to the tender skin. They have but one node between the pedicel and abdomen. Our largest species is *Formica pennsylvanica*, which is black, and three-fifths of an inch long. It is a wood-borer and may often be found in hollow trees and decaying stumps. *Formica sanguinea*, a medium-sized red species, is the most common slave-making ant.



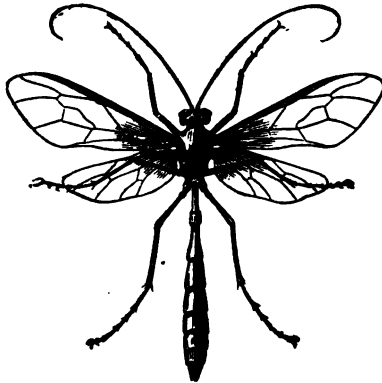
Red Ant (*Myrmica*), greatly enlarged. keepers.

## CHAPTER XII.

### Order HYMENOPTERA. Section TEREBRANTIA.

#### PARASITES AND GALL-FLIES.

[Fig. 19.]



Ichneumon Fly (after Riley).

This division of the HYMENOPTERA includes both the species that are of most service to man, and those that are most directly injurious. They are grouped in the same section because in all, the ovipositor is a *piercer*, adapted for penetrating either hard or soft substances. It is

usually a conspicuous appendage of the abdomen, and is of a variety of singular forms, but is not connected with any poison gland, and while that of some species may inflict a sharp prick, it is in no case a true sting.

Among the PIERCERS are found those species that vary most from what is considered the type of the Order, many of which, in points of their general structure, and in the forms of their larvæ, seem to be closely allied to the Lepidoptera.

The Piercers (T E R E B R A N T I A) are very conveniently separated into two tribes :

1. Insect eaters (ENTOMOPHAGA), Parasitic flies, and also Gall-flies, and a very few other vegetable feeders.

2. Plant eaters (PHYTOPHAGA), Saw-flies and Wood-borers. The first tribe includes a vast number of species, some with bodies, including the ovipositor, two inches or more in length, others so minute that their different parts can only be distinguished with a lens, the office of all of which seems to be to keep in check those members of its class which prey upon vegetation, and which, but for them, would multiply to such an extent as to threaten extinction to many of our most valuable food plants.

The Parasitic species may be readily separated into three families, ICHNEUMONIDÆ, PROCTOTRYPIDÆ and CHALCIDIDÆ. Some authors separate various species from these groups, for which they define several more families, but those mentioned include all the more important species.

Among the members of the first-named family may be found some very large species, a great number that are of medium size—with a wing expanse of from one-third to one-half inch—and some that are extremely small. The typical *Ichneumon* flies have long and rather slender bodies, usually terminated by an exerted ovipositor, which is composed of several thread-like stylets, and which varies in length from three or four inches in *Thalassa*, to a scarcely noticeable point at the tip of the abdomen, as in *Microgaster*.

The head is somewhat square, the antennæ thread-like and many-jointed; both pairs of palpi are well developed, but the biting organs are rather small and weak. The thorax is compact, but the different parts are often outlined by deep grooves. The veining of the wings is much like that in bees and wasps, but the membrane is more delicate and transparent. The legs are smooth and cylindrical. These insects lay their eggs in or upon the bodies of other insects, usually caterpillars, piercing the skins with their sharply pointed ovipositors. Sometimes but a single egg is laid; in other cases the dorsal surface is thickly

punctured and a great number of the little grub-like larvæ hatch and burrow back and forth in the fatty tissue of their victim, avoiding at first its vital parts; and when it is fatally injured, though perhaps it

[Fig. 20.]



Sphinx larvæ with cocoons of parasites (after Riley). Color, white.

does not die for several days, they emerge in an erect position and cover the back of the caterpillar with their small white cocoons attached at the lower end and standing up like grains of rice all over it. Most of the larger species weave their cocoons inside the body of their victim. The internal parasitic larvæ are said to breathe through *branchia* similar to those of water insects, which are situated at one end of the body and communicate with the air tubes of the insect they infest.

The large species represented in Fig. 19 is *Opilon Macrurum*, Linn. The abdomen broadens toward the tip and is compressed laterally. The entire body and wing-veins are of a honey-yellow color. It quite frequently enters our lighted rooms on summer nights, and if taken into the hand will administer so sharp a thrust with its ovipositor that the captor involuntarily releases it. It is parasitic on the large caterpillars belonging to the family of our native silk worms.

The PROCTOTREPIDÆ is a family of exceedingly small flies, most of which are "Egg parasites." Their bodies are rather slender and the wings almost without veins, but in some species are fringed with fine hairs around the edges. They breed, as a rule, in the eggs of larger insects, of which they destroy great numbers. The family of the CHALCIDIDÆ is also composed mainly of very small species, some of which also breed in eggs, but usually in the bodies of other insects, especially in those of Aphides. They are often of beautiful metallic colors. The antennæ are elbowed and have from six to fourteen joints. A considerable number have the thighs of the hinder legs very much thickened for jumping. The wings have very few veins and no enclosed cells. In the male the abdomen is seven-jointed, while in the female it has only six joints. Except in a very few species the ovipositor is entirely withdrawn into the body except when in use. They are not infrequently parasitic upon other parasites, and, therefore, to be reckoned among injurious species. In this group, also, we find the destructive "Joint-worm flies" (*Isosoma hordii* Har. *tritici* and *I. grande* Riley), which puncture the stalks of small grain at the joints in depositing their eggs, the larvæ afterward feeding upon the sap, and where they are numerous, preventing the growth of the stalk and the filling of the head. Mr. F. M. Webster of Indiana made the discovery that many of the females of *I. grande* were wingless. As most of these insects hibernate in the straw, burning the latter after threshing and

also burning the stubble is the best preventive of their increase. This fly differs very slightly in structure from the parasitic species.

One family included in this group—the *Cynipidæ*—while resembling the Chalcids very closely in structure, are vegetable feeders, causing on Oak, Rose and other woody plants, the singular fruit-like and nut-like growths called “galls.” The females differ from the parasitic CHALCIDIDÆ in their larger size, and in the shorter and more compressed abdomen and in the notch on the under side of the latter. The antennæ, also, are straight and slender, with the joints all equal.

The abnormal plant growth is supposed to be caused by the deposition of a minute quantity of a peculiar fluid, along with the egg, by the parent fly, the tissue resulting forming a more suitable kind of food for the larvæ than ordinary wood fiber or leaves. The gall makers are all more or less injurious to the plants they attack, but one species makes a sort of reparation in producing on a European oak the “nut galls,” used in the manufacture of the best ink.

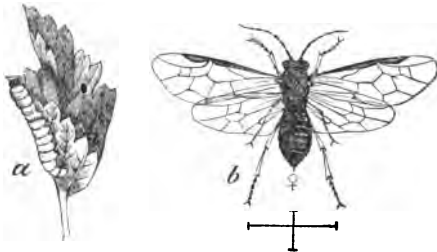
---

### CHAPTER XIII.

#### Order HYMENOPTERA. Section TEREBRANTIA.

##### SAW-FLIES AND HORN TAILS.

[Fig. 21.]



Native Currant Saw-fly.

Colors—(a) green and black ; (b) black and honey-yellow.  
Native Currant-worm—*Pristiphora grossularia*—after Riley.

The insects of this Order, included among the true Plant-eaters (PHYTOPHAGA), differ very much in all stages of their development from those described in preceding chapters.

The perfect insects have rather heavy bodies, upon which the three principal divisions are not so distinct as in bees, wasps and ichneu-

mons. The head is broad, connected with the thorax by a very short neck, and the abdomen is *sessile*: *i. e.*, joins the thorax by a wide base instead of a slender stalk.

The larvæ are much more independent than those of the higher families of the Order. They are not confined to cells or chambers, and the only provision made for them by the parent insect is the insertion of her eggs in the kind of leaves or wood which her young require for food. They subsist entirely upon vegetation, and are separated into two families:

- 1st. Saw-flies (TENTHREDINIDÆ), and
- 2d. Horn-tails or Wood-borers (UROCERIDÆ).

The Saw-flies are easily recognized by their broad, thin wings, which are divided into numerous cells by fine veins or nervures, and by the soft and yielding integument of the body. The antennæ are usually short and simple, varying in the females in the number of joints. A few species have these organs knobbed at the tip or toothed or feathered on one edge. The ovipositor, from the peculiar structure of which these insects derive their popular name, consists of two saw-like blades, the sides of which are ridged and the lower edges finely serrated or notched. The blades are strengthened by a back so grooved that they can slide back and forth upon it. When not in use they are protected by a sheath and concealed in an opening on the under side of the abdomen. With this most ingenious instrument the insect saws little oblique slits in the cuticle of leaves or in the principal veins, in which she places her eggs. There are some exceptions to this rule, found among species that are very prolific and destructive: *e. g.*, the Imported Currant-worm, in which the eggs are attached externally to the veins of the leaf and kept in place by a sticky fluid which is exuded with them. In such species the ovipositor is found to have lost, in great measure, its saw-like character. The Saw-flies are slow and heavy in flight, sluggish in all their motions and easily captured.

The larvæ are called "slugs" and "false caterpillars," and are classed with the most destructive of insect pests. The Imported and the Native Currant-worms, the Rose slug, the Pear slug, the White Pine and the Larch false caterpillars are some of the most pernicious species. They are of elongate, worm-like form, with large, roundish, glossy heads, on some of which are seen a pair of antennæ-like processes. The thoracic legs are well developed, and the hinder end of the body is supported upon six to eight pairs of fleshy points or props, which differ from the pro-legs of genuine caterpillars, not only in their greater number, but in lacking the little circle of hooks by which the latter can so firmly attach themselves to any surface. In some of these

larvæ the surface is smooth and glossy, in others spiny or mossy or covered with a slimy exudation, while others excrete a powdery or cottony substance that gives them a very peculiar appearance.

Some species, such as the White-pine worm, have the habit of elevating the head and tail when at rest, others keep the body coiled when not feeding, while a few construct leafy cases which they carry about with them or to which they retire for repose.

A few species are gregarious, feeding in large companies or spinning large gummy webs in which they cluster in masses. When full grown many of these larvæ drop to the ground and form tough oval cocoons among the fallen leaves and rubbish, or they burrow into the earth and enclose themselves in cells thinly lined with silk. Most species hibernate in the larva state, without changing to pupæ until the following spring.

The family of the Horn-tails (UROCERIDÆ) contains comparatively few species. They are mostly large insects with stout cylindrical bodies, characterized by a long straight horn extending from the abdomen. In the males this appendage is at the tip, but in the females it arises from the middle of the underside of the abdomen and constitutes the ovipositor. It is more auger-like than saw-like in its form and use, and is used for boring into the trunks of trees, especially the elm and pear, to which the boring larvæ are often very destructive.

The wings are narrow but strong, expanding more than two inches, and in flight making a loud buzzing sound. The length of the body including the horn is also more than two inches.

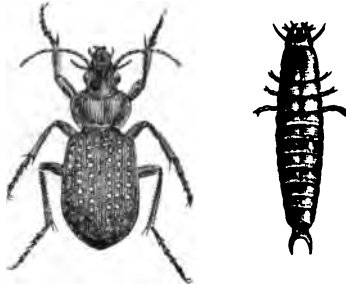
The species known as the Pigeon Tremex (*Tremex columba*, Linn.) is one of the most injurious. Its multiplication is, however, very much checked by a large ichneumon fly which runs its long ovipositor into the auger-holes of the Tremex, leaving in each one an egg, from which hatches a deadly enemy and devourer of the first Horn-tail larva which it meets.



## CHAPTER XIV.

## Order II. COLEOPTERA.

[Fig. 22.]



A Carabid, *Calosoma calidum* with larva  
(after Riley).

This Order of insects—the Beetles—includes a far greater number of described species—more than one hundred thousand—than either of the other primary groups. And while among this vast assemblage we find an almost infinite variety in size, form, color and the adaptation of certain organs for certain functions, a single glance is sufficient to enable us to recognize a member of the Order, except, perhaps, in the case of a very few rare and unusual forms.

On account of the ease with which specimens may be collected and preserved, and the accuracy with which the external structure may be defined, these insects have always been favorites with entomologists, and the student will find them most interesting and convenient subjects upon which to begin his studies of insect anatomy.

The popular term “beetle” is said to be derived from an old English word signifying a “biter,” and is most appropriate for this group of insects in which the organs for biting are so complex and so perfect.

Beetles are chiefly characterized by the peculiar structure of the upper wings, which are transformed into a pair of horny or leathery cases, or sheaths meeting in a straight line down the back, and covering not only the abdomen, but two joints of the thorax (the *mezo* and *meta thorax*). These are called the *elytra* (sing. *elytron*). They are not used to any extent in flight—their office appearing to be mainly that of armor for the protection of the softer parts of the body. The true membranous wings, when not in use, are snugly folded beneath them, not only lengthwise, in fan-like plaits, but, by means of a hinge or joint in the supporting veins, a little beyond the middle, crosswise as well, so that

in most species they may be completely covered. This wing structure can be most satisfactorily studied in the common May beetle, one of the species which few people have any repugnance in handling.

The frame-work or body-wall of most beetles is very hard and firm compared to that of many other insects. This is very necessary to preserve them from the varied dangers incident to their terrestrial habits.

The mouth of beetles is considered as presenting the typical form of that important organ. The six principal parts, mandibles, maxillæ, labrum and labium, described in chapter III, Pt. 1st (in which see Fig. 3), are always present, together with other appendages of less direct use.

The eyes are usually prominent and of various forms, round, oblong, kidney-shaped, curved, and in one group of water beetles entirely divided in the middle, so that there would seem to be two on each side. The ocelli are not usually present, though a few species have a single pair, or perhaps only one.

The antennæ present a great variety of forms, some of which are very singular and beautiful, as may be seen by referring to Fig. 4, Pt. 1st. They are mostly eleven-jointed. Only the pro-thorax, which is usually very wide, is visible on the back, with the exception of a small wedge-shaped section of the meso-thorax, termed the *scutellum*. The abdomen joins the thorax by a wide base, and, in a great majority of beetles, is almost, if not entirely covered by the wing cases. Many of the leaf-feeding species and a few of those that are predaceous, fly with great ease and rapidity, but as a rule, the legs are the principal organs of locomotion. They are horny and strong, and of various shapes to adapt them for running, leaping, swimming and other uses. The apparent joints of the feet vary in number from *three* to *five*, and the foot terminates in most cases in a pair of sharp claws.

The larvæ of beetles are commonly called "grubs." Most of these are soft, clumsy looking objects, with horny heads and three pairs of sprawling legs on the thoracic segments. Some species have in addition a sort of pro-leg at the hinder end of the body, or one or two rows of tubercles (fleshy points) along the sides, or on the upper or under surface, by which they are enabled to move with ease in the situations in which they are found. The larvæ of Water-beetles have numerous oar-like processes along the sides and are capable of swimming very rapidly.

Besides these forms are others which, living enclosed in the fruit or wood upon which they feed, have no use for legs of any kind, and consequently do not possess them. Of such are the Curculios and many kinds of wood-borers.

Coleopterous larvæ feed upon almost all kinds of vegetable and animal substances, from the petals of the most delicate flower to the most rank smelling carrion, from fruits and nuts to the most pungent spices to be found at the grocer's or druggist's. A considerable proportion are cannibals, and prey upon members of their own class. Larvæ of such species are usually very active, while the vegetable feeders are, as a rule, awkward and sluggish in their movements. In this Order the transformations are *complete*. The larvæ molt or change their skins several times, and their growing period varies in length from a few weeks to two or three years. They transform either upon or beneath the surface of the ground, or upon the leaves or within the fruit or wood upon which they have fed. The pupæ are *obtectæ*, resembling those of Hymenoptera in having each member encased in a separate sheath.

In the matter of classification, this Order is so comprehensive, that it is impossible within the limits of this little work to include any system that will enable the tyro to determine every species of which he may find an example, except as to the primary divisions. Beyond this the most that will be attempted will be a definition of such groups as contain conspicuously injurious or conspicuously beneficial species. When we learn that in North America alone, exclusive of Mexico, we have more than nine thousand named species, representing upwards of seventeen hundred genera and about eighty distinct families, it is evident that volumes are required for anything like adequate description and definition.

Following the system of the recognized authorities, the primary divisions of the Coleoptera are as follows :

Sub-Order I. The True Beetles (COLEOPTERA), in which the mouth parts are all present and the front of the head is not elongated.

Sub-Order II. The Snout Beetles (RHYNCOPHORA), in which the front part of the head is more or less prolonged into a beak, the labrum not distinguishable and the palpi reduced to minute, jointless points.

The first of these Sub-Orders is then separated into two sections, based upon the correspondence or lack of correspondence in the number of tarsal joints.

1st. ISOMERA (Similar joints) species which, with rare exceptions, have the same number of joints in all the feet.

2d. HETEROMERA (Different joints), including species which have five joints in each of the front and middle feet, and only four joints in each of the hinder pair.

Beetles belonging in the **ISOMERA** are sub-divided into five tribes:

I. **ADEPHAGA** (carnivorous beetles), Land and Water Tigers, hunters and trappers of other insects for the most part, although a few species subsist on vegetation. In these the antennæ are thread-like, cylindrical, with the joints distinct.

II. **CLAVICOERNIA** (Club-horns), having the antennæ thickened gradually or abruptly toward the tip; feet with from one to five joints; small beetles of various habits.

III. **SEBBICOERNIA** (Saw-horns), having the antennæ toothed or serrated (in some few species also enlarged at the tip, much as in the preceding tribe, but the species in other respects agreeing with the members of this tribe). This group includes a great number of small borers.

IV. **LAMELLICOERNIA** (Leaf-horns), having the knob of the antennæ composed of several leaf-like or blade-like parts, which the insect can unfold or close up at will. This Tribe includes the largest insects in the Order, most of which feed, often in the perfect as well as the larvæ state, upon vegetation, foliage, roots and decayed wood.

V. **PHYTOPHAGA** (Plant-eaters), mostly with thread-like antennæ, in some species very long, in others short and slightly thickened toward the tip; fourth and fifth joints of the feet consolidated, the former minute. All the species feed on vegetation and many are extremely destructive.

Neither the Section **HETEROMERA** nor the Sub-Order **RHYNCHOPHORA** requires division into tribes for convenience of study.

---

## CHAPTER XV.

### Order COLEOPTERA. Tribe I. ADEPHAGA.

#### CANNIBAL BEETLES.

In this group of beetles we find mainly carnivorous species, many of which prey especially on insects destructive to vegetation, and on this account claim recognition as among our best friends. They also merit consideration by their great beauty of form and color, and by the grace and agility of their movements. The most important families are the Tiger-beetles (**CICINDELIDÆ**), the Caterpillar-hunters (**CARABIDÆ**), the Water-tigers (**DYTISCIDÆ**), and the Water-whirligigs (**GYRINIDÆ**).

The Tiger-beetles received their popular name on account of their ferocious habits, their swift movements and the stealthy manner in which their larvæ lie in wait for their prey. They are diurnal insects of

medium or rather small size (three-fourths inch and under in length), of elegant form and often of brilliant metallic color. Their chosen haunts are sunny path-ways, hard beaten roads and the sandy shores of streams, lakes and the ocean.

The head of a Tiger-beetle is broader than the thorax. It is provided with a very complete mouth, of which the most important parts are the long, sharply-toothed and curved jaws, which cross each other when closed. The eyes are large, round or somewhat oblong and protruding; the antennæ long and slender, arising from the face just above the base of the mandibles. The prothorax is nearly square, the scutellum very small, and the wing cases, which are rather narrow, widen slightly toward the hinder end of the body. The under wings are well developed, and the insect rises easily into the air for short flights. The legs are long and slender and the joints of the feet spiny. The dark metallic color is in some species variegated by dots and zigzag lines of yellow or cream white. The larvæ live in perpendicular holes in the ground and are extremely ugly in appearance. They have a broad head and immense jaws, and long sprawling legs. On the middle of the back is a large double hump, terminating in backward curving hooks, of which these creatures make use in climbing to the entrance to their holes and sustaining themselves there while lying in wait for their prey. Any unlucky insect happening to stray within reach of those terrible jaws is seized with a grasp from which there is no escape, dragged into the hole and devoured.

More than sixty species of *Oicindelidæ* are found in the United States. (See beetle on plate.)

The Ground-beetles or "Caterpillar-hunters" include a great number of predaceous species, which may occasionally be seen running over the ground in fields and gardens, but are usually hidden under stones, boards, fallen leaves and the like during the day. They are easily distinguished from the Tiger-beetles by the head being narrower than the prothorax, and the latter somewhat more constricted or tapering toward the base of the wing covers. They are also, with a few exceptions, of plainer coloring, and the most conspicuous species are of larger size than is the rule among the Tiger-beetles. One of the chief structural characters of these beetles is the peculiar eardrop-shaped trochanter of each of the hinder legs. (See Part 1st, Fig. 6, A, b.)

They are, as rule, *nocturnal* in their habits, running out of their hiding places at nightfall, and exploring field and garden, even climbing trees in the search for their six-legged game, tearing in pieces caterpillars and grubs, and even other beetles, wherever found. They are often

attracted to lamplight, and I have, on several occasions, seen the sidewalks around the electric light posts almost covered with dead and disabled specimens of the beautiful, metallic-green *Calosoma scrutator*, Fabr. As they are very swift runners, most species make but little use of their wings; indeed, the latter are in some cases entirely undeveloped, and the elytra are firmly joined at the suture on the back.

The larvæ are elongate, somewhat flattened grubs, having the body protected on top by horny plates, and in some instances terminated in a pair of branching spines or forceps-like appendages. They burrow back and forth just beneath the surface of the earth, and destroy many of the soft larvæ of fruit and leaf-feeding species that have entered the ground for transformation.

Among the most beneficial species is the Fiery Ground-beetle (*Calosoma calidum*, Fabr.), a large and elegant beetle of a black color, with elytra (wing covers) thickly dotted with shining, impressed, coppery spots (see Fig. —). This beetle preys upon cut-worms, and its larvæ, having the same habit, has been called the "Cut-worm lion." Another smaller species, *Lebia grandis*, with a red-brown thorax, and legs and dark-blue wing covers renders us good service in destroying the larvæ of the Colorado potato-beetle.

One species, a little larger than the above, but closely resembling it in form and color, is called the Bombardier beetle (*Brachinus fumus*), as it has the singular power of discharging a volatile and pungent fluid from the tip of the abdomen, which rises in the air like a little puff of smoke. It is a means of defense against its enemies.

The Water-tigers are quite common in ponds and sluggish streams. The beetles are easily recognized by their broad, flat, ovate, polished bodies, often an inch and a quarter in length, and by the hairy, oar-like shape of the hinder legs. When disturbed these beetles dive deep under water, carrying with them a bubble of air which sustains respiration until they again rise to the surface. Their larvæ are long and cylindrical, with a pair of breathing tubes at the posterior end that can be protruded above the surface of the water. The head is armed with powerful, scissor-like jaws which are kept in almost constant motion. They are very savage and greedy, feeding upon other aquatic insects, tadpoles and small fish, in some streams proving very destructive to the latter. When full grown they crawl upon shore and enclose themselves in earthen cells within which they change to pupæ. The perfect insects make their way into the water as soon as they emerge.

The "Whirligigs" are another family of preying water-beetles which, though allied to the Water-tigers, are distinguished from them

by their smaller size, their round blue-black bodies, long front legs and very short swimming legs. The eyes are bilobed, giving them the appearance of two on each side. They usually appear in groups on the surface of the water, sporting and circling about in great apparent enjoyment. The larvæ look like myriapods, having a pair of long, spiny processes on each abdominal segment.

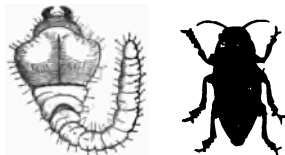
---

## CHAPTER XVI.

Order, COLEOPTERA. Tribes, CLAVICORNIA and SERRICORNIA.

### CLUB-HORNED AND SAW-HORNED BEETLES.

[Fig 23.]



Flat-headed Apple tree borer (*Chrysobothris femorata*), with larva  
(after Riley.)

In the first of these Tribes we find a large number of quite distinct families and genera of beetles in which the principal point of agreement is found in the antennæ, which in most of the species are "clubbed," or rather thick and gradually and slightly enlarged toward the tip. But even in this character there is some variation—*Ips fasciata* and the species of *Nitidula*, for example, having antennæ that are distinctly *knobbed* at the end.

Among the Clavicorn beetles the number of joints of the feet ranges from one to five, most species having the same number in the hind tarsi as in the others.

The representative Families of this subdivision of the Order are the Burying beetles (SILPHIDÆ), the Rove beetles (STAPHYLINIDÆ), the Lady-bird beetles (COCCINELLIDÆ), and the Museum pests and Carpet beetles (DERMESTIDÆ).

The Burying beetles or Sexton beetles are so called from their habit of first burying the dead bodies of other insects, birds and small animals upon which their larvæ feed, before placing their eggs upon them; and one is sometimes astonished upon coming across such small car-

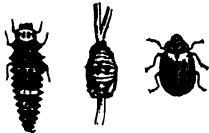
rior to find it being moved by some unseen force. If taken up or turned over, several species of large beetles that were at work digging out the earth beneath it will be disclosed. Many of the species are easily collected by means of such unsavory traps.

These beetles differ considerably in size and color, but all have rather broad, flattened bodies, five joints in all the feet, which end in long claws. The antennæ are rather abruptly enlarged at the tips. The prothorax is expanded into a broad plate used as a shovel in the digging operations. *Necrophorus americanus*, Oliv., is our largest species, frequently measuring one and one-fourth inch in length by one-half inch in breadth. It is of a glossy-black color, with a large red-brown spot in the middle of the head, the prothorax being almost entirely of red-brown, and there are two large patches of the same bright color on each wing cover. The black antennæ end in a leafy knob of golden brown, and the joints of the front feet are covered on the under side with silky hairs of a similar color. The pointed tip of the abdomen protrudes about one-fourth inch beyond the squarely cut wing covers.

In the genus *Silpha* the body is very flat and almost orbicular, the prothorax being expanded into a wide, thin flange, and is usually of a brighter color than the broad, roughened wing covers.

The Rove beetles have long, slender, black or dark colored bodies, with very short, square wing covers which leave more than one-half of the abdomen unprotected. The head is usually somewhat broader than the prothorax, the sharply pointed jaws crossed in front, and the rather small, oval eyes are wide apart. Some species are an inch or more in length, while others are very minute. Like the preceding tribe, they are carrion feeders, but prefer the carcasses of the larger animals, such as dogs and horses.

[Fig. 24.]



Lady Bird beetle (*Hippodamia convergens*), with larva and pupæ—after Riley.

The Lady-bird beetles include a group of small, handsome beetles of an oval or hemispherical form, with three-jointed feet and short antennæ. The surface is polished and usually ornamented with round or oval spots of black on a rose-red, brick-red or orange ground, or with red spots on a black ground. The Lady birds are among the best known

of their order, and deserve to be the popular favorites which they are, on account of the excellent service which they render in ridding our gardens and orchards of plant-lice, bark-lice and other small insect pests. The larvæ are ugly, alligator-shaped creatures, generally of a dull, black color, in some species banded with yellow. Some have the surface covered with spines, while others are simply ridged and hairy.



*Megilla maculata*, one of the most familiar, is about one-fifth of an inch long, of oval shape and pink color, marked on head, thorax and wing covers with large, black spots. *Hippodamia convergens* is somewhat larger, of a dull orange color, with very small black dots. *Chilocorus bivulneris* is hemispherical, about one-sixth inch in diameter, shining black, with a conspicuous blood-red spot on each wing cover, near the base. It is an especial enemy of all sorts of bark-lice or scale insects, and may be found on trees or shrubs infested with the latter. *Vedalia cardinalis*, which resembles the above species in size and shape, but is of a bright red color, with four black spots on the wing covers, is at present the most celebrated member of its group, having been imported under the instructions of Dr. Riley, U. S. Entomologist, from Australia into California, in 1888, for the purpose of keeping in check the Fluted scale of the orange (*Icerya*), and having in less than two years almost exterminated the pest.

About one hundred and forty-five species of Lady-birds are known in North America, all of which, so far as known, are carnivorous, except one species (*Epilachna borealis*), the Northern Lady-bird, which is a vegetarian and occasionally quite destructive to squash and cucumber vines.

The Museum Pests—*Dermestes*—are also mostly small species, which are not only the special pests of museums, derstroying very rapidly the contents of entomological and ornithological cabinets when they have once found entrance to them, but they are very destructive, also, to furs, woolens, feathers and similar animal products, and some species even invade the pantry. In these beetles the head and prothorax are short, the latter having grooves for the reception of the eleven jointed antennæ; the eyes are round and between them is a single ocellus. The legs are short, with five jointed feet. The larvæ are very active, hairy grubs, some of which have a tuft of bristles at the tail, and most species shun the light, although the beetles of one or two kinds have been taken on flowers.

*Dermestes lardarius*, one of the larger species, black with broad gray bands at the base of the wing covers, is sometimes destructive to dried meats and similar articles of food. *D. vulpinus*, one-third of an inch long and entirely dull black, attacks stored hides and manufactured leather. *Anthrenus varius*, the worst of the museum pests, is round oval in form, only about one-tenth inch in length, bright chestnut brown with the wing covers crossed by three wavy bands of pale gray, between which are dashes and flecks of black. *A. scrophularia*, the "Buffalo bug," or carpet beetle, is still smaller than the above species, is black with markings of pale red and white. It was introduced

some years ago in imported carpets from Europe, and has already become a widely disseminated pest. Among the beetles classified as *SERRICORNIA* are found many very beautiful and interesting insects, as well as some that are exceedingly pernicious. Most of the species have rather short serrate antennæ, are of oblong or elongate oval form, with five-pointed, or in a few species, four-pointed tarsi. The most important Families are Spring or snapping beetles (*ELATERIDÆ*), the saw-horned borers (*BUPRESTIDÆ*), and the fire-fly and soldier beetles (*LAMPYRADÆ*). The spring beetles have the entirely peculiar habit, if laid upon their backs, of throwing themselves into the air with a jerk, in most cases coming down in proper position. If held loosely in the hand, also, they will bend themselves backward and strike again and again in the effort to obtain their freedom. The power to effect these motions lies in an ingenious sort of spring in the shape of a strong pointed projection on the prosternum (the under side of the prothorax), which by curving the body backward is caught suddenly in a socket on the mezo sternum, causing an elastic rebound of the whole body. These beetles are of long, oval, somewhat flattened form, and usually of dull brown color, though a few species display brighter tints, and the surface is covered with a fine pubescence. The outer angles of the very wide prothorax are prolonged into points which curve around the edge of the wing covers.

The larvæ are known as "Wire-worms," in reference to their long, hard, slender bodies. Some species rank with injurious insects from their habit of cutting off the roots of young corn and other vegetation. On the other hand, several are beneficial, and are known to find their way into the tunnels of wood-boring larvæ and destroy them. The majority, however, so far as known, breed in decaying wood or the pith of weeds. A few large species are luminous, and are, at night, objects of great splendor.

Our largest and most striking American species, the Eye-spotted Elater or Snapping-beetle (*Alaus oculatus*, Linn.), varies in length from one to one and one-half inches. It is of a black color, with the wing covers longitudinally ridged, and marked with fine lines and flecks of white, which, being of the nature of scale-like hairs, are liable to rub off. On the top of the broad pro-thorax are two large velvety black spots encircled with white, which from their resemblance to eyes are often mistaken for them.

The Saw-horned borers (*BUPRESTIDÆ*), compose a large group of handsome hard-shelled, compactly formed beetles, all of which have the antennæ, which are rather short, serrate on the inner edge. They are usually of a pale brown or gray color, with brassy or coppery reflections :

indeed the entire surface, minutely roughened and indented as it is, appears like beaten metal. The head is deeply sunken into the thorax, and the latter widens slightly behind and fits tightly over the base of the wing covers.

The Buprestians are diurnal insects, flying in the sunshine or basking in it while slowly crawling up and down the trunks of trees, in the bark of which they deposit their eggs. The larvæ are wood-borers, gall-makers or leaf-miners, and are all more or less destructive to forest and fruit trees and shrubbery. They are characterized by a relatively enormous expansion of the pro-thoracic joint, from which the remaining two joints of the thorax taper abruptly to the slender, cylindrical abdominal division. There are no legs, and the enlarged joint has a smooth horny plate on both upper and under sides, and is much flattened.

The well-known Flat-headed borer (*Chysobothras femorata*, Fabr.), so destructive to many kinds of fruit and shade trees, is the best representative of the boring species. The species of *Agilus* cause swellings in the stems of blackberries and raspberries. These beetles are slender and cylindrical, with dark-blue or black wing covers and copper-colored thorax, and are about one-fourth of an inch long. The larvæ of the species, included in the genus *Brachys*, mine the leaves of apple and oak.

The Fire-flies and Soldier beetles are very different in many respects from the preceding group. Their bodies are very soft and the wing covers thin and flexible. In the "Fire-flies" or "Lightning-bugs" (genera *Photinus* and *Photurus*), the head is almost concealed under the expanded margin of the pro-thorax. The light which they emit is supposed to be from a phosphorescent substance in the abdomen, and is given off in flashes at irregular intervals, both during flight and repose. In *Photinus pyralis* both sexes are winged and luminous. In *Photurus*, the somewhat smaller and less brilliant species often have wingless females.

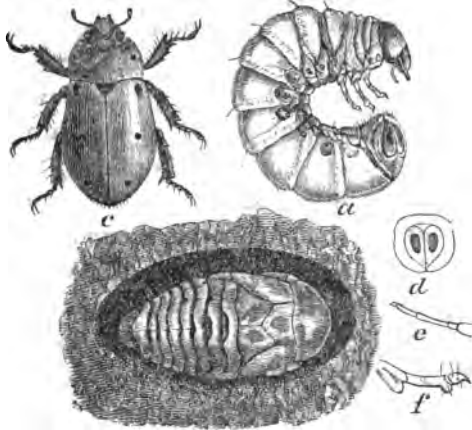
The larvæ, which are "glow-worms," burrow in the earth, often coming to the surface, and have a faint luminosity. They feed on the soft larvæ of other insects and on earth-worms.

The most common species of Soldier-beetle is a slender, clay-yellow insect, with a large black spot on the top of the pro-thorax and an oblong one near the tip of each wing cover. This beetle bears the rather formidable name of *Chauliognathus pennsylvanicus*, De G. The larvæ somewhat resemble those of the lady-birds and like them are of service to us by feeding on other insects that are injurious to vegetation. The beetles may almost always be found in the autumn upon the flowers of the Golden-rod and Eupatorium.

## CHAPTER XVII.

## Order COLEOPTERA. Tribe LAMELLICORNIA.

[Fig. 25.]

Spotted Pelidnota, (*Pelidnota punctata*) with larvæ and pupæ (after Riley).

The Tribe LAMELLICORNIA is of great extent, and in it we find mostly large or medium-sized beetles which feed on vegetation, either fresh or in a state of decay, or on the excrement of the larger animals. These beetles resemble each other chiefly in the form of the antennæ, which terminate in a knob or expansion, composed of three—sometimes more—leaf-like blades, attached by one end and capable of being opened or closed like the pages of a book, at the will of the insect.

Before taking up the true Lamellicorns we find a small group, sometimes distinguished as PECTICORNIA (tooth-horned), in which the antennæ are furnished at the tips with several stiff projections on one side, like the teeth to a comb, and are further characterized by being bent or elbowed in the middle.

In this division the principal Family (LUCANIDÆ) contains the Stag beetles or Pinching beetles. In these the head is very broad, the eyes comparatively small, the shanks (tibiæ) notched or spined on the outer edge, and the feet are all five-jointed. The great peculiarity, however, is found in the unusual development of the jaws, which protrude from the front of the head, and are from one-fourth to one-half the length of the body, armed with spines and tooth-like projections on their inner edges. The larvæ are large, horny textured grubs, with four or six sprangling thoracic legs, and are mostly found in rotten stumps or roots.

Our largest species, *Lucanus elaphus*, Fab., occurs most abundantly in the southern States, but is often taken as far north as St. Louis. This is indeed a formidable looking insect. It is very hard and smooth, of a mahogany-brown color, the body one and one-half inch in length, and the immense mandibles extending forward three-fourths of an inch more. It is from the resemblance of these to the antlers of a deer that it receives the most appropriate name of "Stag beetle." *Lucanus dama*, Hum., is the most common "Pinch beetle," and often enters our rooms on summer evenings to the terror of nervous people, whom it could not injure, but to whom it might give a severe pinch with its sharply toothed jaws, which curve inward and are about one-fourth inch long. The beetle is of the same form and texture, but a little lighter in color and considerably smaller than the southern Stag beetle.

Another large beetle belonging in this group is the Horned Passalus (*Passalus cornutus*, Fab.). This is a shining black species of an oblong form, having the squarish pro-thorax separated on top from the abdomen by a decided "waist" or constriction. The wing covers are longitudinally grooved. In this species the jaws are not abnormally enlarged, but on each side of the head is a little pointed horn, and between them a longer one curving downward over the mouth. This beetle is usually one and one-fourth inch in length.

The typical LAMELLICORNIA are, for convenience, separated into two divisions, in consideration of their different feeding habit chiefly, viz.: the *Excrementivora*, the larvæ of which mostly breed in manure, and *Herbivora*, in which the larvæ feed on vegetation, either growing or dead. In the first division the principal families are the *Copridæ*, *Aphodiidæ* and *Trogidæ*.

They are all scavengers and rank either as beneficial or innoxious. The largest species, *Copris Carolina*, Lim., is a great, squarish, clumsy creature, nearly an inch long and three-fourths inch wide, that frequently flies into our lighted rooms at night, and after bumping about against the walls and ceiling falls to the floor with a thud, generally landing upon its back, and lying helpless, kicking its legs about wildly in the effort to turn over. It is of a black color, somewhat hairy on the under surface and legs, and the latter have the shanks of the fore legs expanded and notched for use in digging, as is characteristic of all the Lamellicorns. The female beetle tunnels perpendicularly under the droppings of cows and horses, and at the bottom of the hole places a large round ball of manure on which she deposits an egg. The larva, an unsightly, much-wrinkled grub, very thick in the middle and tapering toward each end, works its way into this compact ball, and beginning somewhere near the middle, eats toward the surface until it is reduced

to a mere shell, which serves as a sort of cocoon for the protection of the pupa.

Here also we find the common "Tumble-bug" or "Tumble-dung" (*Canthon laevis*, Drury), a much smaller, dark-brown species, usually seen in pairs rolling a ball of manure about the size of a large marble. This species affords one of the rare instances in which the male assists the female in making provision for the young. When a suitable spot is found, a shaft is sunk four or five inches into the earth, the ball rolled in, and the female, after pausing long enough to deposit an egg upon it, begins filling up the hole, in which labor her partner assists. But little pains, however, is taken with this part of the work, and often the hole is left partly unfilled. A beautiful species, somewhat larger than the above, has similar habits. This is (*Phanæus carnifex*, Linn.) It is of a metallic green color with copper-colored thorax, which in the male is adorned with a backward curving horn.

The APHODIDÆ are all small shining black or black and red beetles, which sometimes astonish gardeners by the numbers in which they appear in green-houses and on hot-bed sashes, having bred from the manure used as a fertilizer.

The family TROGIDÆ includes but one genus, *Trox*. The most common species are small, dingy, black, roundish beetles, often attracted to the light at night. They are distinguished by the widely dilated thighs of the front legs and by the deeply ridged and pitted surface of the thorax and wing covers.

The Leaf-chafers, Herbivorous Lamellicorns, are distinguished from the manure-beetles by their more slender legs, long sharp claws, and by the tip of the abdomen projecting slightly beyond the wing covers. They feed entirely on vegetable matter, and unlike most other insects in their perfect state, the beetles themselves often do great damage to flowers and foliage. Many of the larvæ live underground, subsisting on the roots of grasses and other valuable plants; others are found in rotten wood or other decaying vegetation. They are fat, white, wrinkled grubs, with horny heads, long, sprawling legs, and the hinder part of the body in many species thicker than the remainder, and filled with dark waste matter.

This group has been separated into four families: the Monarch beetles (*Dynastidæ*), the Dor beetles or May beetles (*Melonthidæ*), the Brilliant chafers (*Rutelidæ*), and the Flower chafers (*Cetonædæ*). Among the Monarch beetles we find the largest insects in the Order. One species, sometimes called the Rhinoceros beetle (*Dynastes tityus*, Linn.), is often seen in the Southern and Middle States. It is fully two

inches in length, by an inch in diameter, and thick in proportion. The color is pale gray, the wing covers being marked with numerous irregular blotches and spots of black. From the front of the head of the male a long, pointed, polished horn curves upward, which is almost met by a similar downward curving one on the thorax, on each side of which are two small, straight ones. The female has no thoracic horn, and only a small protuberance on the head. The larvæ are, as a rule, found in rotten wood, but are also said to injure ash trees by feeding on the roots.

Under the name of Dor-beetles or May or June beetles (*MELONTHIDÆ*), are grouped a great variety of medium-sized, leaf-feeding species, most of which have thick, oblong bodies and are of a plain brown color. In some the surface is smooth and shining, in others more or less thickly covered with hairs or scales. One of their most peculiar characters is that each of the claws of the feet is minutely bifid or forked at the tip, which accounts for the persistence with which they cling to any but the hardest and most polished surfaces. This fine division of the claws can be distinctly seen only with a lens.

In this family the agriculturist finds a large number of the prominent pests of his farm and orchard, to only a few of which have we here space for reference.

One of these destructive species is the common May or June beetle (*Lachnosterna fusca*, Froh.), a smooth, shining, chestnut-brown insect, which issues from the ground in swarms during the latter part of May or early in June, filling the air at twilight, and finding its way in numbers into lamp-lighted rooms, unless excluded with the utmost care. These beetles settle on trees at night and feed voraciously on the foliage. They are cleanly, inodorous and inoffensive creatures to handle, and therefore make excellent and interesting subjects for examination and experiment.

They remain hidden and dormant during the day, but awake to renewed activity for several successive evenings. After pairing the male dies and the female burrows into the earth to lay her eggs.

From the latter are hatched the "white grubs," so well known as among the chief pests of corn fields, meadows, lawns and strawberry beds. The observations of earlier entomologists pointed to the conclusion that these grubs required at least two years for development, but Prof. Forbes, of Illinois, has demonstrated that under certain conditions the insect attains its growth and passes through all its transformations in a single year.

In the same genus (*Lachnosterna*—which means "hairy-breasted") are a large number of other chafers, having essentially the same habits

as *L. fusca*, but many of these have not only the under side of the thorax hairy, but the pro-thorax and wing-covers also covered with a soft pubescence, sometimes evenly distributed and again arranged on the wing-covers in longitudinal ridges. Some of the species are much smaller and lighter colored. The Rose chafer or Rose-bug (*Macroductylus subspinosus*, Fabr.) belongs also in this family (MELOLONTHIDÆ). This is an ochreous-yellow beetle, rather slender in form, about one-third inch in length, with very long, spiny legs. Its color is really almost black, but when fresh it is densely and evenly clothed in pale ochreous scales, which give to it its light color. It is altogether too common in the Eastern and Northwestern States, where it is exceedingly destructive to the blossoms of the grape, rose, and some other plants. Its larvæ feed on the roots of shrubbery, and in their turn do much damage.

Among the Brilliant chafers (RUTELIDÆ), which are separated from the Melolonthians by the unequal claws, which are not bifid at the tip, is a large species, the Spotted Pelidnota (*Pelidnota punctata*, Linn.), which is illustrated as a type of the Family. (Fig. 25.) This is one of the grape-vine pests, gnawing the foliage. It is a stout species, about three-fourths of an inch long, of a clay-yellow color, with three large, black dots on each wing-cover. Dr. Riley bred the larva in decaying stumps and roots. The Goldsmith beetle (*Catalpa lanigera*, Linn.), a beautiful species, is very like the above in form and size, but is entirely of a cream yellow color, with golden and prismatic reflections.

Among the Flower beetles (CETONIIDÆ) are a few of great size, but, while none are very small, most of the North American species are of medium or under medium size. The form is slightly flattened, the scutellum unusually large, and the wing covers are peculiarly notched or hollowed out on the sides near the base, so that it is not necessary to raise them to allow the wings to be unfolded for flight. The mouth is provided with a brush for collecting pollen, of which these insects are very greedy, as they also are of nectar, and to procure it they cut into tubular flowers. They may be found in spring drinking the sap that sometimes oozes from the trunks of maples and other trees, and are also quite injurious to ripe fruit. They differ from other members of their family in being diurnal in habit. *Allorhina nitida*, Linn., is a beautiful, large, velvety green species, with light-brown margins to the wing covers. *Euryomia inda* and *E. melancholica*, smaller, red-brown mottled species, are the most destructive to flowers and fruit.



## CHAPTER XVIII.

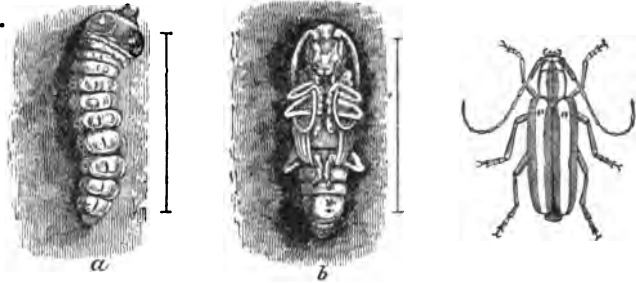
## Order COLEOPTERA. Tribe PHYTOPHAGA.

## BORERS AND LEAF BEETLES.

## Also Section HETEROMERA.

## BLISTER BEETLES, ETC.

[Fig. 26.]

Round-headed Apple Tree Borer (*Saperda Candida*.)

This division of similar footed beetles comprises a great variety of forms, all of which feed on vegetation, and many of which are extremely destructive to trees, herbaceous plants and seeds. Three of the most important families are the Long-horned borers (CERAMBYCIDÆ), the Leaf beetles (CHYSOMELIDÆ), and the Seed beetles (BRUCHIDÆ).

The first of these families, often termed the "Longicorns" or "Capricorns," is a large and interesting one, including many species of great size, others of rare beauty and all very injurious. They may be recognized at a glance by their long and usually slender antennæ, which in a few species are more than twice the length of the body, and which curve backward like the horns of a goat. The form of the body is elongate sub-cylindrical, in some species tapering toward the hinder end. The head is broad, vertical, and furnished with strong jaws. The eyes are quite peculiar, being *lunate* (hollowed out) on the inner side, with the antennæ implanted in the hollows. The basal joint of the latter is almost invariably longer than any of the succeeding joints, which gradually taper to a point. The thorax is seldom as broad as the hind body, and is square or barrel-shaped, often with one or two spines or teeth on each side. The legs are long, but scarcely so well fitted for running as for affording a secure support to the insect when at rest. The joints of the feet are four in number, spongy or

cushioned beneath, and the third one bilobed. These beetles have the power of producing a squeaking sound by rubbing the pro-thorax up and down over the bases of the wing covers. This is done not only as an expression of fear when captured, but for amusement or as a call to their mates, and is termed *Stridulation*. The females have an ovipositor that can be telescopically extended to a considerable length, in order to place the eggs deep into holes or into the crevices of bark of the trees in which the larvæ feed. The colors of many species are very bright, disposed in stripes or bands or in dotted patterns on a plain ground. They are for the most part nocturnal, and conceal themselves carefully during the day. A few, however, are exceptional, and may, at certain seasons, be found on flowers or enjoying the sunshine on the trunks of trees.

The larvæ are all wood-borers, and many of them do great damage to fruit and forest trees, and in vineyards. They are fleshy, white cylindrical grubs, terminating bluntly behind, with all the joints separated by deep incisions, and the first thoracic one much enlarged and covered with a horny plate. The head is small and usually dark brown, the greater part of it comprised in a pair of powerful jaws, capable of cutting into the hardest wood. A few of these larvæ have the usual number of very small thoracic legs, but the majority have no legs at all, and move up and down in their burrows by alternate contractions and extensions of the body, and by means of the hunched segments. It is a habit with some species to keep one end of the burrow open, through which to push out the chips and castings, and their presence is often betrayed by the little heaps of sawdust on the bark. The great majority, however, leave their castings in a compact mass behind them as they proceed. Many of these larvæ grow for two or three years, and a few even longer. When ready for transformation they tunnel their way to the surface, leaving a slight shell of the bark entire over the place of exit. They then retreat to a safe distance and form a cell or nest of wood fibers and castings, and here assume the pupæ form. In this stage they are soft and white, sometimes almost transparent, but with each member of the future beetle clearly defined, and they have a peculiar mummified appearance. At the end of two or three weeks the membranous casings are slipped off and the perfect beetle, but in a very soft and imperfectly colored condition, is disclosed. The insect remains quiet in its cell for some time until all the parts are hardened, after which it breaks through the slight door and enters upon the enjoyments and business of its mature life.

In the genus *Prionus* we find several very large, dark-brown species, whose larvæ, measuring two and one-half or three inches in length, are quite frequently found boring roots of grape-vines, apple trees and similar plants.

*Saperda candida*, Fab., a beautiful species of a cinnamon-brown color above, with two broad milk-white stripes extending the whole length of the body, is the parent of the much execrated "Round-headed Apple tree borer" (see Fig. 26), which does so much damage in orchards by boring the trees near the ground.

The Twig-girdler (*Oncideres cingulatus*, Say) has the bad habit of girdling the twigs in which the female lays her eggs. It attacks both fruit and forest trees. Maples, Locust and Hickory are bored by the larvæ of a group of beautiful beetles of the genus *Olytus*. They are rather large, of dark colors, ornamented with curved and V-shaped

[Fig. 27.] transverse bands of bright yellow, pale green or white.



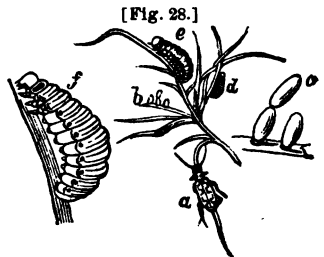
Twig-girdler.  
Colors, dull-brown  
and dingy-white.

The Leaf-beetles (CHRYSO-  
MELIDÆ) constitute an im-  
mense group of small to medi-  
um-sized species, many of which  
display brilliant and beautiful  
colors. The scientific name  
given to the family, from words  
signifying a *golden apple*, re-  
fers to this quality as well as  
to the round or oval form so common among them. The

head is very short and much narrower than the pro-thorax; the antennæ somewhat enlarged toward the tips and set wide apart; the eyes are round and prominent; the legs are short and stout; the joints of the feet are four in number, each broad and cushioned beneath. The larvæ are of a variety of forms, but mostly broad and thick, with well-developed thoracic legs. They feed exposed upon the surface of leaves, or, in the case of a few of the smaller species, they mine between the upper and under cuticles.

Among these beetles we find such notorious pests as the Colorado Potato beetle (*Doryphora 10-lineata*, Say), the Asparagus beetle (*Crioceris asparagi*, Linn.), the Striped Cucumber beetle (*Diabrotica vittata*, Fab.), the Streaked Cottonwood beetle (*Plagioperma scripta*, Fab.), and great numbers of others.

The Tortoise beetles, which are the especial enemies of the Sweet potato plant and of other *Convolvulacæ* are round or oval species from one-fifth to one-fourth inch in length, of a flattened oval form, with a



Asparagus beetle-- a, beetle; b, eggs; c, d, larvæ; f, same enlarged; e, eggs enlarged--after Riley.

membranous margin around the thorax and wing covers which almost conceals the legs. The coloring is extremely beautiful—in one species, *Cassida aurichalcea*, being at times of the most brilliantly burnished gold, and again with opalescent reflections. Other species are mottled or striped in gold and brown.

The flat, oval larvæ have a spiny surface and lateral margin, and the body terminates in a pair of strong bristles, upon which during growth the cast-off skins and excrement are accumulated and held up over the body to shield it from the sun and from its enemies.

The larvæ of species belonging to the genera *Chlamys* and *Cosinoptera* make cases, which, when feeding, they carry over or drag behind them, and to which they retire for repose.

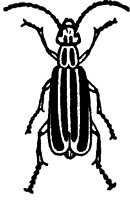
Another group with whose destructive work the farmer and gardener is only too well acquainted, contains the Flea-beetles. These are mostly small species, characterized by their greatly expanded and thickened thighs, which give them their remarkable jumping power. *Haltica chalybea*, Illig., is a dark steel-blue species, often very troublesome on grape-vines. The Cucumber-flea beetle *Crepidodera cucumeris*, Har., is one of the pests of the Gourd family of plants. The Striped Flea beetles (*Phyllotreta sinuata*, Steph., and *P. vittata*, Fabr.), riddle the leaves of turnips, radishes and cabbage with small, round holes. The larvæ feed under ground on the roots or mine the leaves of plants belonging in the same family with the vegetables mentioned. *Haltica (Graptodera) foliacea*, Lec., is very destructive in the far western States to the foliage of young apple trees.

The Seed weevils (BRUCHIDÆ) are a small family of beetles that breed in seeds and grain. They are of broad oval, flattened form, from one-tenth to one-fifth inch long. The antennæ are rather short and serrate, and the tip of the abdomen protrudes beyond the wing-covers. The Pea weevil (*Bruchus pisi*, Linn.), the Bean weevil (*B. obsoletus*, Say.), and the Grain weevil (*B. granarius*, Linn.) are the most destructive species, whose habits are well known to every farmer and gardener.

#### Section HETEROMERA.

In this somewhat isolated group of beetles, we find the chief peculiarity in the feet, the front and middle pair of which are five-jointed and the hind pair four-jointed. These are not cushioned beneath, as are those of the Leaf beetles. Many of the species are exceedingly interesting to the biologist on account of their peculiar development, which has one or two seemingly retrograde stages in those of parasitic habits.

[Fig. 29.]

Blister beetle—  
after Riley.

The Heteromeroous beetles are separated into quite a number of families, of which two only are of especial interest to the economic entomologist, viz.: The Oil or Blister beetles (MELOIDÆ) and the Meal beetles (TENEBRIONIDÆ). The Blister beetles are rather elegantly formed insects and differ from all others in having the somewhat triangular head set on vertically with a distinct neck. The wing covers and entire body wall are rather thin and leathery. The colors are satin black or plain ash-gray, or black, margined with pale gray, or striped longitudinally with yellow. They are diurnal insects, and, in their perfect state, feed voraciously on the foliage of the potato and also on certain kinds of flowers, and in the early autumn may be found on golden rod. The larvæ, which undergo what is termed *hypermetamorphosis*, exist in two forms, and are parasitic in the nests of bees and on the eggs of locusts (grasshoppers). They belong to the genera *Oantharis* and *Epicauta*.

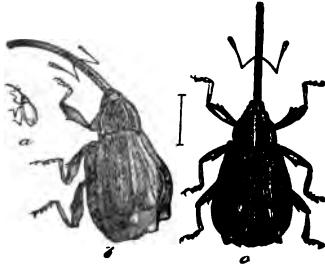
Among the Meal beetles, the most abundant and pernicious species is *Tenebrio molitor*, Linn, a plain black or very dark brown species, about three-fifths inch long, rather slender and elongate, and without any striking characteristics. The larvæ are horny skinned, slender, cylindrical worms, with well-developed feet, and are great pests in warehouses and storerooms where ground grain is kept.

## CHAPTER XIX.

## Order COLEOPTERA. Sub-Order RHYNCHOPHORA.

## SNOUT-BEETLES AND BARK-BORERS.

[Fig. 30.]

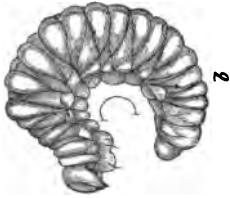


Apple curculio—(a) natural size; (b) side view; (c) back view, enlarged—after Riley.

The snout-beetles are all included, by the most recent writers on the subject, in seven or eight very distinct families, but the species are very numerous. None of the North American species are of more than medium size, while the majority are small—under one-fourth inch in length. The great peculiarity of these insects is found in the prolongation of the front part of the head into a *beak* or *snout*, termed the *rostrum*, which is either broad and short, or long and thin, in some species straight, in others curved. The small but sharp jaws are situated at the end of the beak, and the labrum and palpi are but very slightly developed or wanting. The antennæ arise from the sides of the beak; they are slender, elbowed or bent in the middle, and end in a knob or club. The rostrum is often grooved at the sides for the reception of these organs. The eyes are small and round. The body is compact and often wedge-shaped, and in many species the surface is ridged, pitted and raised into tubercles. The feet are four-jointed, each joint strongly bilobed and cushioned beneath.

When disturbed or frightened, most of the species “play ’possum,” feigning death most skillfully and persistently. The antennæ sink into the grooves in the beak, the latter, where its structure permits, is bent under, close to the body, as are also the legs, and the insect drops to the ground motionless, where its color and shape so closely simulate a dried bud, bit of twig or seed, that only the most practiced eye can detect it.

The great majority of these beetles are fruit and nut-eaters. The beak is used to drill the holes in which the eggs are placed. The larvæ are fat, white, thin-skinned and wrinkled grubs, without feet or prolegs—except in one small and peculiar group, the Brænthians, which are wood borers. They are usually in a more or less curved position from which some species, like the Apple-curculio, can never straighten themselves. Some, when full fed, work their way out of the fruit or nuts and drop to the ground, into which the burrow to transform; others change where they have fed.



Larva and pupa of Apple curculio.--After Riley.

Among the more important families are the Fruit and Nut weevils (CURCULIONIDÆ), the Rice weevils and "Bill bugs" (CALANDRIDÆ), and the Leaf-rollers (ATTALABIDÆ). In the amount and value of the products destroyed by it, the Peach or Plum curculio (*Conotrachelus nenuphar*, *Herbst*) may well head the list of the pernicious species. Its characters and habits are so well known that it is not necessary to recapitulate them here.

In some parts of the country this species is rivaled in the injury done to stone fruits by a slightly larger, smoother species called the Plum Gouger (*Ocoturus scutellaris* *Lec.*) The Apple curculio (*Anthonomus quadrigibbus*, *Say*), represented in Fig. 30, breeds in the fruit and passes its transformations without leaving it. The Nut weevils are nearly all included in the genus *Balinius*. They are smooth, oval beetles of an ochreous-drab color, with a very long, slender, dark brown beak, with which they drill holes in the green nuts for the reception of their eggs.

The principal genus of the CALANDRIDÆ is *Sphenophorus*, in which are found the Corn Bill-bugs which often do so much injury to Indian corn by boring the roots and lower part of the stalk. The Rice weevil (*Calandra oryza*, *Linn.*) is injurious to stored rice and other grain in the Southern States. The small beetles composing the family *Attalabidæ* breed on the leaves of Oak, *Rhus* and other trees. After placing an egg a portion of the leaf is rolled into a knapsack-like case, in which the larva develops, feeding on the partially withered portions of the enclosed leaf.

The Bark-beetles (SCOLYTIIDÆ) are small, hard, cylindrical insects of a shining black or brown color, the abdomen appearing as though cut off obliquely behind, encircled by a ring of little points or teeth. The antennæ are very short and knobbed at the tip. The larvæ are much like those of curculios, but have stronger jaws to adapt them for

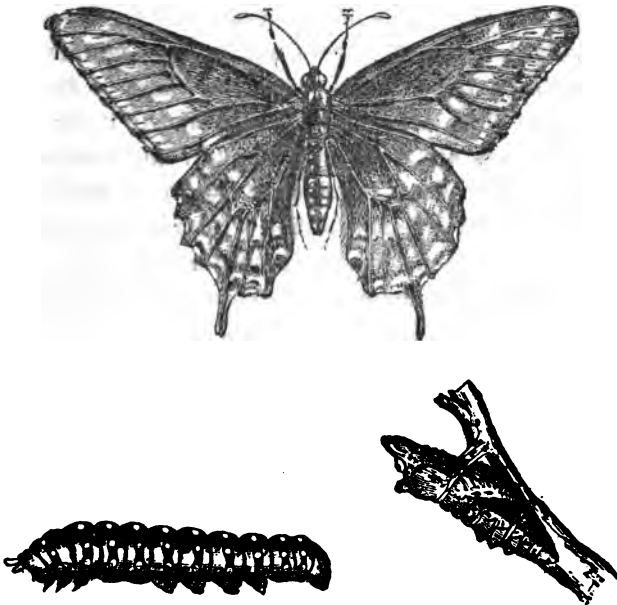
wood-boring. They bore between the bark and solid wood, several of them working from a common center—their burrows, which gradually widen to the place of exit, radiating in all directions, making fanciful carvings on the inner side of the bark and the surface of the wood. They often prove very destructive in forests, to both pine and hard-wood trees. A species introduced from Europe (*Scolytus rugulosus*, Ratz.) has recently excited alarm among the fruit-growers of Illinois, by working under the bark of twigs and young branches, principally of stone fruits, producing an effect like blight, and in some cases causing the death of the tree. Prof. Forbes, who has published the first account of its injuries in this country, finds it very generally distributed and promising to become a very serious enemy to all varieties of fruit trees.

---

## CHAPTER XX.

### Order III. LEPIDOPTERA.

[Fig. 82.]



Asterias butterfly, larva and chrysalis—after Tenney.

Among the butterflies and moths we find the most attractive, and with a few exceptions, the most conspicuous members of the class of insects. They are recognized without difficulty by their broad and often



gaily colored wings, their soft, hairy bodies, small heads, prominent eyes and antennæ, and in most species, the long, coiled tongue.

In the Lepidoptera the three principal divisions of the body are distinct, but the neck is very short and there is no slender pedicel connecting the thorax and abdomen. The head is small, but broad in proportion to its length, and moves freely on the neck; the eyes are hemispherical and of various colors, sometimes sparsely hairy.

Two ocelli are present in some of the moths, but are concealed under the hairy scales that clothe the top and front of the head, and probably are not of much use as organs of vision.

The antennæ are always conspicuous. They are either filiform, feathered or club-shaped. The upper jaws are not developed in the perfect insects, and the lower jaws (*maxillæ*) are united and lengthened out to form a horny tube called the tongue or *lingua*, which is coiled up like a watch spring when not in use. The palpi—at least one pair of them—are large and plummy and curve up in front of the face on each side of the tongue.

The usual form of the body is long and slender, tapering somewhat in both directions. The pro-thorax is a very narrow ring, scarcely visible on top except for the two little knobs which it bears, from which arise small tufts of hairs. The mezo-thorax is the most developed segment of the body, bearing the fore-wings and the middle legs, and the two little lappets (*patagia*) that cover the bases of the wings. The meta-thorax is also quite large, and has attached to it the hind legs and hind wings. The legs are weak and slender, and are used chiefly as supports for the body when the insect is at rest, and only rarely for walking or crawling. They are clothed with hair-like scales, and have one or two pairs of spurs at or near the outer end of the shank (*tibia*). The feet have five slender cylindrical joints, and terminate in a pair of minute claws.

The wings, in this order of insects, are the most striking features of the organism, and of first importance in every respect. They are formed of membrane supported by numerous strong veins (see Fig. 5), and covered with a powdery substance which, when magnified, is found to consist of minute scales narrowly or broadly oblong, attached by a little stem; they are notched on the outer edge and overlap each other in irregular rows, like the shingles on a roof. It is in the brilliant colors and elegant patterns formed by the arrangement of these scales, that the beauty of the butterflies and moths chiefly resides.

The *patagia* are covered with long hairs, and fit over the bases of the upper wings like epaulettes. In their perfect state lepidopterous insects are rather short-lived, if we except the comparatively few species

that hibernate. The only nourishment they require is an occasional sip of nectar from flowers or water from a dew-drop or from the moist earth. Their business in life is to seek their mates and place their eggs upon the plants or other substances upon which their larvæ subsist. The eggs of butterflies are usually conical and ridged or fretted on the surface, and as a rule are deposited singly, while those of moths are mostly spherical or circular, and deposited in clusters.

The transformations in this order are complete, and more easily observed than in most other insects. The larvæ are all properly termed *caterpillars*, but the smooth species are often popularly designated "worms," as for example, "cut-worms," "canker-worms," "bud-worms," etc. Like the parent insects, they vary greatly in form, size and color. The body is usually cylindrical, composed of twelve or thirteen segments, besides the head. The latter is covered by a horny plate, often divided in the middle by a triangular "face," which has its base at the labrum. The jaws are broad and strong, serrated or toothed on the edges, the under lip (labium) is well developed, but the maxillæ and palpi are in most species quite rudimentary. The antennæ are represented by a pair of three or four jointed tubercles, and the eyes by three or four little dots or simple eyes, which probably enable them to distinguish daylight from darkness. As Dr. Packard says, "this is useful information from a caterpillar's stand-point, as most of them hide by day and feed by night." The *spinneret* is a small conical tube on the lower lip, through which a gummy substance, secreted by most caterpillars, is drawn out and becomes a fine silken thread, of which these insects make great use in forming their nests or cocoons, in attaching themselves when molting, or suspending themselves in the air as a means of escape from their enemies.

Caterpillars, with very few exceptions, have from *ten* to *sixteen* legs—six of which, on the thoracic joints, are termed the *true* or *thoracic* legs, and are pointed and horny; the others, which support the hinder part of the body, are broad fleshy props, and are termed the *false* legs or *pro-legs*; they terminate in a circle of minute hooks, by which their possessor is enabled to cling to any surface upon which it wishes to crawl. Some caterpillars have the surface of the body smooth, while in others it is covered with hair or protected by clusters of sharp branching spines, or roughened by warts and tubercles. On the top of the first joint, just back of the head, there is in many species a clearly defined horny plate called the *cervical collar* or *shield*, and a similar plate at the hinder end forms the *anal* or *supra-anal* plate.

In the process of growth, lepidopterous larvæ *molt* or change their skins from three to five times. The operation is as follows: The hindmost or anal pro-legs are made fast to some rough surface, or to a mat of silk prepared for the purpose. The larva then rests and fasts for a certain length of time. Presently the head plates begin to separate from the neck, and a longitudinal slit appears on the top of the thoracic segments, which gradually widens until the fore part of the body can be forced through, after which, by alternate expansions and contractions, the outgrown skin is made to slip backward until, by a final effort, the anal legs are withdrawn and the crumpled mass of cast-off skin, termed the *exuvium* (plural, *exuviae*), is left attached to the leaf or bark, while the caterpillar, in its new dress—which is, in some cases, quite differently colored and ornamented from the out-grown one—crawls off in search of food with which to renew its exhausted strength.

The great majority of caterpillars subsist on the leaves, flowers and fruit of trees, shrubs and herbaceous plants. Of these they consume vast quantities every year, often partially or entirely destroying the most valuable crops in satisfying their voracious appetites. A few species infest drugs and grocers' wares and some gnaw furs and woolen goods.

When full grown, caterpillars cease to feed, and seek some place in which they will be concealed from their enemies while unable either to escape or defend themselves. In this they succeed so well that it is but rarely that the pupæ are discovered by any but practiced eyes.

Lepidopterous pupæ are called *chrysalides*. They are of various shapes, some being angular and irregular in outline, and have the surface roughened with humps and protuberances, while others are smooth, oval or oblong and highly polished. The integument is horny or shelly in its nature, composed of *chitine*, a substance which enters largely into the composition of the body-wall of insects in all stages of development. Each member is not encased in a separate sheath, as with the Hymenoptera and Coleoptera, but the outlines of the parts can, in most species, be distinguished through the case in which they are enclosed. The chrysalides of many species have no covering or outer envelope, but are simply attached by bands of silk to some surface. Others are enclosed in thick cocoons, or hidden within rolled-up leaves, or formed in earthen cells several inches under ground. The pupa state varies in duration from eight or ten days to several months, according to the habit of the species or the season of the year.

The Lepidoptera cannot be so readily classified by the beginner as the bees and beetles, although the primary groups are not difficult to distinguish. The first division is into two sections or sub-orders:

- I. BUTTERFLIES (*Rhopalocera*—club-horns).
- II. MOTHS (*Heterocera*—variable horns).

A glance at the antennæ serves to show us to which of these groups an insect belongs. In the butterflies these organs are stiff, thread-like, and either abruptly or gradually enlarged at the tip, so that they always terminate in a *knob* or *club*. The antennæ of moths, on the other hand, no matter what their general form may be, whether feathered or filiform, or spindle-shaped, invariably end in a *point*. Besides the antennæ there are many other characters which separate the insects composing these two divisions. In the butterflies the body is usually small and slender in proportion to the size of the wings, while in many moths it is stout and clumsy; the fore and hind wings of butterflies are not attached during flight, while those of moths are held together near the base by a bristle termed a *frenulum* on the secondaries, which fits into a loop or socket on the inner margin of the primaries. The butterflies are *diurnal* insects, while most of the moths fly at *night* or during the morning and evening twilight. When at rest butterflies hold the wings, at least one pair of them, erect, with the under surfaces exposed; the moths on the contrary close the wings either flat or roof-like over the body, with the upper pair entirely concealing the under pair, except in one family, where both are spread out.

While an entomologist rarely mistakes a butterfly larva for that of a moth, or *vice versa*, it is somewhat difficult to give a list of the characters by which they can be distinguished. The chrysalides of butterflies are usually unprotected by any sort of cover or cocoon, and are very angular and irregular in outline, or are brightly colored, while those of moths are protected in cocoons of silk, or in rolled leaves, or hidden in the earth, and are mostly smooth and oval or oblong in outline, and in no instance display brilliant or metallic colors.

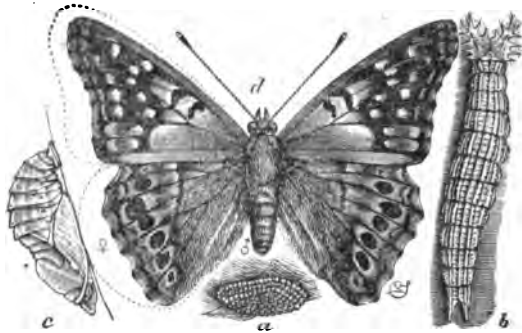
It must be borne in mind that in entomology the term "moth" is not restricted to the few small insects that breed in furs, woolens and similar substances, but is used to designate the greater proportion of the scale-winged insects, without regard to size or habit. The gigantic *Cecropia*, whose wings expand about six inches, and whose body is as thick as one's finger, is as much a "moth" as is the tiny creature that sometimes flutters out of closets or up from the borders of carpets, to the disturbance of the thrifty housekeeper.

## CHAPTER XXI.

## Order LEPIDOPTERA. Sub-Order RHOPALOCERA.

## BUTTERFLIES.

[Fig. 33.]

Hackberry butterfly, *Apatura-clyton*, with larva and chrysalis. After Riley.

Of all the insect tribes the butterflies are the popular favorites. None of the prejudice with which insects are generally regarded seems to attach to them. Used by the classic writers to symbolize the soul, they have ever continued to be favorites of the poets, and are associated with whatever is most airily graceful and beautiful in nature.

The larvæ of butterflies feed exclusively on vegetation, each species being restricted to one, or at most to two or three kinds of plants. In their general form they do not vary so much as the larvæ of moths, being all more or less cylindrical and always possessing the full complement of six legs and ten prolegs. The head, though not always large, is quite distinct, usually with a somewhat fretted or stippled surface, and in a few species, adorned with branching horns (see Fig. 33*b*), or spiny tubercles. The surface of the body is in some species smooth and velvety, in others bearing fleshy horns and protuberances or covered with spines.

The pupæ are naked, except in the species constituting one family, where they are slightly enclosed in threads of silk. They are, as a rule, very angular, especially toward the anterior end, and are either pendent by the tail, or are supported in an upright position by a band of silk which the larva, before changing, contrives to weave across its back.

Some of the characters by which butterflies are grouped into families and genera are found in the outline and venation of the wings, the shape of the club of the antennæ and of the palpi, the presence or

seeming absence of the front pair of legs, and, to a certain extent, in the coloring.

Butterflies have been classified and re-classified in various ways, by different naturalists, each system based on some excellent ideas, but all more or less defective. The simplest arrangement is that by which they are all grouped into four comprehensive families, all of which are numerous represented in all parts of the United States. These families are: the Swallow-tails and their allies (PAPILIONIDÆ), the Browns and Silver-spots (NYMPHALIDÆ), the Little Blues and Coppers (LYCÆNIDÆ,) and the Skippers (HESPERIDÆ).

The Swallow-tails (genus *Papilio*) are so called from the narrow lobes or tabs into which the outer edges of the lower wings are prolonged. Among these we find the largest and some of the most beautiful of our native species. They are mostly of dark colors—black or rich brown, ornamented on the wings and body with spots and streaks of bright yellow and orange, with shadings or lustrous reflections of blue or green. The club of the antennæ is rather small; the tibiæ of the hind legs have a single pair of spurs, and those of the fore legs at the base a sort of flap covered with long hairs. All the species in the family have six equally developed legs. (See Fig. 32.)

The larvæ are, with one or two exceptions, smooth, cylindrical caterpillars, often gaily striped or ornamented with eye-like spots (see Fig. —), and possess a distinguishing character in a V-shaped scent organ (*osmaterium*) of an orange color, which can be protruded at will and emits a disagreeable odor. It is used to frighten away parasitic enemies. This appendage is peculiar to the larvæ of the true Papilios, and when the insect is quiet, is completely retracted under the edge of the segment next the head. The larva of *Papilio asterias* feeds on the foliage of carrots, parsley, caraway and other umbeliferous plants. The chrysalis is marked in wood brown and white, and has the form represented in Fig. 32. The butterfly is black, with bluish shadings, and is ornamented with several rows of bright yellow dots near the outer edges of the wings. The Turnus butterfly (*Papilio turnus*, Linn.) is one of the largest and commonest species, expanding over four inches. It differs from all its congeners in having the ground color of the wings bright yellow, but crossed by broad dashes and streaks of black, and with a black border in which are set lunate yellow spots. The larva is deep green, and about one and one-half inches in length deep when full grown. The front edge of the second joint and a part of the fifth joint are yellow, and on each side of the fourth joint are a couple of small purple spots. The chrysalis is in various shades of

brown, in shape much like that of *P. asterias*, but is larger and has a more prominent horn projecting forward over the head. The larvæ feed on a variety of fruit and shade trees, and are sometimes quite destructive. There are eight or nine North American species of Swallow-tailed butterflies, besides several quite distinct varieties, all of which are very handsome.

The Garden Whites or Cabbage butterflies (genus *Pieris*) include about a half dozen species, among which are found several very serious pests of the vegetable garden. They are of rather small size, expanding not more than two inches, and are all of a dingy white with blackish margins and dustings, or are more or less thickly spotted with grayish black. The larvæ are slender, cylindrical caterpillars with a rugose or velvety surface, and either plain green or with a striped and checkered pattern in dull green, black, lilac and white.

The European cabbage butterfly (*Pieris rapæ*, Linn.) was accidentally introduced into this country about twenty years ago, and has now become naturalized in almost every section, proving very destructive to cabbages, turnips and other cruciferous plants.

The Sulphur yellows (genus *Colias*) include the medium-sized, gay yellow and black or orange and black butterflies that are so numerous late in spring and early in autumn. Their larvæ are of a green color, with a velvety surface, and many of them have a lateral band, composed of a line of bright crimson, and one of white, extending from the second to the eleventh segments. They feed upon clover, lucern and other leguminous plants.

The Browns and Silver Spots composing the family NYMPHALIDÆ are called the "four-footed" butterflies, from the apparent absence of the front pair of legs. If carefully examined these members are seen to be folded and closely appressed to the breast, and often have the tarsi undeveloped. The majority of these butterflies are of large size and of dark, rich colors, many species being elegantly ornamented on the under side of the wings with silvery spots. The larvæ of most species have the surface covered with spines or raised into humps and prominences. The pupæ are always suspended by the tail and hang head downward. A few of the chrysalides are smooth and casket-shaped, but the majority are characterized by many angles and projections. Nearly all are studded with golden or gem-like spots, which disappear or lose their luster shortly before the butterfly emerges.

The manner in which these pupæ contrive to attach themselves to the point of support is a process so interesting that the observer is well repaid for the time expended in watching it. It may be briefly described as follows: The caterpillar, when ready to change, spins a

little mat or tuft of silk upon some convenient surface. Into this it entangles the hooks of the hind legs, and loosening its hold in front and curling up the head, it suffers itself to drop and hang by these anal pro-legs. In this position it remains from twelve to thirty-six hours. The skin then bursts open just back of the head, and the anterior end of the chrysalis is protruded. By violent exertion, in alternate lengthenings and contractions, the larval skin is shoved backward until it forms a shriveled mass near the point of attachment. The crowning effort is now to be made in withdrawing the tail of the chrysalis and fixing it into the little mat of silk prepared for it. The chrysalis, it must be remembered, is not yet hard and stiff, but is capable of considerable motion; accordingly, by a sharp contraction, a portion of the larval skin is firmly grasped between two of the abdominal joints, and with only this slight hold the hinder end of the chrysalis is withdrawn from the old skin, and, with a vigorous thrust, the little spike, termed the *cremaster*, with which it is provided, is struck sharply into the tuft of silk. Sometimes the first stroke suffices to fix it; in other cases two or three efforts are required, and, occasionally, there is utter failure and the chrysalis drops to the ground. When the chrysalis is made fast it whirls itself rapidly round and round to detach the larval skin and to more firmly entangle the barbs of the cremaster. After this the chrysalis contracts and hardens, and the beautiful colors which characterize the particular species are displayed.

Among the most beautiful and most easily recognized genera of the four-footed butterflies may be mentioned *Danais*, *Argynnis*, *Apatura*, *Vanessa*, *Grapta* and *Hipparchia*. The Archippus butterfly (*Danais archippus*, Fabr.) is one of the most common and abundant species. The wing expanse is between four and five inches, the color a bright red-brown with black veins and black border in which are set two rows of white dots. The larva feeds on the milkweed or silkweed (*Asclepias*), and is elegantly colored in transverse stripes of black, white and yellow, with a pair of black velvety horns on the third and eleventh joints. The chrysalis is shaped like a lady's ear-drop, and is of a clear green color, ornamented with black and gold.

The *Argynnis* butterflies have broad velvety wings of a tawny orange color, shaded and spotted with dark-brown on the upper surface, while the under sides are resplendent with numerous silvery spots. In these species the antennæ terminate in a large, roundish knob. The larvæ are covered with spines and feed upon violets.

The Hackberry butterflies (genus *Apatura*) are of a dull brown, mottled with white and black spots. The eggs of *A. clyton* (see Fig. 33)



are laid in a mass, and the head of the larva bears a pair of branching horns.

In *Vanessa* the edges of the wings are scalloped and angular in outline. The palpi are large, and project in front of the head like a beak. The beautiful *Antiopa* butterfly (*Vanessa antiopa*, Linn), which has deep purple, buff-bordered wings, and whose larva are very destructive to the Lombardy poplar and elm, and the red Admiral (*V. atalanta*, Linn), distinguished by broad, orange-red stripes, passing obliquely across the upper wings and bordering the outer edges of the lower ones, and whose larvæ feed on the nettle, belong to this genus.

The genus *Grapta* may be recognized by the very jagged outline of the wings. The upper pair, besides being notched, are deeply hollowed out on the outer edge, and the lower pair are furnished with two short "tails." The upper surface is pale reddish-brown, mottled with large, irregular spots of dark brown. Some species have a narrow border of pale blue. The under side is of duller colors, with a single silvery or golden mark. These butterflies may be popularly termed the "Punctuation" butterflies, since, from the punctuation-like marks on the under side of the wings, the various species have been named *Grapta comma*, *Grapta interrogationis*, etc.

The genus *Hipparchia* contains the "Wood butterflies," so named from the fact of their being usually found in groves and thickets, and also from their wood-brown colors, relieved by eye-like spots.

The family LYCÆNIDÆ contains the small coppery red and the blue butterflies often seen fluttering about pools of water and muddy places by road-sides.

The larvæ feed on grass, are smooth, short and thick, and secure themselves with a loop in an upright position, when about to transform. The genus *Theckla* may be recognized by the two thread-like tails which ornament each of the hind wings.

The HESPERIDÆ comprise a large number of black and brown, dull-colored butterflies, mostly of small size, and which differ in so many respects from the other RHOPALOCERA that they seem to furnish the connecting link between the true butterflies and the moths. The body is generally short and thick, and in repose only the fore wings are held erect, and these not pressed together, while the hind wings are laid flat upon the back. The antennæ end in a little hook. They fly with rapid, jerky motions, often alighting. Hence they are popularly denominated "Skippers." The larvæ are spindle-shaped, with a rough surface, a small, distinct neck and a large head, which is usually somewhat heart-shaped and marked with two or more conspicuous spots. They live in cases which they form by folding leaves and fast-

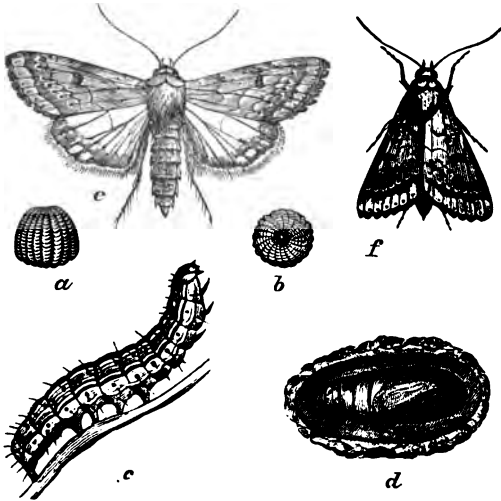
ening them in place with what look like long stitches of coarse, white silk. They leave their cases at night to feed, and when one case is outgrown they construct a new one. They change to pupæ within their leafy homes and further enclosed in a lace-like silken cocoon. The chrysalis is smooth and oval, often covered with a fine powder or "bloom," and is suspended by the tail. The Tityrus skipper (*Eudamus tityrus*, Fabr.), the larva of which feeds on the locust and acacia, is the largest and best known species.

CHAPTER XXII.

Order LEPIDOPTERA. Sub-Order HETEROCERA.

MOTHS.

Fig. 34.



Corn-worm (*Heliothis armigera*)—after Riley; a, b, egg magnified; c, larva; d, pupa; e, f, imago or moth.

The moths greatly exceed the butterflies in number of species and individuals and in diversity of size, structure and habit. Among them may be found some (tropical) species whose expanded wings measure a foot from tip to tip, and others whose wing expanse is scarcely one-eighth inch. Some forms are slender and graceful, and can scarcely be distinguished from butterflies; others, when on the wing, might easily be mistaken for bees or wasps; still others simulate beetles, while a few, destitute of wings, and in some cases of legs also, present the appearance of over-grown maggots or grubs. In the peculiarities of their development, also, the entomologist finds a field of inexhaust-

ible interest, and in which he learns much that can be turned to practical account in his endeavors to discover the best methods of keeping pernicious species in check. A *general* description of the insects composing this sub-order is almost impossible. Almost the only characters common to all are the pointed antennæ, the horizontal position of the wings in repose, the rounded or oval and inclosed pupæ, and, with some exceptions, the nocturnal habit. The moths are very conveniently separated into *ten* families: Sphinx moths (SPHINGIDÆ), Clear-wings (ÆGERIIDÆ), Butterfly Mimics (ZYGÆNIDÆ), Spinners (BOMBYCIDÆ), Owlet moths or Cut-worm moths (NOCTUIDÆ), Spanworm or Measuring-worm moths (GEOMETRIDÆ), Snout moths (PYRALIDÆ), Leaf-rollers (TORTRICIDÆ), Fringe-wings or Tineids (TINEIDÆ) and Plume moths or Feather-wings (PTEROPHORIDÆ). Of these families the first six are sometimes collectively termed the Macro-lepidoptera, and the remaining four the Micro-lepidoptera.

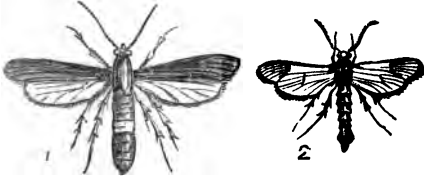
The Ægerians and Zygænids are *diurnal*; the Sphinx moths are *crepuscular*—*i. e.*, flying in the twilight—while all the others are nocturnal.

The Sphinx moths are so named from a habit of many of the larvæ when at rest, of raising the front part of the body and drawing in the head, giving them a fanciful resemblance to the figures of the Sphinx in Egyptian carvings and pictures. They are also called "hawk moths" from the strength of their narrow and pointed wings, and "humming-bird moths" from their manner of hovering over flowers while extracting the nectar. These moths have stout, smooth, spindle-shaped bodies, and the fore wings are nearly twice the length and breadth of the hinder pair, and close roof fashion over the body in repose. The antennæ are somewhat thickened in the middle, and in most species end in a hook. The "tongue" is remarkably long, often five or six inches, enabling the insects, while on the wing, to reach the deepest nectaries of the flowers for which they have a preference, among which may be mentioned the Daturas, Petunias, and other long-tubed blossoms. The larvæ are cylindrical caterpillars with a roughened or granulated surface, generally of some shade of green, and often with oblique stripes along each side, and almost always have a pointed horn or an eye-like spot on the top of the twelfth joint. With a few exceptions they enter the ground to transform, and some species have an external tongue case which is bent over like a jug-handle in front.

The common tomato or tobacco worm (*Sphinx quinquemaculata*, Haw.) and the Sphinx caterpillars of the grape vine are good examples of this family. All the species are very voracious and destructive to valuable trees and plants.

The Clear-winged moths (*ÆGERIIDÆ*) are mostly of small size and might easily be mistaken for bees or small wasps when on the wing.

[Fig. 35.]



Peach-borer (*Ægeria caitiosa*, Say.—after Riley. a, female; b, male.

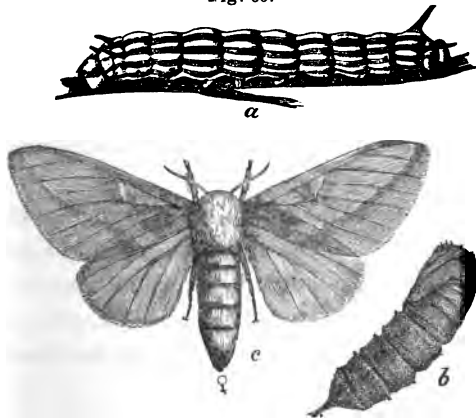
They have slender bodies, sometimes ending in a tuft of long hairs. In some species only the underwings are transparent, in others there is merely a border of scales around each pair. Among the larvæ

we find some of the worst borers, such as the Peach-tree borer (*Ægeria exitiosa*, Say.), the Raspberry borer (*Ærubi*, Riley), and the Pickle worm (*Phakellura nitidalis*, Cram).

The beautiful insects that I have termed “Butterfly Mimics” (*ZYGÆNIDÆ*) can scarcely be distinguished from the genuine butterflies, except by the pointed antennæ, and even these organs sometimes have a little silken tuft near the tip which helps the deception. They delight in the hottest sunshine, and display very gay colors on their broad wings. The larvæ are usually transversely striped in black and white with an orange-colored hump on the top of the eleventh segment. Some very injurious species are known as the “Blue caterpillars of the vine.” When ready to change they enter the ground or bore into the wood of the grape posts.

Among the spinners (*BOMBYCIDÆ*) are most of our largest and most elegant moths, as well as the few species which are in the highest degree valuable, viz., the silk producers. Some of these species expand from six to nine inches. The wings are broad, and sometimes *falcate*: i. e., hollowed out at the outer edges. They are densely covered with hairs and scales of rich colors. The head is small, and the antennæ beautifully feathered, and are in some species so broad as to

Fig. 36.



Green-striped Maple worm (*Anisota rubicunda*, Fabr) after Riley. a, larva; b, pupa; c, moth—all natural size.

be mistaken for an additional pair of wings. The mouth parts are undeveloped, and, large as they are, these moths are incapable of taking even a sip of nectar. The body is stout and heavy, and the plumy legs rather weak. The magnificent Cecropia moth (*Samia cecropia*, Linn). or the Polyphemus (*Telea polyphemus*, Cram.)—named for the fabled one-eyed monster of classic poetry, because of the great eye-like spot that orna-

ments each hind wing—occasionally enter lighted rooms on summer nights; but, as a rule, the moths of this family are not much attracted by light. The most delicately beautiful of our native species is the Luna moth (*Actias luna*, Linn.), which is of a pale green color with an eye spot at the end of the discal cell in each wing, and the hind wings extended at the outer edges into lobes or tails sometimes one and one-half inches long. The full grown larvæ of these species are immense caterpillars, usually of a green color, sparsely hairy and studded with wart-like tubercles of brilliant colors, or bear, near the head, from one to six long, spiny horns that give them a most formidable aspect.

The invaluable and interesting Chinese silk-worm (*Bombyx mori*, Linn.) is a near relative of the species named above. It is of a bluish or creamy white, with a few more or less distinct brown markings. The surface is smooth, except for a few ridges and wrinkles on the thoracic joints and a small pointed horn on the top of the eleventh joint. All these species are very voracious, and feed for from four to six weeks.

The native spinners are often quite destructive to various kinds of fruit and shade trees, while the Chinese silk-worm thrives best on the White mulberry, but may be grown successfully on the Osage orange, and, in the Southern States, it is said to feed on Alfalfa. The silk gland, lying along the under side of the body, is very large in all the typical Bombycids, and secretes a quantity of viscid fluid, which upon being drawn out through the spinneret on the labium, forms fine threads of the exquisite substance known as *silk*. Of this the larvæ form thick oval, or slender, oblong cocoons, weaving layer over layer until about half the substance of the caterpillar is transformed into the covering for the pupa. In the latter stage our native species hibernate, but the imported species cuts its way out in about two weeks, appearing as a rather small, white moth, whose weak wings are incapable of supporting it in flight. The female lays a quantity of eggs, and by means of these the species is carried over winter.

Among the most interesting species of Bombycids are the singular forms termed "slug caterpillars."

In these the feet are but slightly developed, and the insect moves with a snail-like glide, over a leaf or other surface, by means of ridges on the under side, leaving a slimy track behind it. Some have a rectangular shape with several fleshy prominences on the back, others are almost circular, or of the shape of a beech nut. Some are adorned on top with a double row of plummy spines.

Nearly all are brightly colored, or have the colors displayed in peculiar and beautiful patterns. Great care must be exercised in

handling them, as the hairs and spines inflict a nettle-like sting. Quite a number of species included among the spinners do not secrete silk, and change to pupæ under ground in a frail earthen cell. Among these is the Green-striped Maple worm (*Dryocampa rubicunda*, Fab.), (see Fig. 36), which is occasionally very destructive to the shade trees from which it derives its name.

The Cut-worm moths or Owlet moths (NOCTUIDÆ) are a very extensive group of medium sized insects, mostly of plain colors, but containing a few very gaily decked species. The body is rather thick and heavy, the fore wings narrow, and in repose entirely cover the hind wings, which are folded beneath them. The head is small, the antennæ simple (thread-like), the tongue long, and the eyes in many cases hairy or encircled by hairs.

The thorax is often crested or tufted, with long, erect scales. The upper wings, whatever their color and markings, display two more or less distinct spots, the one round, the other kidney-shaped (*orbicular* and *reniform*). The true cut-worms are smooth, dingy-colored caterpillars, many of which commonly rest in a coiled position. They conceal themselves by day and crawl out by night to their work of destruction, cutting off not only tender herbaceous vegetation, but ascending trees and vines to nip off the young leaves. When ready to transform, these "worms" burrow into the earth or conceal themselves under rubbish on its surface, but never spin any regular cocoon.

The well-known Army worm (*Leucania unipuncta*, Haw.), which sometimes devastates numerous grain fields in a single march, is one of the representatives of this group. So, also, is the wide-spread Corn worm or Boll worm (*Heliothis armigera*, Hub.) See Fig. 34. The large moths of the genus *Oatocala*, easily recognized by their gaily banded under-wings, in which scarlet, crimson, orange or white alternates with black, are also included in the family NOCTUIDÆ.

The Span-worm moths (GEOMETRIDÆ) are mostly of pale, delicate colors, with slender bodies, broad thin wings, which in repose are spread out at right angles from the body, and by the usually slightly or broadly feathered antennæ. In this family the females are sometimes wingless. The larvæ are called

Fig. 37.



“Measuring worms” or “Span worms” from their looping mode of crawling. This is necessitated by the lack of two or three pairs of the abdominal pro-legs, so that in crawling the hinder end of the body is brought up close to the head at every onward motion. These worms are generally long, slender and cylindrical. Some have bud-like or scale-like humps on the body, so that when the latter is at rest and held out from a branch in an oblique direction, it simulates a twig so closely as to escape recognition. In preparing for transformation, these larvæ either enter the ground or enclose themselves in thin cocoons in some concealed spot. Among the pernicious species we find the Apple and Elm tree Canker worms (*Anisopteryx vernata*, Har., and *A. autumnalis*, Pack.), and the Lime tree Winter moth (*Hybernia tiliari*, Har.) See Fig. 37.

The Snout moths (*Pyralidæ*) are much like many of the Geometers in general appearance, but may usually be distinguished from them by their smaller size and the long, slender palpi, which are held close together and project in front of the head like a beak. Some of the larvæ are leaf-rollers; others feed on meal or in clover hay, while others are true “grass worms” and do much damage to meadows and pastures.

The true leaf-rollers (*Tortricidæ*) are a family of small moths, many of which are richly and beautifully colored. They are characterized by the oblong form of the upper wings, which, in repose, are folded

roof-like over the body. The eyes are large, the antennæ filiform, the palpi broad, tufted and somewhat triangular. The larvæ are usually rather soft, plainly colored worms with a heart-shaped head, a distinct horny collar, and horny plate on top of the last joint. The great majority conceal themselves within leaves variously twisted and rolled, from which habit the group derives its name. A few species feed on fruit, among which the universal apple enemy, the Codling moth (*Carpocopsa pomonella*, Linn.), is the most notorious.

The Fringe-wings (TINEIDÆ) include the smallest insects in the Order. They have slender, lance-shaped wings, bordered by long fringes, and many of them are exquisitely colored in various metallic and prismatic tints. The antennæ are simple, and usually nearly as long as the body. The palpi vary in form, but are, as a rule, long and conspicuous, in many species curving upward in front of the head. The larvæ are often leaf-miners or case-bearers. Others are destructive to fruit or grain, or feed upon feathers, furs and wool, being the "clothes moths," against whose ravages it is necessary to protect some of our costliest apparel.

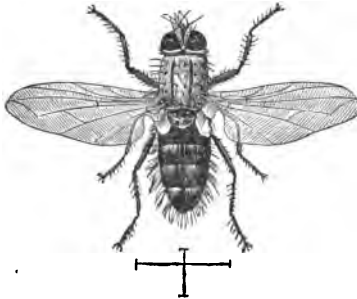
The Feather-wings or Plume moths (PTEROPHORIDÆ) have the wings cleft so that each appears composed of several feathers. They are small insects, only one or two of which are seriously destructive, as for example the Grape-vine Plume.

---

## CHAPTER XXIII.

### Order IV. DIPTERA.

[Fig. 38.]



Tachina fly (*Lydella doryphoræ*) Riley.

In this Order are grouped the insects that have but a single pair of wings, and a few others that have no wings at all. They are popu-



larly distinguished as flies. Although many flies, in the larva state, are undoubtedly useful as scavengers, yet the perfect insects are, most of them, so annoying, and often so positively injurious, that the entire Order is regarded with much disfavor. Mosquitos, gnats, house-flies, gad-flies and other species frequently occur in such immense swarms in certain localities as to render life almost intolerable. A few species are brilliantly colored, or of striking size or form, but, as a rule, the members of this division are the most individually inconspicuous of insects.

The bodies of most flies are soft and fragile. The head is usually large, round or hemispherical, often quite concave behind, and is attached to the thorax by a peg-like neck, on which it can be twirled almost completely around without being separated from the body. The eyes are, except in a few very lowly organized species, very large, covering the greater part of the head, and their faceted structure can be seen even without the aid of a lens. The mouth-parts are very differently developed in the different families, but are all peculiarly fitted for sipping fluids. In the house-fly the jaws and true maxillæ are wanting, but the secondary maxillæ and the lower lip form a proboscis which ends in a pair of broad flaps, whose ridged surface enables the insect to lap up sweet fluids or the perspiration from the hand, or the juices of meat or other liquids to which it is attracted. When not in use, the proboscis being jointed, is folded up and fits into a groove in the face. The so-called "stinging flies" have the jaws modified into very sharp lancets, which are so strong that they are capable of piercing even the thick skin of a horse and drawing the blood. The antennæ are either short and stout, having but three joints and a bristle, or are many-jointed, long and feathered, as in the mosquito. The thorax is large and round, the first and third segments—pro-thorax and meta-thorax—being very small and closely consolidated above with the meso-thorax, which is large and muscular. The wings are composed of thin, transparent or smoky membrane supported by strong veins. They can be vibrated with exceeding swiftness, and the insects are capable of longer and more continuous flights than any of the four-winged species. At the base of each wing is a little roundish scale called the *winglet* or *alulet*, the use of which has not yet been discovered. The hind wings are represented by two thread-like organs ending in little knobs, which are the *halteres*, *poisers* or *balancers*, whose function is likewise unknown. The legs are generally rather weak and slender, and in some species are very long. The feet are five-jointed, and besides the claws, are provided with a bilobed cushion clothed with microscopic hairs

from which exudes a sticky fluid, by means of which the insect is enabled to walk up and down the panes of a window or along the ceiling of a room. The old, ingenious theory of "the exhaustion of air under its feet," by which the crawling of a fly on such surfaces used to be explained, is now known to be erroneous. In the abdomen of the stouter-bodied flies it is difficult to distinguish more than four segments, the terminal ones being abruptly narrowed and drawn within the body to form the ovipositor.

Such flies as the house-fly and the gad-fly are on the wing and troublesome only during the day. Others, like the mosquito, are most active at night, while some are equally tormenting during the entire twenty-four hours.

The transformations of dipterous insects are complete. The eggs are deposited singly or in masses upon the solids or fluids upon which the larvæ feed. Those of many species are smooth and white and of a linear oblong shape.

The larvae of terrestrial flies are called *maggots*. They are soft, thin-skinned, cylindrical, and taper most toward the head, or rather the mouth, for but few of them have any distinct head. They have no legs or other organs of locomotion, and wriggle from place to place by a peculiar twisting of the body, or, as in the case of the "cheese skippers," they coil themselves up and seize the tail between the jaws, and then by suddenly letting go, jerk themselves to great distances by the rebound.

Aquatic larvæ are furnished with fin-like swimming organs, and some species breathe through long tubes situated on the posterior end of the body, which can be elevated above the surface of the water. Many dipterous larvæ are parasitic; others feed upon decaying animal or vegetable matter; those which are aquatic subsist on organic impurities of water, and a considerable proportion feed on the tissues of growing plants. Except in the case of some aquatic species, the pupæ are *inactive*. They are of two forms: *coarctate*, that is, inclosed in the dry and hardened larva skin, or *obtectæ*, with the larva skin thrown off, and the rudimentary members of the mature insect separately encased, as in the pupæ of Hymenoptera and Coleoptera. The pupa state is generally of short duration. The Diptera may be considered under two sub-orders:

I. **ORTHOGRAPHIA**, in which the obtectæ pupa escapes from the larval skin through a cross slit or T-shaped opening between the seventh and eighth joints; and

II. **CYCLOBAPHA**, including mostly coarctate pupæ, from which the perfect fly escapes through a circular hole on top of the puparium.

Each of these divisions contains many families which differ in many points of structure and habit. It will be possible here to refer only to those which include the species most commonly met with, and of most importance from an economic standpoint. In the first we find the Gall-gnats and grain-flies (CECIDOMYIDÆ). These are all small species, which are injurious to vegetation. They have slender bodies and long antennæ, which are often plummy. The wings have three or four veins, extending from base to outer margin, and are usually fringed around the edge. The halteres are long and round-knobbed, and the legs long and slender. The gall-making species place their eggs upon leaves or tender stems, into the tissues of which the larvæ work their way, causing by irritation, peculiar fleshy or woody swellings. On this abnormal vegetable tissue the larvæ feed. The latter are minute maggots, often of a pale red color, with a peculiar, clove-shaped dark mark on the under side near the head, which can be clearly distinguished only by the aid of a lens.

The Hessian fly (*Oecidomyia destructor*, Say.) and the Wheat-midge (*Diplosis tritici*, Kirby) are the most notoriously destructive of these gnats. The larvæ of the former are flesh-colored maggots, which are found beneath the sheaths of the lower joints of the wheat stalk in autumn and early spring, and which dwarf and sometimes entirely kill the plant by extracting the sap from the tender stems. In the change to pupa, the larval skin hardens and turns brown, forming a "flax-seed"-like *puparium*, within which the transformations take place.

The Wheat-midge is a tiny, orange-colored fly which places its eggs on the young heads of wheat, from which the red maggots extract the juices and cause the kernels to shrivel.

The Buffalo-gnats (SIMULIDÆ) are short, thick species with a very rounded thorax, short antennæ and strong mouth parts, capable of drawing blood from cattle and mules as well as from man. At certain seasons of the year they are an almost insupportable pest on the shores of the northern lakes and in the south, along the principal water-courses. The larvæ breed in water and have a singular feathery gill at the hinder end.

Mosquitos (CULICIDÆ) are characterized chiefly by the complex mouth parts, which are projected straight forward in front of the head. The beak or sting of the female mosquito—for the males are inoffensive creatures, that neither sing nor *sting*—when closely examined, is seen to consist of a bundle of fine bristles, seven in number, which together form a sharp-pointed tube by which the skin of man and the larger animals is pierced, and through which a minute portion of poison from a gland in the pro-thorax is forced into the wound, before or after

the blood has been drawn. The mouth parts of the male mosquito are not so long, and are adapted to sipping the nectar of flowers instead of the sanguinary nourishment preferred by his partner. The eyes are very large and somewhat oblong. The antennæ are plummy in both sexes, but those of the male are much more ornamental than those of the female. The thorax is considerably humped and the hind body long and slender. The legs are also very long and thin. The wings are fringed on the edge and the principal veins are outlined by fine scales. The eggs are laid in a boat-shaped mass on the surface of still water, and the larvæ are the well-known "wrigglers" so often seen in standing water. They swim by the aid of unsymmetrically arranged tufts of bristles, and breathe through a tube at the hinder end of the body, which they frequently project above the surface of the water. The pupæ do not take any nourishment, but are active, club-headed affairs which swim by means of the two paddles in which the abdomen terminates. There are a great many species of these venomous gnats, some of which are strictly nocturnal while others are equally active day and night. *Culex ciliatus*, Fab. is perhaps the most generally distributed species.

The Crane-flies (TIPULIDÆ) resemble mosquitoes in general appearance, but many species are from five to ten times the size of the latter. They have no sting and are not injurious in any way. The larvæ breed in soil that is rich in decaying organic matter, and therefore often emerge from flower-pots and hot-beds. They also occur in mould and other fungi, and in water.

Gad-flies or Breeze-flies (TABANIDÆ).—In this and the two following families of the Orthorapha, the antennæ are short and three-jointed. The Gad-flies or Horse-flies are shaped much like the house-fly, but are very much larger. The mouth parts are very strong and awl-shaped, and the bite is very painful. There are several species, of which the "Green-head fly" (*Tabanus lineola*, Fabr.) and the large black Horse-fly (*T. atratus* Fabr.) are exceedingly annoying to horses during the summer months, their sharp stabs and their menacing buzz driving the animals into a frenzy, and not infrequently causing them to run away.

The Mottled Breeze-fly, a somewhat smaller species, mottled in a dirty white and brown, is more especially injurious to horn cattle. The larvæ are aquatic or semi-aquatic, and those that have been described are glossy, greenish or yellowish "worms," with a row of rounded tubercles on each side, and taper to a very small head. The pupæ are ridged or roughened on the abdominal joints, and formed in the ground.

The Robber-flies (ASILIDÆ) have long, slender bodies and wings, and spiny, long, stout legs. The beak is short but strong, and the under lip well developed. The eyes are almost globular, and the antennæ short, often tipped with a bristle. The body is usually hairy, varying in length from one to two inches, and tapers toward the tip. The colors are mostly black and white, though some species have the thorax clothed with yellow hairs. In their perfect state, the Robber-flies are fierce and greedy cannibals, especially destructive to the honey-bee, of which one species has been known to kill and suck the vital juices of more than one hundred and forty in a day, according to Dr. Packard. They sometimes make amends, however, by preying on the Cabbage butterfly, though I fear this has not yet become a very general habit. The larvæ live in the ground, and those that have been studied have fed upon roots.

The Bee-flies (BOMBYLIDÆ) resemble small Humble bees in their thick, hairy bodies. They are very swift on the wing, and are often found on flowers, from which they extract nectar with the long proboscis. The larvæ are parasitic on bees and on the eggs of locusts (grasshoppers).

In the Sub-Order CYCLOBRAPHA we find a large number of families of flies whose larvæ are parasites or scavengers and a few that feed on vegetation, among which are some common gall-makers, also some that live in water. The transformations take place either underground or on the surfaces upon which the larvæ fed—the larval skin thickening and hardening into an oblong case, within which the soft, white pupa is formed. The flies always come out through a round hole on the top. They usually have rather short, thick bodies, broad heads and short antennæ, ending in a bristle. The following families contain the species that are most directly beneficial or injurious to man: Syrphus flies (SYRPHIDÆ). See Plate of Orders.) This is a group of handsome flies, ranging in size from small to medium (having a body length of from one-fifth to one-half inch). The colors are often arranged in bright bands, giving the insects quite a wasp-like appearance. The front of the face has no groove for the reception of the antennæ, which have the last joint much thickened just back of the bristle. The larvæ are legless and headless, leech-like creatures, which do us great service in destroying all kinds of plant-lice (*Aphididæ*), and may almost always be found in the colonies of the latter, which they very rapidly exterminate. The great majority of the beneficial species are found in the genus *Syrphus*. Their transformations are very easily observed, as they are hardy and develop rapidly.

The singular "rat-tailed" larvæ, often found in stagnant pools or other foul water, produce hairy flies of the genus *Eristalis*.

Bot-flies (ESTRIDÆ) are stout, hairy insects, much resembling small Humble bees. The mouth parts are but slightly developed, and the small antennæ, hidden in little cavities in the very narrow face, seem, at first glance, to be wanting. They are chiefly interesting from the habits of the larvæ, which live in the stomachs of horses, in the heads of sheep, and on the backs and other parts of the bodies of cattle and other animals, causing great suffering and sometimes even death to the poor creatures infested. The Bot-flies of the horse (*Gastrophilus equi*, Fabr.) lay their eggs on the horse's front legs or on the flanks or hips, glueing them most firmly to the hairs. The larvæ, which are hatched very shortly, produce an irritation which induces the horse to bite at those parts, and by this means they enter the mouth and make their way into the stomach. There they attach themselves, by means of mouth hooks, to the lining membrane, feeding on the mucus and digestive fluids, occasionally penetrating to the muscular tissue, causing much irritation and pain, and, when very numerous, producing dangerous fever and weakness. When full grown, the "bots" pass out with the excrement and burrow into the earth, from which the flies issue in six or seven weeks. The Sheep bot-fly (*Æstrus ovis*, Linn.) deposits its larvæ, already hatched, in the nostrils of the sheep, which immediately work their way into the nasal cavities and frontal sinus of the head and attach themselves to the walls, producing the disease known as "grub in the head," from which sheep so commonly suffer and not infrequently die. When these maggots are full grown they drop from the nostrils to the ground, beneath the surface of which they transform.

The Ox bot-fly (*Hipoderma bovis*, De Geer) is a similar, but larger species, which causes tumors on the backs of cattle, usually laying its eggs on parts which the creature cannot conveniently reach with its tongue. The larvæ, termed "warbles," burrow beneath the skin and cause very disfiguring and painful swellings.

The Tachina flies (TACHINIDÆ) are stout, dark-colored, bristly flies, which deserve to be held in the highest estimation on account of the parasitic habits of all the larvæ, which feed in the bodies of numerous destructive caterpillars and grubs, and greatly reduce the numbers of these pests. The small, oval, ivory-white eggs are laid, sometimes singly, sometimes two or three in a cluster, on the back of the caterpillar or other insect, often just behind the head, in order to be safe from the jaws of the victim. These eggs adhere so firmly that

it is impossible to remove them entire. The larvæ, immediately upon hatching, penetrate the skin of the insect and feed upon the non-vital parts, so that, as a rule, the infested specimen is able to enter the ground or to spin its cocoon before it is killed by the parasite. The transformations of the latter then take place, and the flies appear very shortly, or, in other cases, hibernate with the remains of their host and emerge in the spring, at the season when fresh victims are most numerous. Army worms and all cut-worms, various spinners and sphinxes, grasshoppers, the larvæ of the Colorado potato-beetles and many other pests are destroyed by them. See Fig. 38.

House-flies, blow-flies, etc. (*Muscidæ*). No family of insects are more familiar to us than the principal members of this group. At almost any season of the year the student can obtain a fresh specimen for examination, since many individuals of the common house-fly, and also of the meat-fly, contrive to secure winter quarters in our warm sitting-rooms and pantries. In these insects the greater portion of the head is occupied by the eyes, which are, in some species, quite brightly colored. The short antennæ are plummy<sup>d</sup> or sparingly bristled; the labrum is elongated into a jointed proboscis, terminating in a pair of broad, sucker-like flaps, which have their ridged inner surfaces closely pressed together when not in use, but are spread out when lapping up liquids, as may be easily observed in the House-fly. Other species have the proboscis terminate in minute lancets. The body is sparingly clothed with stiff hairs, and is either of a dull black and white or gray color, or, as in the "Blue-bottles" or green meat-flies, it is of a dark metallic blue or green. The wings are transparent, the legs rather stouter than in other flies and more or less hairy. The eggs are soft, pearl-white and slender-oblong, deposited singly or in little bundles or masses. The larvæ are soft, white or whitish maggots, some of them elongate-conical, thick and blunt at the hinder end and tapering to a point in front; others are slender and cylindrical; most of them have a smooth or somewhat ridged surface, but a few are hairy. Those of the House-fly (*Musca domestica*, Linn.) breed mainly in horse manure. Another species which also breeds in stables and barn-yards is the Lancet-fly (*Stomoxys calcitrans*, Linn.) It is scarcely to be distinguished from the common House-fly, except that when crawling or at rest the wings are held more apart and the proboscis is more slender and terminates in a point instead of a pair of fleshy lips. It bites severely and is very troublesome to horses and cattle, nor does it hesitate, upon occasion, to draw human blood. It is most abundant late in summer and in early autumn.

Still another plague of the herds has recently appeared in this country as an immigrant from Europe. This is the Horn-fly (*Hæmato-bia serrata*, Rob.—Des). From the accounts of Dr. Riley of Washington, and other eastern entomologists, we learn that it is a dark species, much smaller than the house-fly, but otherwise much like it, which has the habit of settling in swarms on the necks, shoulders, and around the bases of the horns of cattle. It punctures the skin with its horny beak and draws the blood, so worrying the poor animals that they become reduced in flesh, and cows fail to give the usual quantity of milk. The flies lay their eggs on the fresh droppings of the cattle, in which the larvæ breed.

The large hairy "Blue-bottle" fly (*Musca cæsar*, Linn.), and the smaller Green "Meat-fly" (*Caliphora erythrocephala*, Meig.), are well-known species which give much trouble to meat dealers and house-keepers.

The Screw-worm fly (*Lucilia macellaria*, Fabr.) has occasionally proved fatal to human life by laying its eggs in wounds or in the nostrils of persons who were sleeping in the open air. It occurs in the South-western States, where it is a great plague on cattle.

The family TRYPETIDÆ includes a number of very pretty flies, which have the wings variegated with smoky-brown spots and bands. Many of these flies are gall-makers on various weeds, and are not especially injurious. One, however (*Trypeta pomonella*, Walsh.), is the parent of the Apple maggot, which has, in some of the Eastern States, proved very destructive to apples, rivaling, and in some instances exceeding, the damage done by the Codling moth.

The Onion fly (*Tritoxa flexa*, Wied.) is sometimes quite injurious to growing onions. It has dark, oblong wings, crossed by three curving white bands. It is now placed in the family ORTALIDÆ.

In the PIOPHILIDÆ we find the Cheese fly (*Piophila casei*, Linn). The family DROSPHILIDÆ includes several small species that attack ripe and preserved fruits. In OSCINIDÆ are a few species injurious to growing grain. *Meromyza americana*, Fitch., burrows in the tender stalks.

A third Sub-Order (P U P I P A R A) has been grouped with the more lowly organized Diptera, although the usually minute insects composing it are not much like the typical flies. These are the Sheep-tick (*Melophagus ovinus*, Linn.) and the Horse tick (*Hippobosca equina* Linn.), which is the only winged species. Others, very minute, are the Bat-ticks and Bee-lice.

The Fleas also have many affinities with flies, and may here be considered in connection with them; yet most authors now class them in a

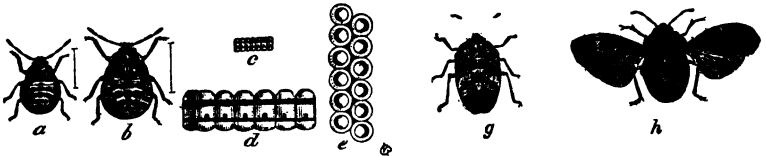


small separate Order—SIPHONAPTERA. They are hard, thick, wingless creatures, having the body compressed at the sides and sparsely hairy. In place of the usual compound eyes they have two ocelli. The pointed head is armed with backward pointing teeth. The legs are stout, with the thighs greatly thickened, giving them their wonderful leaping power. The eggs are scattered about in untidy human dwellings, dog kennels and the like, and the slender maggot-like larvæ feed in the dust and organic particles that accumulate in the cracks of floors, under rugs and similar hiding places. When ready to transform the larvæ enclose themselves in silken cocoons. The human flea is *Pulex irritans*, Linn., while *P. canis*, Dug., affects the dog and cat. The tropical "jigger," "chigoe" or "chique" (*Sarcopsylla penetrans*) is the pest of hot, sandy regions, but must not be confounded with a small tick—a species of mite—that occurs further north, and also burrows into the skin and causes sores, and which is likewise often called a "jigger."

## CHAPTER XXIV.

### Order V. HEMIPTERA.

[Fig. 40.]



Harlequin Cabbage-bug (*Murgantia histrionica*, Hahn.—after Riley. a, b, larva and pupa (nymphæ); c, eggs natural size; d, e, same magnified; g, h, perfect bug.

This Order derives its name from a compound Greek word signifying *half-wing*, and refers to the half membranous, half-leathery (coriaceous) structure of the wings of many of the representatives. It contains the only insects that may, with perfect accuracy, be called *bugs*. The term "bug," so generally but incorrectly applied to many kinds of insects, is supposed to have had its origin in the word "bug-bear," as something frightful or dangerous, and it is most fitting that, correctly used, it should refer to the division which includes such insects as the bed-bug, louse and similar objects of dread and disgust.

The insects of this Order display great differences of form and habit, but as all subsist solely on liquid nourishment, extracted from living plants or animals, all the principal representatives agree perfectly in the structure of the mouth. This consists of a strong, three or four-jointed beak, which is a modification of the under lip into a channeled brace in which rest two pairs of very fine bristles, corresponding to the two pairs of jaws, the combination being an admirable arrangement for piercing and sucking. (In some of the more lowly organized members of this Order, there is no horny-jointed beak, but the front of the head is merely elongated, forming a sucker-like cup provided with minute biting organs.) The upper lip (labrum) is consolidated with the lower part of the face to form a strong support to the developed mouth parts. The eyes are large and round, in some cases brightly colored, and two ocelli may be distinguished in many species. The antennæ are usually thread-like or bristle-like, in some cases quite long, with the terminal joints slightly enlarged.

In their general form the Hemiptera are among the most variable of insects. Some have the body almost hemispherical, others are thick and square or oblong, while others still are very long and slender. There is no general plan on which the joints of the thorax are developed, some having the pro-thorax crowded down out of sight from the upper side, while in others it is very large and conspicuous. The meso-thorax is usually the least variable division, except as to the scutellum, which is sometimes so large as to extend backward almost to the tip of the abdomen. The six legs are always present and the feet are three-jointed; some terminate in a very distinct claw or pair of claws with cushions (*pulvilli*) between them, while in others these appendages cannot be distinguished. The upper wings, sometimes termed *hemelytra*, in the typical bugs lie flat upon the back, the transparent or translucent tips overlapping, appearing as though crossed in the middle. In other forms they are altogether membranous or coriaceous, and fold roof-like over the body.

In this and the remaining Orders the transformations are usually *incomplete*, the pupa being as active and as voracious as the larva or the perfect insect. These Orders are termed *inferior*, not only on account of the less distinct metamorphosis, but also because of the many lowly organized forms which they include.

Hemipterists are not agreed as to the primary subdivisions of the Order, some finding it more convenient to consider the various forms under *three* Sub-Orders, while others find it necessary to define *five*.

As two of these include but few species of general interest, we shall here consider but three:

- I. True Bugs (Sub-Order HETEROPTERA).
- II. Harvest-flies, Leaf-hoppers, etc. (Sub-Order HOMOPTERA).
- III. Lice (Sub-Order PARASITA).

---

## CHAPTER XXV.

### Order HEMIPTERA. Sub-Order HETEROPTERA.

#### PRINCIPAL FAMILIES OF TRUE BUGS.

[Fig. 41.]



Rapacious Soldier-bug (*Reduvius raptatorius*, Say.)—after Riley.

The insects in this Sub-Order always have the head horizontal—namely, on a plane with the body, with the beak arising from the front. The form of the head is somewhat flattened and triangular, attached to the thorax by a broad base or by a very short neck. The thorax from above does not present any striking peculiarities, except in the varying size of the scutellum; on the under side, however, of a large majority of the species are two small openings, connected with an internal scent gland that emit a vile and persistent odor—one of the chief characteristics of these insects, familiar to the farmer in the smell of the chinch-bug and squashbug, and to the housekeeper in that of the bedbug. The wing-covers show considerable variety in coloring and in the relative size of the opaque and transparent portions. The hind wings are veined somewhat like those of beetles, and afford no characters used in classification. The eggs of many bugs are conspicuous for their beauty, making amends, in some measure, for the deficiencies of most of the perfect insects in this respect. Some of them can only be compared to strings or clusters of tiny beads of the purest gold; others are bronzed or reflect prismatic colors; others, again, are remarkable for their graceful shapes or for their elaborate ornamentation in what appears like filigree work. Instead of larvæ, the immature

bugs are termed *nymphæ*, and after the third molt the rudiments of the wings begin to show, there being two stages corresponding to the pupæ of the higher Orders. These nymphæ are often quite differently colored from the mature insects.

A convenient division of the Heteroptera is into three sections: Terrestrial bugs, Amphibious bugs and Aquatic bugs.

The Terrestrial bugs may be again divided into Plant-eaters and Cannibals.

Plant-eating bugs have a more slender beak than those that prey on other insects, or draw the blood of larger animals, but are otherwise not very different from them. The most important Families are: COE-EIDÆ, LYGÆIDÆ, CAPSIDÆ and COREMÆLIDÆ. Inclusive popular names are difficult to suggest for these groups.

The first of these families is best represented by the well-known Squash-bug (*Anasa tristis*, DeGeer). (See bug on plate.) This is a medium-sized, oblong, dingy-brown insect, paler beneath, with the head marked on top with two dull black stripes. The antennæ are about half the length of the body and rather stout; the feet are three-jointed. The young are dull green or yellowish, much broader in proportion than the perfect insect. This is one of the most universal and serious pests of melon, cucumber and squash vines. Some very large and striking species belonging in this family occur in the Southern states.

The LYGÆIDÆ is a large group of rather small bugs which are gaily or contrastingly colored, among which we find the pernicious Chinch-bug (*Blissus leucopterus*, Say). Few farmers, especially in the Western States, have escaped a costly acquaintance with this insect, which is one of the chief enemies of cereal crops, particularly of wheat and Indian corn. The perfect bug is of oblong form, about one-eighth inch in length and of clear black and white color. The yellow eggs are laid in the spring upon the roots or base of the stalk of wheat or other grain, and from these hatch myriads of pale-red young, which by their punctures soon dwarf and deaden the plant. Although the perfect insects have ample wings, they seldom rise into the air, and mostly perform their emigrations from field to field on foot. The false Chinch-bug (*Nysius destructor*, Riley) is rather smaller than its namesake, and less strikingly marked, being of a shaded grayish brown color. It is very injurious in certain sections of the country to grape-vines, potatoes, radishes and a number of other plants.

As the most familiar example of the family CAPSIDÆ, the Tarnished Plant-bug (*Lygus lineolaris*, Beaur.) may be instanced. This species is one-fourth inch in length, of flat, oblong form, with four-jointed antennæ, the joints being long. It varies in color from yellowish gray to

ochreous brown, has a yellow V-shaped mark on the scutel, and two or three parallel dark veins on each wing cover. The larvæ of these bugs are green, and broad oval in form. They may be found during summer in great abundance in all stages of development upon flowers. They injure fruit trees in the spring by puncturing the leaf and flower buds and the tender twigs and sucking the sap. They also feed on berries, to which they impart a flavor as nauseous as their odor.

Another abundant member of this family is the Four-lined Leaf-bug (*Pæcilocapsus lineatus*). This is somewhat larger than the preceding species, is of a deep yellow color, ornamented with four black lines, extending the whole length of the body. It feeds on various shrubs and herbaceous plants, and is at times seriously destructive to currant bushes, clover and other valuable plants.

The CORIMELÆNIDÆ contains but a single genus, the "Negro-bugs" (*Corimelæna*), small, shining, almost round, beetle-like insects of a black color, sometimes with bluish or greenish reflections. The great peculiarity is the depth of the scutellum, which extends backward so far as to entirely cover the wings. These little bugs are sometimes very destructive on strawberry beds and on the foliage of various flowering plants. They also have a great predilection for ripe raspberries, to which they give their own disagreeable, bed-buggy odor and flavor.

Among the cannibal bugs the most important families are the PENTATOMIDÆ, REDUVIADÆ and ACANTHIINÆ.

In the first of these groups we find many species of flattened, short, oblong bugs, somewhat under medium size, having the large scutellum extended backward in a rather slender point. The head and pro thorax together form an obtuse angle, there being no constriction to form a neck; the antennæ are five-jointed and the thighs are but slightly broadened and not spiny; the beak is stout. Although the great majority of the species are predaceous, and rank among useful insects, we find among them one serious pest. This is the Harlequin Cabbage-bug (*Murgantia histrionica*, Hahn.), a notorious exception to the rule, being very destructive, in the Middle and Southern States, to the vegetable from which it gets its popular name. It is a handsome insect, as bugs go (See Fig. 40), of a polished black color, with the scutel margined and the wing covers crossed by stripes of bright red or orange, and with two distinct white spots on the head; beneath, it is marked by lines of yellow dots. Dr. Riley says the eggs "may be likened to little barrels, for though the sides are straight, the edges are rounded off, and the black bands recalling the hoops, and a black spot near the middle recalling the bung-hole, add to the resemblance."

The larvæ, or young nymphæ, are pale green, marked with black, while those more mature show some of the colors of the perfect insect and have large wing-pads. The development is very rapid, often requiring not more than two weeks from the egg to the mature insect. It attacks not only cabbage and other cruciferous plants, but sometimes injures peas and other vegetables.

The other members of this family make amends for the injuries done by this one. Among them we find the Spined Soldier-bug (*Podisus spinosus* Dallas), long celebrated as a most persistent enemy of the Colorado Potato-beetle. This insect is of a dull green, and is chiefly characterized by having the sides of the pro-thorax produced into sharp spines. The beak is so strong that the habit of the bug, even when very young and small, is to impale the beetle larva or young caterpillar upon the end of it, and hold it up in the air while sucking out the fluid contents of the body.

The REDUVIADÆ are fiercely predaceous and destroy great numbers of other insects, and are thus directly of the greatest benefit to the agriculturist. They are more slender and elongate in form and of harder texture than the members of the preceding family, and some are rather elegantly colored. The strong, horny beak is folded under against the breast when not in use. The legs are stout in some species, somewhat bristly, but seldom toothed or spined. Some of the species are more than an inch in length, but the majority only about half that length.

The Wheel-bug (*Prionidas cristatus*), which is quite common in the more southern States, is one of the largest and most formidable species. It is of a shaded gray color, and has a curious notched crest on the pro-thorax, which resembles a section of a cog-wheel—whence its popular name.

The young bugs are bright red, with black markings. They are most ferocious, and Mr. Glover says: "They kill their prey by inserting into it the proboscis, which ejects a most powerful poisonous liquid into the wound. The victim, thus pierced, dies in a very short time. They then leisurely suck out the juices and drop the empty skin."

They attack all kinds of caterpillars and grubs, and even destroy one another at times in true cannibal fashion.

The Blood-sucking Cone-nose or Big Bed-bug (*Conorhinus sanguisugus* Lec.) is sometimes found hiding in beds and stuffed furniture, and does not hesitate to attack the rightful occupants, upon whom it inflicts very painful wounds. People have been known to die from the effects of its venomous stabs. It is about an inch in length, black margined all around with short red dashes.

A similar but more plainly colored species has been named by Prof. Comstock the Masked Bed-bug hunter (*Opsicætas personatus*), from its habit of preying on the genuine bed-bug. It is an European species, but a variety is also native to the Eastern States. The young secrete all over the surface a viscid fluid to which dust and particles of wool and feathers adhere, giving them a most singular and disguised appearance. The Rapacious Soldier-bug (*Reduvius raptatorius*, Say.) is a slender, rather graceful bug with a long narrow head, and stout raptatorial front legs. The sides of the thorax are sharply angled. (See Fig. 41.) It preys on all soft-bodied insects. Of similar form and habits is the Many-banded robber (*Milyas cinctus*, Fabr.), which appears in yellow, black and white colors.

The family ACANTHIINÆ, is represented by a single species of the worst repute—the mal-odorous and cosmopolitan bed-bug (*Acanthia lectularia*, Linn). Few people are so happy as not to have made the acquaintance of this annoying insect, if not in their own well-kept chambers, at least in those of hotels and boarding houses, from which it can only by the greatest care be excluded. It is of flat, broad-oval form and red-brown color, about one-fifth of an inch long. It never acquires wings, and the perfect bugs can only be known from the young by their larger size, darker color and very minute rudiments of wing covers. It is strictly nocturnal, and hides by day in the smallest cracks and crevices. It is capable of enduring long fasts, and it is said will recover its vitality after being imprisoned for many months without food.

A solution of corrosive sublimate in alcohol is the most certain remedy in infested rooms and on bed-steads. Benzine and kerosene are also much used, and by dusting the sheets with pyrethrum powder, travelers may obtain a night's rest even in infested rooms. This bug is said to occur in myriads under the dead bark of certain trees in the far west, although, if animal fluids be necessary to its development, it is difficult to imagine on what it can feed under such circumstances.

There are several families of amphibious bugs which are chiefly interesting from their adaptation to walking lightly on the surface of the water, or in marshy spots, without having the feet broadened or any sail-like or oar-like processes to aid locomotion.

The Water-striders (HYDROBATIDÆ) have the middle and hinder legs very long, the bodies slender and flattened, and no distinct scutellum. They are predaceous in habit, and leap into the air after the small flies and gnats on which they subsist.

Among the Aquatic bugs are the Water scorpions and Giant water bugs (NEPIDÆ), where we find some species that exceed in size all

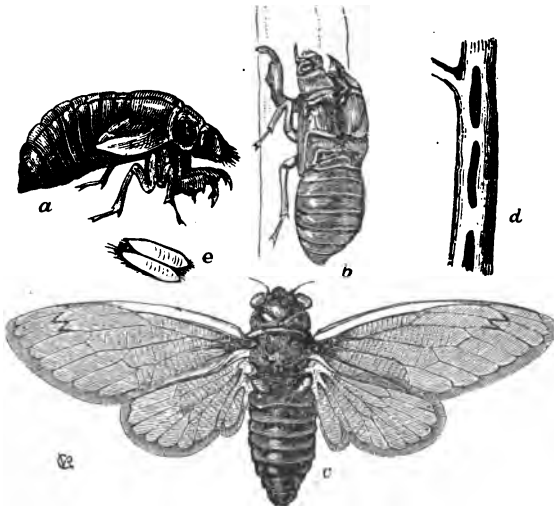
other species of the Order. They possess oar-like legs and flat bodies. The species are all carnivorous and are provided with strong, sharp beaks, upon which the bodies, not only of other insects, but of tadpoles and young fish, are impaled until they can be drained of the vital fluids. The Water scorpions are of slender form, and the abdomen is terminated by a pair of long, slender, grooved styles, which, when shut together, form a breathing tube that can be elevated above the water, while the insect is making its predatory excursions beneath the surface. The Giant water bug (*Belostoma grisea*, Say.) is more than two inches in length, by one in width, with a flat, boat-shaped body and powerful swimming legs. It also flies long distances, and is often attracted in great numbers to electric lights. The Back-swimmers (NOTONECTIDÆ) swim in a reversed position, and have very long, feathery hind legs.

CHAPTER XXVI.

Order HEMIPTERA. Sub-Order HOMOPTERA.

CICADAS, LEAF-HOPPERS, PLANT-LICE AND BARK-LICE.

[Fig. 42.]



17-year Cicada (*C. septendecim*, Linn.), after Riley. a, pupa or nymph; b, shell of same; c, perfect Cicada; d, punctures in twig made for the eggs; e, eggs, much magnified.

In this division of beaked insects we find the wings—where these organs are present—of the same texture throughout, and closing roof-



like over the body. In several large groups they are transparent, and supported by many or few strong veins; in others they are tough and opaque, and show many different colors. The head is broad, but usually very short, without any neck, and has the beak arising so far under that it seems to be attached to the breast, against which it may be closely folded. The eyes are round and prominent. The antennæ in the larger species are very inconspicuous, but in the more minute forms are long, and often beautifully feathered. Some species are provided with a strong, horny ovipositor by which the eggs are inserted into woody stems or branches of trees; others place their eggs on exposed surfaces, or under loosened bark.

The most important families of homopterous insects are the CICA-  
DIDÆ, MEMBRACIDÆ, JASSIDÆ, APHIDIDÆ and COCCIDÆ.

In the first of these families we find the large and noisy Harvest-  
flies or Dog-day flies (genus *Cicada*). They have an oval form, with the body enclosed in a firm, shelly crust, head as broad as the thorax, protruding eyes, with three distinct ocelli between them, and the antennæ are short and awl-shaped or end in a sharp-pointed bristle. The feet are three-jointed; wings large and glassy; abdomen of the females bearing an ovipositor which rests in a fissure on the under side of the abdomen, and is adapted for sawing and boring into hard wood. The males have a most ingenious musical apparatus for producing the deafening buzzing or "drumming" with which our shade trees and groves resound from early summer until autumn. These instruments are little membranous sacs, which are gathered into fine plaits and fit over cavities at the base of the abdomen. The sound is produced by rapid expansion and contraction, by means of strong muscles within that part of the body.

The most interesting of these insects is the Periodical or Seventeen-  
year Cicada, or "Locust"—incorrectly so-called—(*Cicada septemdecim*, Linn.) see Fig. 42, which enjoys the distinction of being the longest-lived insect known to entomologists. The perfect cicadas are of a dark brown or black color, with red eyes and glassy, orange-veined wings, beneath which are situated the "drums," whose sound is thought by some to be the word "Pharaoh," very much prolonged.

These singular insects appear in the same locality only once in seventeen or thirteen years—the development in the Southern States being somewhat more rapid than in the Northern States. Their life, as perfect insects, is comparatively brief, lasting not more than five or six weeks. The females saw numerous consecutive, longitudinal slits in the branches of fruit and forest trees, often severely injuring the trees in the process. The young hatch in the course of a few weeks

and drop to the ground, into which they burrow and where they remain, descending deeper and deeper year by year, feeding on the rootlets of trees and growing very slowly, until ready to change to pupæ, when they begin to ascend. The pupa is active, and after emerging from the ground crawls to the trunk of some tree or shrub, to which it clings with its spiny claws, while the perfect cicada emerges. As these pupa shells retain their form, except for the slit on the top, through which the imago escaped, they are often mistaken for dead "locusts," and it used to be a popular superstition that they "sang until they burst." They appear in May or June.

The annual Dog-day or Harvest-flies, of which there are but two or three, not very distinct species, in this country, develop about mid-summer, and sing late in the afternoon and in the twilight, until frost. The most common species is somewhat larger than the seventeen-year species, of a green and black color, having the body thickly covered by a whitish powder or "bloom," from which circumstance it received its name, *Cicada pruinosa*, Say.

The Tree-hoppers (MEMBRACIDÆ) are rather small insects, but among them are some of the most singular and grotesque forms of animate life. The pro-thorax is the part most subject to variation. This often extends backward almost to the tip of the abdomen, or the front edge is prolonged into a horn that curves far over the head.

The Buffalo Tree-hopper (*Ceresa bubalus*, Fabr.) exhibits in its form a variety of triangles; in front, on top, and on each side, one or more of these geometric figures can be traced. It is of a dull green color, nearly one-half inch in length, and the female often does considerable damage to the tender twigs of fruit trees by the numerous slits which she saws in them for the reception of her eggs.

Among the Leaf-hoppers (JASSIDÆ) are a number of small, but very destructive species. These insects have oblong forms, long wings, often beautifully colored, a rounded pro-thorax and a triangular head. A few are about one-half inch in length, but the greater number are very small. The Grape-vine Leaf-hopper (*Erythroneura vitis*, Har.), commonly but erroneously called "Thrips," frets the leaves of the vine with innumerable punctures until they turn brown and wither. These insects are often so numerous late in summer that they leap off in clouds when the vines are shaken. Other species are injurious to roses, growing grain and grass.

The Plant-lice (APHIDIDÆ) are a very comprehensive and interesting class of insects. They range from small to exceedingly minute, but make up in numbers what they lack in size, and include some of the most destructive pests known to the agriculturist. They are soft-

bodied and gregarious, and most numerous in the wingless forms. The eyes are usually quite large and of a dark color, and the antennæ of many species long and thread-like; the beak is two-jointed, and in some cases as long or longer than the body; legs, in the leaf-feeding species, rather long and slender, but in the root-feeding and gall-inhabiting forms short and stout; wings thin and transparent, with dark veins on the anterior margin. Near the tip of the abdomen, on the back, many species have a pair of little tubes through which exudes a sweet fluid, sometimes in such quantities as to thickly besprinkle the plants infested. This is then termed "honey dew," although the genuine "honey dew" is an excretion from the leaves of certain plants during dry, hot weather. Ants, as is well known, are extremely fond of "aphis nectar," and induce the insects to yield it in large quantities by caressing them with their antennæ, for which reason they are called the "ants' cows." Other species of aphides excrete from a part or the whole of the surface of the body a whitish powder or "bloom," or numerous filaments of fine, cottony matter, in which they become completely enveloped. The reproductive processes of aphides are very complicated and remarkable, and have been the subject of much careful study and experiment. Our knowledge in regard to them may be briefly summarized as follows: At certain seasons of the year—usually late in summer or early autumn—individuals of both sexes are produced, and the females lay eggs, which in some species hatch immediately, in others remain dormant over winter. The sexed aphides were formerly supposed to be the winged form, but later discovery shows that there is not necessarily any connection between the possession of wings and of true sexual organs, the wings being simply an adaptation for migration from one locality or plant to another. The form hatching from the egg is denominated the "stem mother," and in the course of a few days begins a peculiar process of reproduction, called *parthenogenesis* or *agamis* reproduction, bringing forth her young alive and in very rapid succession. This process has been likened to the multiplication of certain kinds of plants by slipping and budding. The offspring of the "stem mother" begin, in their turn, to produce viviparously in the course of a few days, and in this way the multiplication of individuals proceeds at a most extraordinary rate. Fortunately for the safety of vegetation, plant lice have a variety of natural enemies. They may also be destroyed by alkaline applications, tobacco smoke or infusion, or kerosene emulsions. Poisons such as Paris green or London purple do not have much effect upon them, as they do not eat leaves, but puncture them and extract the sap from beneath the cuticle.

Among the excessively injurious species of Aphides may be mentioned the Grape *Phylloxera* (*P. vastatrix*, Plan.) which has caused such wholesale destruction of the vineyards in France and other European countries, and prevents the cultivation of many choice varieties of grapes in this country. This species occurs in two forms, one inhabiting warty galls on the foliage, but the most destructive form occurring on the roots, which it causes to decay. This species and its allies do not produce the young alive, but always by means of eggs. Another root-louse, belonging in another family, is the Woolly louse of the apple (*Schizoneura lanigera*, Hausm.) This also sometimes appears above ground on the trunk of the tree, and is one of the species that clothes itself in a cottony or woolly excretion.

The Hop Aphid (*Phorodon humuli*) often occasions great loss in hop-yards, and Dr. Riley has made the interesting discovery that in autumn the winged migrant form resorts to plum trees and there produces the sexed individuals whose eggs hibernate on the plum, on the leaves of which the first spring generations feed, becoming winged early in summer and again returning to the hop-yards. The largest species are found on the hickory and sycamore trees. These belong to the genus *Lachnus*, and when thickly congregated on the trunks and branches are a most repulsive sight. Some species, especially those of the genus *Pemphigus*, cause very singular galls on trees of the poplar and willow family. As nearly all aphids are more or less injurious, it is out of the question to attempt here to give a list, even of those that are serious pests.

In the family COCCIDIDÆ are grouped the Scale-insects or Barklice, the Mealy-bugs and a few similar forms, which rival the members of the preceding family in rapidity of increase, in injurious effect upon the plants attacked and in the difficulty with which they are eradicated or even kept in check. In these insects only the males undergo transformation, protected by a small larval scale. They acquire wings, two in number, very transparent and with only one or two veins. The antennæ are long, and, under the microscope, are seen to be many-jointed and hairy or plumy. The mouth parts are undeveloped, and in their place we find a second pair of eyes. The females never acquire wings, and most of the species become fixed in one spot very shortly after hatching, the long but extremely fine beak penetrating to the sapwood of the tree or shrub infested and slowly imbibing the sap required to perfect the growth and development of the insect. Immediately upon becoming fixed the surface of the body exudes a waxy substance that very soon forms, together with the mottled skins, a complete shell or scale over the body. After being visited by the winged male, the

eggs begin to form and soon fill the body of the mother insect. Upon hatching, the very minute lice creep from under the scale and disperse with great activity all over the tree or branch, from whence some are carried by birds and insects, or are wafted by the wind to other trees, and in this way they are disseminated from one orchard or vineyard or grove to another. Besides the waxy scale, some species excrete a great quantity of white, cottony matter, as a protection to the eggs. This substance is arranged in various forms characteristic of the species.

Among the coccids that form simple scales is the widely-distributed Oyster-shell Bark-louse of the apple (*Mytilaspis pomonum*, Bouche.) This species covers the branches and trunks of trees with its pale brown, somewhat oyster-shaped scales, beneath which are the females, each with its almost invisible beak penetrating to the growing wood and extracting sap in such quantities as to retard the growth of the tree, and reduce the quantity and impair the quality of the fruit. The young are hatched late in spring, and are active for a few days only. Alkaline washes or kerosene emulsion applied at this time are most effectual in preventing their increase. They have a few natural enemies in the shape of Coccinelid beetles, Lace-wing fly larvæ and one or two minute parasitic flies. Two similar scales of other species are found in the South on orange trees. Several species of white scales (*Chionaspis*) are also found on apple, pear, pine and willow. A smaller, white, scurfy scale (*Diaspis*) is sometimes very abundant on the stems of roses, blackberries and raspberries. The scale insects most troublesome in green-houses and on house-plants, and occurring also on the orange, belong to the genus *Aspidiotus*. Among the scale insects that produce cottony masses is *Pulvinaria innumerabilis* (Rath.), which appears in great numbers on grape vines, and especially on maple and elm trees, covering the bark with its masses of flocculent matter and honey-dew like excretions, greatly disfiguring and injuring vines and trees. The orange tree is especially subject to the attacks of scale insects; and one of these, the Fluted scale (*Icerya purchasi*), seriously threatened the existence of the groves of California, until Dr. Riley happily discovered its chief natural enemy in Australia, from which country the scale had been introduced, and secured the importation of the useful Lady-bird beetle, which in about two years has almost exterminated the particular species of pest on which it naturally preys.

The Mealy bugs (*Dactylopius*)—especially troublesome on house-plants and in green-houses—while agreeing with the scale insects in many particulars, do not secrete scales and the females do not become fixed in one place. The bodies are covered with a white powdery

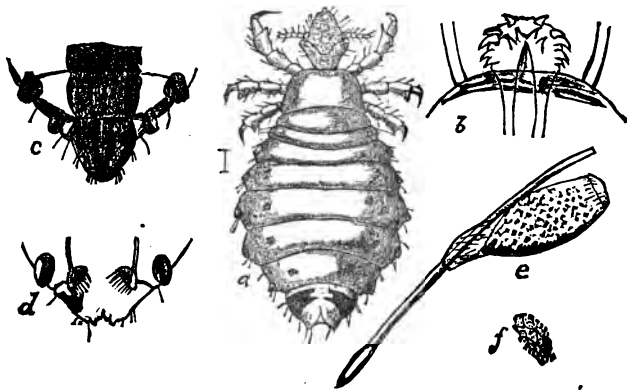
matter, with short filaments around the anterior end and sides and several long ones at the tail. One of the Coccidæ (*Coccus cacti*) is the insect so well known as "cochineal," which, until the invention of the aniline dyes, was the source of the beautiful red and crimson colors so much used in the manufacture of textile fabrics.

CHAPTER XXVII.

Order HEMIPTERA. Sub-Order PARASITICA.

HUMAN AND CATTLE PARASITES.

[Fig. 44.]



The Short-nosed Ox-lice (*Hematopinus eurysternus*) after Osborne. *a.* female; *b.* rostrum (beak); *c.* under surface of last joint of male; *e.* egg; *f.* surface of egg, all greatly magnified.

In this Sub-order we find the most repulsive and annoying of all insects—the true parasites of mammals, not excepting man. The general structural characters are depicted with great exactness in the illustration, Fig. 44.

The true lice are all very small insects, which never acquire wings. They remain close to the skin and suck the blood of the animals infested, causing great discomfort and irritation by their presence and their innumerable punctures. They are the result of neglect and squalor, and on cattle and horses indicate a very unthrifty physical condition. The proboscis is merely a fleshy prolongation of the front of the head, at the end of which are a pair of extremely sharp lancets, which are retracted within the head when not in use. At the base of these, as shown at *b*, in the figure, is a rosette of sharp, recurved hooks, which,

when the insect is feeding, are thrust into the skin to support the lancets. The eyes are simple and very small, and the antennæ very short and minutely bristly. The legs have thick, short, notched joints and end in a strong curved claw, that when closed down, meets a little tooth on the shank—a provision for clinging to and climbing hairs. There are no transformations. The eggs are called "nits," and are firmly glued at one end to the hairs.

Three species attack man under certain external conditions of poverty and uncleanness, namely: The Head-lice (*Pediculus capitis*), which is confined to the hair and skin of the head, and is most frequently found on neglected children; the Body-lice (*Pediculus vestimenta*), which hides in the seams and folds of the clothing, and draws the blood from any part of the body; and the Crab-lice (*Phthirus pubis*), which attacks the arm pits and pubic region. These pests commonly aggravate the miseries of military prisons and camps and other situations where human beings are congregated without provision for cleanliness and lack nourishing food. Mercurial ointment is the best remedy, with entire change of clothing, where possible.

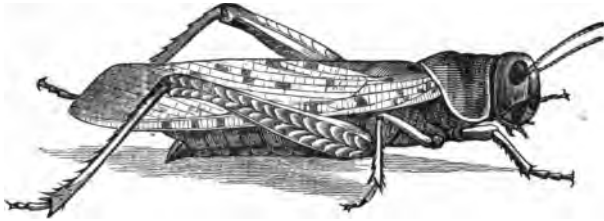
The true lice that are sometimes found on thin and neglected horses, cattle, swine and other animals, differ very slightly from those found on man. They are placed in the genus *Hematopinus*. Strong infusions of tobacco or of larkspur seeds are among the remedial washes, also an ointment of kerosene and lard, thoroughly mixed; but the experiments of Prof. C. P. Gillette, of Colorado, have demonstrated the superiority of that valuable insecticide, the ordinary kerosene emulsion, over every other preparation, in ridding animals of these pests. Dr. Riley, whose invention it was, says of it: "It has long since become recognized as an insecticide of unrivaled merit, against most of the insect enemies of plants, and also in the case of animals, as a means against the Buffalo-gnat, Horse-fly, etc. \* \* \* The only precaution necessary with this substance is to see that the emulsion is properly made, and that in winter time the animal be protected from severe cold."

There are certain other kinds of lice occasionally found on cattle, belonging to the same group with chicken-lice, bird-lice and so forth, which, although they bear considerable resemblance to the true lice, are structurally very different and form a low sub-order of the Neuroptera. The remedies for these are the same as for the more common species.

## CHAPTER XXVIII.

## Order VI. ORTHOPTERA.

[Fig. 45.]

Old World Migratory Locust (*Pachytylus migratorius.*)

In this Order of so-called *straight-winged* insects we find many unusually interesting species. Geologically and historically they are the oldest of insects. In the stratified rocks their remains are found among the very earliest forms of animal life; while the "locusts," so frequently mentioned in the Old Testament, and in equally ancient secular history, as suddenly swooping down upon a country and "devouring every green thing," are among the typical representatives. Excepting the Cicadas, described in a preceding chapter, we find among the Orthoptera the only insects provided with a special musical apparatus, each species having its own peculiar instrument and contributing its characteristic notes, called *stridulations*, to the insect concerts that enliven the summer days and nights. Many of the most singular imitative forms that occur in nature are also found here in the "walking sticks" and "walking leaves" that compose one of the groups; and by many other peculiarities of structure and habit the Orthoptera challenge attention from the student of pure science, the lover of nature, and the economist.

The straight-winged insects are nearly all of a size to be examined without the aid of a microscope, and some forms have been considered superior to all others as subjects for dissection in the study of internal as well as external structure. While they exhibit much variation in form, all the more conspicuous species agree in the vertical position of the head, the biting mouth, the large pro-thorax, and the parchment-like wing-covers—when these organs are present.

The head is usually large, and though somewhat sunken under the pro-thorax in many species, is freely movable on the flexible neck. The eyes are round or oblong, and prominent in most species. The antennæ



are either short, stout and few-jointed, or very long and slender with an indefinite number of indistinct joints.

In these insects we find the mouth parts particularly well developed, and adapted for biting and masticating solid food. The mandibles are short, but broad and strong, with a toothed cutting edge; the maxillæ are adapted to the office of holding the food in place, in which the two pairs of mouth-feelers (palpi) assist; the lower lip (labium) forms the floor to the mouth, and the unusually long and broad labrum closes over the other mouth parts like a true lip, when the insect is not feeding. The pro-thorax only appears on the upper side of the body, and in a great majority of the species it is more or less saddle-shaped, often with a longitudinal ridge on top. There is much variation in the length, thickness and character of the surface of the legs, which are adapted for running, jumping, burrowing, grasping and other uses. The wing-covers are composed of strong membrane more or less thickened and opaque, in which the venation is peculiar to the species. They usually over-lap at the bases or for their entire length, and either lie flat upon the back or are concave, and enclose the sides also like a pod. The under wings are very broad, in many species composed of transparent, but closely net-veined membrane. A few kinds display in life various beautiful colors, which shortly disappear in cabinet specimens. When not in use these wings are folded in fan-like plaits and hidden under the upper pair. In the hind body we can count eight or nine distinct segments, attached to the last of which are the variously shaped claspers of the males, and the equally varied ovipositing organs of the females. On the under side of this part of the body the protecting crust seems thinner and more flexible than elsewhere, and expands and contracts with the inhalation and exhalation of air.

The Orthoptera are very voracious in all stages of their development, and while the majority feed on growing vegetation, others are predaceous, and a considerable number are serious household pests, on account of their preference for the contents of pantries and the offal of kitchens.

The transformations are incomplete, and the young differ from the mature insects even less than young bugs differ from those that have acquired the perfect form.

There is considerable confusion in the terms applied to some of the groups in this Order. Thus the true locusts are very generally called "grasshoppers," while the term "locust" is in this country applied to the Periodical Cicada. Again, all the more conspicuous forms included by entomologists among "grasshoppers" are not found on grass at all, but inhabit the tops of the tallest trees. Nor does this

inapt nomenclature occur only in popular language, for we find the *LOCUSTIDÆ* include only the green grasshoppers and other solitary species, while the genuine, often gregarious, and infinitely more destructive locusts are placed in the Family *ACRIDIDÆ*.

All the more important American species of *ORTHOPTERA* are found in six Families, namely: Crickets (*GRYLLIDÆ*); Green Grasshoppers and Katydid (*LOCUSTIDÆ*); True Locusts (*ACRIDIDÆ*); Walking sticks or Specters (*PHASMIDÆ*); Soothsayers, Devil's horses (*MAN-TIDÆ*) and Cockroaches (*BLATTIDÆ*). The first three Families form a section of the Order distinguished from their mode of progression as the Jumpers (*SALTATORIA*); the fourth Family includes the Walkers (*AMBULATORIA*); the fifth the Graspers (*RAPTATORIA*); the sixth the Runners (*CURSORIA*).

---

## CHAPTER XXIX.

### Order, *ORTHOPTERA*. Section, *SALTATORIA*.

#### CRICKETS, GRASSHOPPERS, KATYDIDS, AND LOCUSTS.

The jumping Orthoptera include all the musical and nearly all the injurious species, namely, the Crickets, Green Grasshoppers and Locusts. The Crickets (*GRYLLIDÆ*) are easily separated into three groups, Mole crickets, House and Field crickets and Tree crickets, each containing comparatively few species. They all agree in having somewhat cylindrical bodies, either short and stout or slender and elongate, and always terminate in more or less conspicuous stylets or a long, exserted ovipositor. The head is large, roundish, or obtusely triangular; eyes hemispherical, widely separated; antennæ long, slender and tapering; upper lip nearly circular, and the palpi, of which both pairs are well developed, are somewhat club-shaped. The pro-thorax is broad and of a firm, horny or shelly texture. The wings and wing covers, except in the Tree crickets, cover only one-half or two-thirds of the abdomen. The wing covers are of thick, leathery or mica-like membrane, with a peculiar ridged venation, by means of which their calls and chirps are produced. The legs vary in the development of certain parts to correspond with the habits of the species, but the hinder pair always have large thighs and more or less spiny shanks.

The Mole crickets do not jump, but are peculiar for their burrowing habits, and seldom emerge from their subterranean abodes until after nightfall. They are large, stout insects, of dull brown colors, and

have the surface thickly clothed with a soft pubescence—in this, as in many other particulars, imitating the genuine mole. In the fore legs all the joints are flattened and broadened, the tibiæ spreading out like the palm of the hand, and having on the lower edge four long, horny, finger-like processes, so that they are almost exact miniatures of the shovel-like fore feet of the animal from which they are named. These insects are usually found in damp soils, where their horizontal galleries are betrayed by the little ridges which appear on the surface of the ground. They feed upon roots and under-ground stems of plants, varying their diet by devouring any burrowing larvæ or exposed pupæ with which they come in contact in their tunneling operations. The most common Northern species is *Gryllotalpa boreales*, Burm, while in the Southern States *G. longipennis* is more frequently met with.

The House and Field crickets live in chimneys, stone walls and similar situations, or in holes in the ground. Modern methods in building have banished the "cricket on the hearth," whose cheerful chirp formerly blended with the cosy "song" of the tea-kettle, inspiring in poets and novelists some of their most beautiful thoughts on the comforts of home.

The House Cricket (*Gryllus domesticus*) is of a brown or grayish color, and is an immigrant from Europe and the far East. It is quite abundant in our eastern cities, but is not yet very generally disseminated over the country. The larger Field Crickets are black with brown wings, and the males of some species survive the winter and may be heard chirping during warm evenings early in the spring. They all belong in the same genus with the Mole and House Crickets, and show much variation in coloring and in the development of the wings. The eggs are deposited in masses of two or three hundred, but are not enclosed in a sac as are those of the Mole Cricket. The young hatch about midsummer and disperse in all directions, feeding on all varieties of vegetation, often proving quite injurious. The species of *Nemobius* appear later in the summer, are of a dull, pale brown color, sometimes obscurely striped, and in one or two species the wings are wanting, and the shelly elytra (wing covers) somewhat loosely enclose the body. The Tree Crickets are of more slender and delicate form, with broader and more glassy wing covers and long slender legs and antennæ. The males of *Æcanthus niveus* Har. and *Æ. latipennis* Riley are white or greenish white, the wing covers transparent, flat, and when closed, completely over-lapping and crossed by W-shaped ridges. When stridulating, these wings are elevated almost at right angles to the body and the surfaces rubbed together with a motion too swift to be followed by the eye, producing a metallic "whirr" that is incredibly loud and pierc-

ing in comparison with the size and delicate texture of the insect. The females are quite different in appearance, being slender and almost cylindrical, with the wing covers curving down at the sides so as to partly enclose the body. The ovipositor is slender but very strong and horny, nearly as long as the abdomen, and terminates in a blunt tip beset with minute points. With this instrument the female of *Cæ. niveus* pierces the young canes of grape or of raspberry, depositing in a row a considerable number of eggs. *Cæ. latipennis* forces hers into the pith of stems or into bark through a series of pinhole-like punctures from one-half an inch to one inch apart. The punctured twigs are invariably killed, and the insects occasionally do considerable damage; but as these crickets feed almost entirely upon aphides and other minute pests, they make ample compensation for all the injury that they do, and may be accounted beneficial rather than injurious.

The most æsthetically interesting insects among the *Locustidæ* are the "Katydid." The peculiar, interrupted stridulations of these little tree-top musicians have inspired many a poetic gem and dainty bit of imaginative prose. Nor are they merely favorites with the poets, who, for the most part, know them only by their notes; but the naturalist, who keeps them as pets, finds in their habits and histories most instructive and suggestive revelations of insect life. They are mostly of large size, and of a bright green color, in this assimilating closely to the foliage amid which they dwell. The large, free head is curiously like that of a horse; the eyes are round and bright, and of a yellowish-brown color; the antennæ are very long, slender and tapering; the various mouth parts are easily distinguished without the aid of a lens, and the processes of cutting and mastication may be closely observed, as the insects will often sit upon one's finger and nibble a leaf or bit of fruit in fearless enjoyment. The upper side of the pro-thorax is covered by a wide collar, which projects slightly over the head in front, and, posteriorly, overlaps the bases of the wings. In repose the wings meet on the back in an acute angle, and are more or less convex at the sides, to enclose the body. At the base they over-lap in a wide, flat triangle, the upper surface of one and the under surface of the other being peculiarly ridged and roughened to form the "taborets," which grate together as the insect raises and lowers its wings. These wing-covers display a venation imitative of that of leaves. The under wings are broad, composed of very delicate, finely-netted membrane, with green tips where they project slightly beyond the upper pair. The legs are slender, with the tibiæ slightly spiny and the tarsi ending in long, sharp claws. The hind legs are very nearly twice the length of the others. At the base of the tibiæ of the fore legs are peculiar oval cavities covered with

transparent membrane, which are supposed to be the seat of the sense of hearing. The bodies of the males terminate in conspicuous stylets or claspers, while those of the females bear a large sickle-shaped or sword-like ovipositor, composed of two thin blades, by means of which the eggs are inserted into bark or leaves, or are laid in over-lapping rows on thin stems or on the edges of leaves.

The true Katydid (*Oxypteryx concavus*) is the most robust-looking species, the wing-covers being oblong and very convex on the sides, almost meeting below as well as on the back. The taborets consist of mica-like plates, with very strong, peculiarly curving ridges. The Angular-winged Katydid (*Microcentrum retinervis*) has longer, narrower and less convex wings. The taborets are opaque, and the sounds produced resemble a metallic clicking sound, which has not been reduced by any imaginative listener to syllables. The Narrow-winged Katydid (*Phaneroptera curvicauda*) is a smaller, duller-green species, with a less noticeable note. It must be remembered that the males are the musicians of the family, although the females are capable of emitting a faint response by a sudden upward jerk of the wings.

Among the Grasshoppers are some long, slender, bright-green species which have the front of the head produced into a point. These are called the Cone-heads. *Xiphidium ensifer* is the largest species. The males produce the most deafening, continuous "whirr" of any of the tribe. The females have a long, straight, sword-shaped ovipositor, and in both sexes the wings are nearly twice the length of the body. The smaller and very graceful *Orchilimums*, which enliven the autumn days with their soft purring notes, belong also in this group.

The true Locusts (ACRIDIDÆ) are the species which live on grass, grains and other low-growing vegetation, and are in this country very generally called "grasshoppers." In this group belong not only the various dull-green and brown species that are so numerous every year in fields and pastures, and which in dry seasons become very injurious, but certain migratory species, which, having exhausted the food supply of the regions to which they are indigenous, by a common impulse rise into the air in clouds and sweep like a besom of destruction over the country. They fly by day and descend at night to feed, often traversing thousands of miles before reaching their limit. These are the only insects which have been used to any great extent as food, and this mainly in trans-Atlantic countries, where the famishing inhabitants of the desolated regions were forced to feed upon them or perish. The Rocky Mountain Locust (*Caloptenus spretus*, Thom.) is the most important American species of migratory locust; but one or two Eastern species manifest a like tendency, and during some years prove very destructive over limited areas.

The Locusts are robust insects, stouter in body and legs than the Grasshopper and Katydid, and are well protected by a firm leathery integument. The head is even larger in proportion to the body than in the preceding family. It is set vertically, in some species receding toward the mouth. The eyes are large and broadly elliptical in form; antennæ short and rather thick; the face is marked in many species by three distinct ridges; upper lip broad, with the lower edge somewhat hollowed out just above the jaws. The saddle-like collar over the back of the pro-thorax, or pro-notum, is marked by transverse indented lines, and rounds out over the insertion of the wings. Many locusts have on the pro-sternum, just under the chin, a cone-like projection sparsely covered with short spines or prickles. The wing covers are of stout, closely netted membrane, with a projecting ridge or heavy vein near the middle on the outside, or a series of prominent veins on the under side. They are of a narrowly oblong form and slightly overlap in a straight line on the back. The broad under wings are so folded as to be entirely covered by them. The legs are all stout, but the hinder pair, always much thicker, and generally much longer also, than the others, provide the leaping power which is so wonderful in these insects. The outer margins of the tibiæ are beset with a varying number of pairs of spines, and just at the base of the three-jointed tarsi are two pairs of jointed spurs. At the base of the abdomen on each side is an oval orifice covered with thin membrane, like those on the fore legs of the Katydid, and, like them, termed the *ears* or aural sacs. In the abdomen of the males nine segments can be perceived from the under side. The anal appendages are a pair of side claspers and an upward curving ventral plate. In the abdomen of the female but eight segments can be distinguished, and the tip has four horny, pointed blades, which can be brought together in a point to penetrate the soil, and afterward spread out to pry the earth apart and prepare a cavity for the reception of the eggs, which are extruded in a compact mass, inclosed in a sort of glutinous pod or case.

The stridulations of Locusts are effected in two ways by differing species. Most of the larger species "fiddle," by rubbing the ridged inner surface of the hind thighs over the prominent mid-vein of the outside of the wing covers. Prof. Comstock, quoting Mr. Scudder, who has made most exact and interesting studies of the so-called musical insects, says: "When about to stridulate they place themselves in a horizontal position, with the head a little elevated; then they raise both hind legs at once, and grating the femora against the outer surface of the tegmina, produce notes which in the different species vary in rapid-

ity, number and duration." Another method of "fiddling" characteristic of other species takes place during flight, when the under surface of the upper wings is grated back and forth over the front edge of the under wings.

These insects are probably all single-brooded, the young hatching in the spring from the eggs laid the previous summer and autumn. The very young locusts have much larger heads in proportion to their bodies than the more mature forms. There are five molts before the insect arrives at its perfect form. At the third molt the embryo wings begin to appear. These are in a reversed position with the under wings on top. By this peculiarity pupæ can always be distinguished from the few species of locusts that never acquire wings, but have these organs represented merely by short pads on each side of the abdomen. Examples of these wingless species are found in the Lubber Grasshoppers of the South and West, which are large, dark, clumsy species, incapable of flight or stridulation.

Our largest and handsomest species is the American Locust (*Acridium americanum*), which is often more than two inches in length, with a golden brown stripe down the back and beautifully mottled wings; the hind shanks are bright red, beset with spines, which are ivory-white tipped with black. There are red markings also on the head, thorax and edges of the wings, and the fore and middle legs are also a paler shade of the same color. The most common and generally distributed species is the Red-legged Locust (*Oaloptenus femur-rubrum* DeG.). This is scarcely more than one-third the size of the first-named species, is of a pale, greenish-brown with dull-red hind legs. It often multiplies to such an extent as to do great injury to growing grain.

The Rocky Mountain Locust, or Western Migratory Locust (*Oaloptenus spretus*, Thomas), is only to be distinguished from the familiar red-legged species by the greater length of its wing-covers and wings. Concerning the destructiveness of this species at irregular periods in the States and territories west of the Mississippi river, Dr. Riley, who has devoted much time and labor to the study of this insect, and to devising methods for keeping it in check, writes: "It was so very destructive in the Northwestern States and Territories from 1873 to 1877 that it may truly be said to have been one of the chief causes of the business crises which characterized that period. So wide-spread and disastrous were the results of its work that Congress provided for a commission to investigate it. \* \* \* No one who has not witnessed the ravaging power of locusts can fully conceive of or appreciate it. The organization and habit of the typical locust admirably fit it for ravenous work. Muscular, gregarious, with powerful jaws, and ample diges-

tive and reproductive systems; strong of wing and assisted in flight by numerous buoyant air sacs—all these traits conspire to make it the terrible engine of destruction which history shows it to have been. Insignificant individually, but mighty collectively, locusts fall upon a country like a plague or blight.”

The winged locusts do not generally appear in swarms until late in summer, when, after devouring all sorts of vegetation, the females fill the ground with their eggs and then die.

The young locusts, which hatch in the spring, are at hand to take the next crop, and unless vigorous and combined effort is made to subdue them, by repeated plowings, they take all the early vegetation of the second year. Those that survive to attain their wings return in small swarms to their native breeding places.

The species of *Edipoda* often have the hind wings brightly colored and prettily banded or bordered. The small species, termed Grouse Locusts, genus *Tettix*, are characterized by the prolongation of the collar backward so as to almost entirely cover the top of the abdomen and taking the place of the upper wings, which, being useless, are reduced to very small pads. In these insects the hind legs, though not long, are very stout. They are of dull black or dark colors, and are usually found along water-courses or in other damp places. None of the species are especially injurious.

---

## CHAPTER XXX.

Order ORTHOPTERA. Sections AMBULATORIA, RAPTORIA,  
and CURSORIA.

### WALKING STICKS, MANTES AND COCKROACHES.

The “Walking sticks,” “Walking leaves,” and so forth, included in the family PHASMIDÆ, are mainly tropical species, exhibiting in their forms the most exact and remarkable resemblances to twigs and leaves that have been observed in nature. These imitations of inanimate objects are the sole reliance of these insects for safety, as they have no means of defense against their enemies, and their movements are too sluggish to permit them to escape. The Walking sticks, of which a few species occur in the United States, are long, slender and cylindrical in form, with long legs, the middle pair having the thighs somewhat thickened. When at rest the front legs are pressed close together and



stuck straight out in front of the head, with the long thread-like antennæ between them, and when in this position the eye may rest for some time upon them without recognizing their difference from the twigs and leaf-stalks by which they are surrounded. They also have a chameleon-like power of changing their colors to assimilate with those of the plant or tree which they inhabit. They never acquire even the rudiments of wings, and the principal difference between the sexes is that the females are somewhat larger and stouter than the males. The former lay their eggs in the autumn, dropping them carelessly to the ground. They are about the size, shape and color of spinach seed, and remain unhatched until late the following spring, or for two years. The young, which are about one-fourth of an inch long when hatched, are precise miniatures of the mature insects, except that they are more uniformly green in color. They feed at first on grass and other low-growing vegetation, but soon ascend the nearest trees, in which they find a home adapted to all their needs. *Diapheromera femorata* is the only common northern species. This is, when full grown, from three to four inches long, exclusive of the front legs, with a diameter varying from one-eighth to one-fifth inch. It seldom appears in any locality in sufficient numbers to be accounted injurious, but there are exceptions to this rule, as, for example, in certain parts of the middle Atlantic states, where during one or two seasons some years ago it almost defoliated the forest trees.

The second section—Graspers (RAPTORIA)—contains the family MANTIDÆ. The singular forms and attitudes of these insects have suggested for them various expressive popular names, such as “Devil’s riding-horses,” “Rear-horses,” “Intelligence bugs,” “Sooth-sayers,” “Praying nuns” and the like. The English names “Camel-cricket” or “Praying mantis” are more appropriate, and worthy of general adoption. These insects have always been the objects of superstitious regard, not only by the ignorant and uncivilized natives of tropical regions, where their species are most numerous, but even by cultured, but too imaginative Europeans. It was formerly believed that they could foretell good and evil fortunes, and that the person on whom one alighted was especially favored of the gods, and they still receive divine honors from many savage tribes. They have indeed a wickedly-wise and weird look, to which their rapacious and cruel habits fully correspond. They are among the fiercest of cannibals, greedily devouring all kinds of soft-bodied insects, which they seize and hold between their spiny front legs until slowly masticated. They do not hesitate to attack each other, and when two chance to meet a battle is the almost invariable result. The females are stronger and more savage than the males, and after

pairing the former generally dines upon her partner. These insects are of large size—two inches or more in length. The head is triangular, free, very wide at the top, with large, round, singularly expressive eyes; antennæ thread-like and not very long; mouth at the apex of the inverted triangle; jaws strong, though small. The thoracic joints are cylindrical and elongated, and move freely upon each other; the fore legs (graspers) are not used for walking, but are folded and held up in a position suggesting the attitude of prayer, though it is really one of menace. The hind body is oval or oblong, somewhat flattened, and in the male completely covered by the folded ample wings, and the overlapping wing covers. The female has much shorter wings and wing covers, and is incapable of flight. The sexes differ also in color, the male being dull-brown while the female is usually some shade of green. This description applies to the only species commonly met with in the United States below the thirty-ninth parallel, namely, *Phasmomentis carolina*. The eggs are laid in a compact oblong mass, which closely resembles a fossil called a "trilobite." It is attached by its flat surface to fence-posts, the wood of trellises and the stems of shrubbery. These egg masses should never be destroyed, as the Mantes are very useful in clearing gardens and vineyards of plant-feeding pests.

The section CURSORIA, family BLATIDÆ, is represented by the disgusting and omnivorous household pests, the Cockroaches. These insects have no attractions of form or color, and have a disagreeable odor which they communicate to the closets and rooms infested, while their swift motions and the deftness with which they disappear into almost invisible cracks and crevices is most exasperating to their pursuer. There is nothing to be said in their favor, except that they prey upon the bed-bug, an instance in which the "cure is as bad as the disease." They have received various common names, such as "black beetles" and "croton bugs," but are quite generally recognized as "roaches" or "cockroaches." They are all nocturnal in their habits and very partial to warmth and moisture, which accounts for their abundance about kitchen sinks and in the holds and pantries of ships, steamboats and similar situations. They are of very flat, oblong form, with the head horizontal and almost concealed by the projecting margin of the collar. The antennæ are long and slender; the legs spiny and nearly equally developed; the wing-covers are usually present, but sometimes short, and the under wings often entirely wanting. The females lay all their eggs in one mass, enclosed in a bean-shaped sack, which is often carried about for some time before being dropped. Dr. Riley has observed that the females of some species remain with and protect their young. The latter are at first pure white, and at every molt the

insects revert more or less to this color, though soon becoming of the shade of brown which characterizes them.

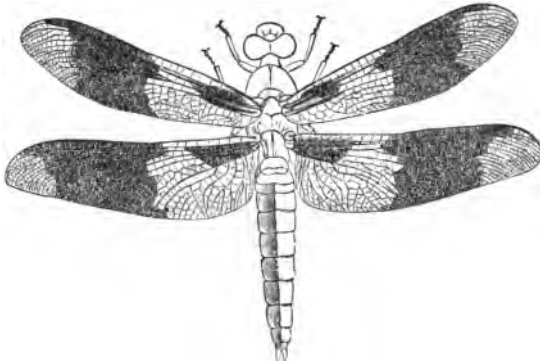
Our native species seldom give us much annoyance. The males occasionally fly into lighted rooms at night, but the females are usually found around rotten stumps and under bark of dead trees. The Light brown cockroach (*Platamodes Pennsylvanica*) is the largest species. It measures about an inch in length, has very delicate wings, and is of a light brown color. A smaller species of a very dark brown or black color, but with lighter margins, is also quite common. This is *Ectobia flavocincta*. The most destructive and annoying cockroaches are found among the introduced species. These are especially, the large, very dark brown or black Oriental cockroach (*Periplaneta orientalis*, Linn.), a species which is supposed to be native in eastern Asia, but which now occurs in all parts of the civilized world. It is about one inch long and one-third of an inch wide, very flat, so that it is able to creep into the smallest crack. The wing covers in the male extend over little more than one-half of the abdomen, and in the female are still more rudimentary. These insects are very long-lived, and it is said require several years to complete their transformations. The smaller, German cockroach, also called the "Croton bug" (*Ectobia germanica*), has become very troublesome in the eastern cities, and from its fondness for wheat bread and dough, is the especial pest of bakeries and bread boxes. This species has fully developed wings, and is of a light brown color, with two dark stripes on the pro-thorax.

The free use of pyrethrum powder will preserve cloth-bound books and similar property from the attacks of these insects, and if used freely in kitchens and other places which they frequent, will render them helpless, so that they may be easily swept up and burned. Powdered borax mixed with sugar will also kill them.

## CHAPTER XXXI.

## Order VII. NEUROPTERA.

Fig. 47.

Dragon-fly (*Plathemis tri-maculata*).

The insects here considered under the old Order NEUROPTERA are now separated into from two to five minor Orders, according to the importance attached by authors to the peculiar development of certain organs, and, more especially, with regard to the different methods of transformation which obtain among them. As very few of these insects are of economic importance, however, and as all the more conspicuous forms agree in general wing structure, and in the possession of biting mouth parts (except in one group, where these organs are entirely undeveloped), it will be more convenient to discuss them as members of a single primary group.

In these insects the body wall is soft and flexible, and there is but little consolidation of segments in any part. The head is usually rather large and free; antennæ always filiform or bristle-like, but sometimes very short; eyes, except in a few of the lowliest forms, conspicuous, and in many species occupying the entire sides of the head; mouth parts, especially the outer jaws and lips, peculiarly large and strong; thoracic joints more equally developed than in most species of preceding orders. The two pairs of wings are composed of delicate, transparent membrane, closely netted with fine veins, with strong supporting ribs on the anterior margin; legs, as a rule, rather small and weak; abdomen slender, oblong or lanceolate, in some cases terminated by a pair of curved forceps or two or three long, bristle-like tails.

In a portion of these insects the metamorphosis is complete, the pupal stage of life being one of quiescence and rest; while in the remainder of the Neuroptera the pupæ are active and voracious and

molt a number of times, although they differ considerably in form from the larvæ. Even the winged insects of a few species molt once or twice, a habit that has no parallel in the life history of the more highly organized forms. The great majority of the species are aquatic, and feed upon insects and other small water animals. In their relation to man they are, with the exception of a few small groups, either neutral or beneficial. The aquatic species form a large part of the food of fishes, and the few terrestrial species mostly prey on small pests of the orchard and garden.

Following the idea of Prof. Comstock, it will be convenient to separate the Nerve-winged insects into two sections, *NEUROPTERA*, proper, and *PSEUDONEUROPTERA*. The insects included in the first section undergo complete metamorphosis, and are therefore ranked by many authors higher than Hemiptera or Orthoptera, although their structural peculiarities would not place them in advance of the latter. The principal families of Neuroptera, proper, are the Caddice flies (*PHRYGANIDÆ*), Ant lions and Lace wings (*HEMEROBIADÆ*) and the Hellgrammite flies and others (*SOIALIDÆ*). In the Pseudoneuroptera are grouped a large number of more or less diverse families, including some wingless and degraded parasitic forms. The most interesting and conspicuous species are found in the families of the Dragon-flies (*LIBELLULIDÆ*), the May-flies (*EPHEMEROIDÆ*), the Stone-flies (*PELIDÆ*), and the White ants (*TERMITIDÆ*). Here also belong the little creatures often seen in old or long unopened books, called book-lice (*PSOCIDÆ*), and the peculiar parasites referred to in a previous chapter, the true Bird-lice (*MALOPHAGIDÆ*).

The Caddice flies closely resemble moths in their general outline, but the wings are of more delicate texture and rather sparsely covered with hairs instead of scales. The antennæ also are like those of moths, being long and thread-like, but there is no coiled tongue, and the other mouth parts are differently developed. The female flies lay their eggs upon water plants, and the aquatic larvæ attract much attention on account of the singular and ingenious little cases which they construct for the protection of their soft bodies. These are made of silk, and to the outside are attached small pebbles, coarse sand, or bits of sticks or leaves, giving them very peculiar and often beautiful forms. Some species make their cases entirely of silk, and of a very elongated cone shape. The thoracic legs are long and strong, and when moving from place to place, the case is dragged along over the hinder end of the body, but when resting or molting the larva retires within it and closes the opening by a little door or grating, which admits the water necessary to respiration, but excludes enemies. These case-bearing larvæ may be found along the shores of lakes and in the beds of shallow

streams. They feed upon small water insects and vegetation. Prof. Comstock describes a species that makes a very simple case under stones in rapid streams, but excites much admiration by its ingenuity in fishing, catching its prey by means of a seine-like web stretched between two stones.

The Ant-lions (genus *Myrmeleon*) are very delicate and beautiful flies, with slender bodies and oblong, lace-like wings, sometimes plain, sometimes ornamented with black dots (see lower figure in plate). They have a graceful flight, and are occasionally attracted into our lamp-lighted rooms at night. The larvæ are ugly and ferocious looking. The body is rough and broad-oval in shape, and the flattened head is provided with a proportionately enormous pair of pincer-like mandibles, adapted for seizing and holding its victims while they are pierced and comminuted by the maxillæ. These larvæ dig funnel-shaped or saucer-shaped pits in sandy soil, with a straight shaft in the center in which they hide, supporting themselves with the tips of the gaping jaws just above the edge, ready to close with lightning-like rapidity on any unlucky ant or other insect that carelessly strays over the edge of the pit-falls and slides into the trap at the bottom. If the insect obtains its footing and attempts to crawl up the steep sides it is brought down with showers of sand thrown upon it by the enraged and disappointed ant-lion, and it is but very rarely that it escapes. These larvæ are called "doodle bugs" in some parts of the country, and are most commonly found on the margins of streams and in sheltered ravines. [Fig. 48.]



Lace-wing fly (*Chrysopa*) and eggs on stalks, after Riley.

The Lace-wing flies are another small group of terrestrial Neuroptera. They are pretty but fragile and ill-odored flies, of a pale green or rosy hue, the wings reflecting prismatic colors. The antennæ are thread-like and nearly as long as the body, and the round eyes gleam like jewels. The oval pale green eggs are laid in clusters, each attached to the top of a slender silken stalk. This is supposed to be a precautionary instinct of the parent fly to preserve them from the rapacity of the larva that hatches first. The larvæ are called "Aphis-lions" from the small insects which are their more especial prey. They are of depressed oval form with pincer-like jaws and long, rather sprawling legs. They render valuable aid to the farmer and horticulturist in clearing his trees and other plants of plant lice, bark lice and similar small pests. When full grown they enclose themselves in round white cocoons, which are closed on top by a lid that is easily pushed up when the fly is ready to emerge.

The Hellgrammite fly and the other, much smaller, species of the family SCIALIDÆ have carnivorous larvæ that live under stones in running water. The large fly above named (*Corydalis cornutus*) is the only conspicuous member of the group. This is one of the largest, if not the very largest, insect in the Order—the length being between two and three inches, with a wing expanse of about five inches. It is quite common in most sections of the United States. The body is soft, with the pro-thoracic joint rather narrow, forming a sort of neck to which the much broader and rather square head is closely joined. The eyes are rather small and wide apart, and the stout, many-jointed antennæ taper to a point. In the female the jaws are broad, curved and notched at the extremity, but in the male these are modified into a pair of long, cylindrical tapering tusks, with which he can clasp the neck of the female. The wings are quite broad, of rather thick membrane, with a fine-net-work of veins, and stippled all over with whitish dots. The general color of the insect is a dull, ash gray. The female lays her eggs on sticks or leaves or stones that overhang the water, protecting and surrounding them by a white substance that gives the entire mass the appearance of a splash of whitewash. The larvæ, upon hatching, drop into the water. They are formidable-looking creatures when full grown. The head is broad and almost square, with strong jaws and other mouth parts. The thoracic joints, of which the first is longest, are quite elegantly sculptured. The feet terminate in a pair of claws. The sides of the hind body are furnished on each joint with spiny, oar-like processes and feathery tufts for gills, and there are also spiracles through which air can be breathed. They are from two to two and a half inches long by nearly one-half inch in diameter. They are highly esteemed for bait by fishermen, by whom they are termed "crawlers," "dobson," etc. It is said that they are nearly three years in completing their growth, and that the transformations are rapid and take place in cells under stones or drift-wood on or near the banks of the stream.

The other insects of this group (genera *Chauliodes* and *Sialis*) bear a close general resemblance to *Corydalis* in structure and habit, but are very much smaller and do not attract much popular attention.

Among the PSEUDONEUROPTERA the most conspicuous and beautiful insects are the Dragon flies or Mosquito-hawks (LIBELLULIDÆ). These are also called "Darning needles," and have been made objects of terror to children by the tradition that they are constantly watching for an opportunity to "sew up their ears," or do them some other bodily harm. In other parts of the country they are termed "Snake doctors," and are said to hover over the bodies of dead reptiles

and "bring them to life." The probable foundation for the latter superstition is that they are in pursuit of the flies that have been attracted by the odor of the carrion. It is needless to say that they are absolutely incapable of injuring any human being, and never show even the disposition to do so. Their motions are very graceful, and their habits are in the highest degree interesting. They are most numerous in the neighborhood of standing water, and dart back and forth through the clouds of mosquitoes and small gnats, seizing and devouring them in great numbers.

Their appearance is familiar to every one. The body is long and slender, tapering backward, and often of brilliant metallic colors, terminating in more or less conspicuous claspers or other appendages. The sides of the head are nearly covered by the large eyes; the antennæ are very short and bristle-tipped; the jaws are small but strong, and the parts corresponding to the lips of larger animals are both very large and close completely over the other mouth parts.

The wings are long, narrow and stiff, the hinder pair a little larger than the others. They are composed of transparent, closely-netted membrane, in many species crossed by broad dark bands or ornamented with spots and cloudings of crimson or orange. The legs are rather soft and weak, and are useful chiefly as supports to the body when the insect alights. The females drop their eggs in masses, embedded in a jelly-like substance, into the water, or attach them to the submerged stems of aquatic plants. The larvæ are carnivorous, and somewhat resemble the perfect insect in form, but breathe through leaf-like gills at the tip or along the sides of the body. In this age the labium (lower lip) shows a still more remarkable form than in the mature insect; it is very broad and hinged in the middle, and when the insect is at rest folds up over the face like a mask. The anterior edge is furnished with a pair of sharp hooks, and the apparatus can be extended to a great length in reaching after the prey, which is seized by the hooks and carried back to the jaws for mastication. The pupæ, when full grown, crawl up the stems of water plants, to which they cling by their legs, while the fly emerges through a slit on the back.

The May flies or Lake flies (*Ephemera*), of which there are many species, often arise in clouds at night from the shores of lakes or rivers, and in the morning the ground, especially around lamp-posts and under lighted windows, will be covered with their dead bodies. These insects are very soft-bodied and frail, and, in the perfect state, live but a few hours—just long enough to pair and lay their eggs. The head is small, the greater part of its surface being occupied by the eyes; the antennæ are very short and fine. The fore wings are broad



somewhat triangular in shape, while the hind wings are scarcely one-fourth their size, and nearly circular. The legs are slender, the front pair longer than the others. The abdomen tapers backward, and ends in two or three bristle-like appendages that are twice or three times the length of the body. The eggs are simply dropped into the water in a mass. The young feed upon minute aquatic vegetation or prey upon microscopic animals. Some species, whose habits have been studied in aquaria, have been observed to molt more than twenty times, and to require from one to three years in which to complete their growth. Among other anomalous characters found in these larvae are a pair of large tracheal gills attached to the under side of the head. Another singular phenomenon occurs in these insects—namely, the molting of the perfect insect. The first winged form is called the sub-imago. This rises into the air, but after a short flight settles upon some object and rapidly sheds its skin, wings, legs, caudal bristles and all, leaving behind it the filmy integument of the sub-imago.

The Stone flies (*Perlidae*), so called because the young are commonly found under stones in running water, are much larger than the May flies, and resemble, in general form and structure of the body and wings, the Hellgrammite fly, although none of the species are so large as the latter. The hind wings are also proportionately much broader, and have few cross-veins. Some very minute species appear very early in the spring, and are called Snow flies, being often coincident with late snows.

The Termites or white ants abound chiefly in tropical regions, where they are excessively destructive and difficult to contend with. A few species also occur in temperate climates, and one, *Termes flavipes*, is found in all parts of the United States, and often does much damage to the sills of buildings and wooden sidewalks, to fence posts and similar property. In the Southern States it also occasionally attacks the roots and trunks of orange trees, and the roots of Pampas grass. It feeds, however, by preference upon dead wood, and works so insidiously that its presence is not even suspected until the walls of a building give way, or an article of furniture drops in pieces upon being moved. Like the true ants, the Termites are social insects, and live in exceedingly populous colonies. In the tropics many species are mound-builders, erecting conical structures of earth or wood fiber, held in place with cement, that are from eight to ten feet high. All the more northern species are more secluded in their habits, avoiding the light and excavating chambers deep in the earth or in the centers of the largest stumps. From these, under-ground passages and tunnels extend for hundreds of feet in every direction. They are all small insects

probably seldom exceeding one-half inch in length, even in the equatorial regions, while our own species are only about one-fifth of an inch long. In this matter of size, however, one individual in each colony is an exception. This is the "queen" or fertile female, whose abdomen becomes so enormously distended with eggs, that it is from two to six or eight inches in length and of a proportionate thickness. The average size of the queen of *Termes flavipes* is from one to one and one-half inches. These insects are of a dingy white color. The head, with which the excavating is done, is large and horny and very nearly square in shape, except in the "soldiers," in which it is oblong, and provided with long, sharp-pointed mandibles. The thoracic segments are constricted anteriorly, but broaden gradually toward the oval abdomen, which has the surface microscopically hairy. The wings are possessed only by the perfect males and females, and by these for a few hours only; they are long and narrow, with forked but not netted venation. The legs are quite long and stout.

As in the colonies of the true ants, the Termites are divided into *castes*, each nest containing not only males, females and neuters, but the latter are divided into "workers" and "soldiers," the sole duty of the latter being the defense of the colony, while the workers perform all the labors of sapping and mining, building and provisioning the different cells, taking care of the helpless queen and feeding the young. Moreover, the sexed individuals are of two sorts, "kings" and "queens" of the first rank, which, upon reaching maturity, acquire wings and make an excursion into the upper world of light and air before settling down to their one duty of providing for the continuance of the colony; and in addition to these, what are termed "supplemental" kings and queens, which never become winged, and whose function is to preserve the colony from extermination in case, after swarming, the workers fail to secure a genuinely royal pair.

The internal economy of *Termes'* nests has been found very difficult to investigate, but so far as it has been observed, corresponds closely to that of the ants. The eggs, as fast as they are laid, are carried out by the workers and placed in other apartments, and the young, which are active but incapable of taking care of themselves, are fed upon comminuted wood or fungi. In due time the males and females acquire wings and make their way out of the nest, but after flying or being wafted by the wind to greater or less distances, fall to the ground and shed their wings. Each male then seizes a female by his mandibles, and such of the couples as escape the greediness of birds and carnivorous insects are, it is said, taken in charge by workers which are on the watch for them, and either taken to old colonies in

need of new queens and kings, or a new colony is founded for them to people. They are placed in the strongest and most healthful chambers and receive every attention, but are not even permitted to wander about the nest, which the queen would indeed be incapable of doing in a very short time. She is supposed to live for several years, and during this period lays innumerable eggs. The swarming of the young males and females in such vast numbers is understood to be a provision for cross-fertilization, as the swarming from a number of colonies takes place at once, and the chances are largely in favor of males and females from different colonies coming together. In the event of the death of the old queen, and the failure to secure a young one after her aerial excursion, a wingless "supplemental" pair are brought into the royal apartments and the colony is preserved by means of their progeny, although the latter are not nearly so numerous as those of the true queen.

*THE END.*

# INDEX

	PAGE		PAGE
Acanthiinae .....	104	Carpenter bees .....	34
Acrididae .....	118	Catocala .....	87
Aculeata .....	28	Cecidomyiidae .....	92
Adephaga .....	53	Cecropia moth .....	85
Aegeriadae .....	85	Cerambycidae .....	66
Animals, classification of .....	4	Cheese fly .....	97
Andrenidae .....	31	Chalcidae .....	46
Annelida .....	4	Chlamys .....	69
Ants .....	41	Chrysalides .....	76
Ant-lion .....	127	Cicadidae .....	106
Anthophila .....	29	Circulatory system .....	13
Aphididae .....	107	Classification .....	2
Aphodiidae .....	62	Clavicornia .....	56
Apple curculio .....	72	Clytus .....	68
Apple maggot .....	97	Cockroaches .....	124
Apple-tree bark-louse .....	110	Coccinellidae .....	57
Argynnis .....	81	Coccididae .....	109
Army worm .....	87	Codling moth .....	89
Asilidae .....	94	Colias .....	80
Asterias butterfly .....	79	Coleoptera .....	24
Attalabidae .....	72	Conehead .....	118
Back swimmers .....	105	Copridae .....	62
Bald-faced hornet .....	38	Corimelaenidae .....	111
Bark beetles .....	72	Corn worm .....	87
Bed-bug .....	104	Corydalis .....	128
Bed-bug hunter .....	104	Cosinoptera .....	63
Bees .....	29	Crane flies .....	93
Big bed-bug .....	103	Cremaster .....	81
Bill bugs .....	72	Crickets .....	55
Blatidae .....	123	Croton bug .....	124
Blister beetles .....	70	Crustacea .....	2
Blue-bottle flies .....	97	Culicidae .....	92
Bombardier beetle .....	55	Curculionidae .....	72
Bombyliidae .....	94	Cursoria .....	123
Bombycidae .....	85	Cyclorapha .....	91
Bot flies .....	95	Cynipidae .....	47
Bruchidae .....	69	Danaid .....	81
Bugs .....	93	Dermeates .....	58
Buffalo tree-hopper .....	107	Digger wasp .....	39
Burying beetles .....	56	Dog-day fly .....	106
Cabbage butterfly .....	80	Doryphora .....	68
Caddice flies .....	123	Dragon flies .....	123
Calandridae .....	72	Drosophilidae .....	97
Caloptenus spretus .....	120	Elateridae .....	59
Canker worms .....	88	Entomology .....	4
Cannibal beetles .....	53	Ephemeridae .....	129
Cantheris .....	70	Epicanta .....	70
Capsidae .....	101	Excrementivora .....	63

	PAGE		PAGE
External structure.....	5	Maple worm.....	87
Feather-wings.....	89	Mason bees.....	85
Flea-beetles.....	69	May beetle.....	64
Fleas.....	98	May flies.....	129
Flies.....	89	Meal beetle.....	70
Formica.....	44	Mealy bugs.....	110
Fringe-wings.....	89	Melolonthidæ.....	64
Fruit weevils.....	72	Membracidæ.....	107
Gall gnats.....	92	Metamorphosis.....	4
Geometridæ.....	88	Migratory locusts.....	118, 118
Giant water-bug.....	105	Mole cricket.....	115
Goldamith beetle.....	65	Moths.....	83
Grapevine leaf-hopper.....	107	Muscular system.....	114
Grapevine phylloxera.....	109	Murgantia histrionica.....	102
Graptæ.....	82	Muscidæ.....	96
Grasshoppers.....	118	Myriapoda.....	2
Hackberry butterfly.....	78	Myrmica.....	44
Harlequin bug.....	103	Necrophoridæ.....	57
Hellgrammite fly.....	128	Nepidæ.....	104
Hemiptera.....	105	Nervous system.....	13
Herbivora.....	62	Neuroptera.....	125
Hesperidæ.....	83	Neuroptera, families of.....	128
Heasian fly.....	92	Noctuidæ.....	87
Heterocera.....	77	Notonectidæ.....	55
Heteromera.....	69	Nut weevils.....	72
Hipparchia.....	83	Nymphalidæ.....	80
Honey bee.....	31	Oedipoda.....	121
Horn flies.....	97	Estridæ.....	95
Horn tails.....	41	Oncideres.....	88
Horse flies.....	98	Onion fly.....	97
House crickets.....	116	Orange scale.....	110
House flies.....	96	Orthoptera.....	113
Humble bees.....	38	Orthoptera, families of.....	115
Hymenoptera.....	96	Orthorapha.....	91
Hypoderma.....	96	Oscinidæ.....	97
Ichneumon fly.....	5	Owlet moths.....	87
Imago.....	4	Parasitica.....	111
Insect.....	3	Parthenogenesis.....	108
Isomera.....	52	Papilio.....	79
Issoma.....	47	Pea weevil.....	69
Jassidæ.....	107	Pecticornia.....	61
Jigger.....	98	Perlidæ.....	130
Katydidæ.....	117	Phæsus carnifex.....	63
Lace-wing.....	127	Phitophaga.....	66
Lachnosterna.....	64	Phylloxera.....	79
Lady-birds.....	57	Pigeon tremex.....	80
Lamellicornia.....	61	Pieris.....	80
Lampyridæ.....	59	Piophilidæ.....	97
Lancet flies.....	96	Plagioderma.....	68
Larva.....	4	Plum curculio.....	73
Leaf-beetles.....	60	Polyphemus.....	85
Leaf-chafers.....	63	Potter wasp.....	39
Leaf-cutter bees.....	85	Preying mantis.....	122
Leaf-rollers.....	88	Prionus.....	68
Lebia grandis.....	55	Pseudoneuroptera.....	128
Lepidoptera.....	73	Pupa.....	4
Lice.....	111	Pupipara.....	97
Lime-tree moth.....	88	Pterophoridæ.....	89
Locustidæ.....	117	Pyrilidæ.....	89
Longicornæ.....	66	Rapacious Soldier-bug.....	104
Lucanidæ.....	61	Reduviidæ.....	103
Luna moth.....	86	Reproductive organs.....	12
Lycanidæ.....	82	Respiration.....	13
Lygæidæ.....	107	Rhinoceros beetle.....	63
Mantidæ.....	122	Rhopalocera.....	77
Many-banded Robber.....	104	Rhynchophora.....	71
		Robber-flies.....	94

	PAGE		PAGE
Rocky Mountain locust.....	118	Tenebrio.....	70
Rose chafer.....	66	Tenthredinidæ.....	48
Rose slug.....	48	Terebrantia.....	45
Rove beetles.....	57	Termitidæ.....	180
Saltatoria.....	116	Termes.....	180
Saperda.....	68	Tettix.....	121
Saw-flies.....	48	Thrips.....	107
Scialidæ.....	128	Tortoise beetles.....	68
Scolytidæ.....	72	Tortricidæ.....	80
Screw-worm fly.....	97	Tree crickets.....	116
Seventeen-year cicada.....	106	Trogidæ.....	118
Serricornia.....	53	True bugs.....	100
Short-horned borers.....	59	Trypetidæ.....	97
Simulidæ.....	92	Tumble bug.....	68
Silphidæ.....	56	Uroceridæ.....	48
Siphonaptera.....	98	Vanessa.....	72
Slug caterpillars.....	86	Vedalia cardinalis.....	58
Snapping beetles.....	59	Walking sticks.....	121
Snout beetles.....	71	Wasps.....	87
Snout moths.....	88	Water scorpions.....	104
Solitary bees.....	34	Water striders.....	104
Span worms.....	88	Wheat midge.....	92
Squash bug.....	101	White ants.....	180
Syrphus flies.....	94	White grub.....	64
Stone flies.....	130	Woolly apple louse.....	109
Tabanidæ.....	98	Wood wasps.....	40
Tachina flies.....	95		

