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ORDER VII. — COLEOPTERA.

The Beetles, or Coleoptera as they are termed by naturalists, briefly defined, are six-legged insects, which have thick and horny fore wings and chewing mouth-parts, and which undergo complete metamorphosis.

The most striking of these characters is the peculiar horn-like, opaque, usually quite rigid fore wings, which, in the beetles, are termed elytra (singular elytron), from the Greek *elutron*, meaning a sheath, a word used by Aristotle to designate the fore-wings of beetles. These elytra give a general aspect to beetles which make them easily recognizable as such, however much they may vary in other respects. As a rule the elytra close together, meeting in a straight line along the posterior portion of the back or dorsum of the insect, and shielding beneath them the delicate hind wings, unless hind wings are absent, as is the case with a small number of beetles. The elytra take no active part in the flight of Coleoptera, but generally are opened outward at right angles to the body of the insect, remaining at rest in that position, while the membranous hind wings perform the necessary strokes for locomotion. In beetles that have rudimentary hind wings, and in those of which the hind wings are absent, the elytron of one side usually is united firmly along the back to that of the other side, to form a single shield, which protects the abdominal portions of the insect beneath it. In one family, the Staphylinidae, or rove-beetles, and in some less commonly known beetles belonging to other families, the elytra are much too short or too small to cover the whole abdomen, although the Staphylinidae manage to bring the entire wings beneath the elytra by a complex system of folding.

The name Coleoptera (from *koleos*, a sheath, and *pteron*, a wing) was first employed for beetles by John Ray, an early English naturalist, in 1705, and has been generally adopted by subsequent naturalists, although Fabricius, in 1775, termed beetles Elen-therata, on account of their free maxillæ, and Schluga, in 1767, used for them the term Vaginata, from *vagina*, the Latin for sheath.

The distinct division of the head, thorax, and abdomen, so clearly discernible in most beetles, extends in less degree to their larvæ. In the larvæ the head is usually quite distinct from the following segment. The first three segments following the head, which correspond to the thorax of the imago, are often quite different from the succeeding abdominal segments of the larvæ, but sometimes they closely resemble the abdominal segments. The abdomen is usually more prolonged in proportion to the thorax and head than it is in the imago, consequently most beetle larvæ have a vermiform appearance, which has given rise to popular names, such as 'meal-worm' for the larvæ of *Tenebrio molitor*, and 'wire-worms' for the larvæ of many Elateridae. The thicker and more fleshy larvæ of Coleoptera, such as are those often dug up about roots, or split from their mines in wood, are in popular parlance 'grubs.'

The larvæ of beetles mostly have six legs, or feet, near the anterior end of their body, that is a pair of legs for each of the first three segments behind the head—the thoracic segments. In the Curculionidae, and in some other beetles of which the larvæ live within their food, the latter are legless. Certain larvæ have more or less developed traces of anal legs, sometimes a product of the evaginated lateral portions of the

FIG. 344. — Larva of *Blaps prodacta*.

anus, and a few have a fairly developed median foot on the posterior abdominal segment. In many larvæ locomotion is aided by the evagination of little wart-like ventral processes on the abdominal segments; these processes in the *Cerambycidae* are found also on the dorsum, and have been termed discs; they aid these larvæ in locomotion within their narrow mines, and call to mind a pair of processes upon the dorsum of the fifth abdominal segment of the larva of *Cicindela*, by which the latter larva is helped to go up and down its tube in the ground.

Beetle larvæ possess, like beetles themselves, without exception, mandibulate mouth-parts, that is to say mouth-parts intended for biting, although in the larvæ of *Dytiscidae* the liquid food is sucked into the œsophagus through channels in the mandibles, as will be explained more fully when treating of that family.

Larvæ of *Coleoptera* mostly live in concealed places under very diversified circumstances; beneath stones, and in wood; in acorns, nuts, and seeds; on both phanerogamous and cryptogamous plants; in furs, woollen goods, and hair goods; a few are parasitic on other insects; others lead a predaceous life, either on land or in water.

FIG. 345.—Pupa of *Monohammus*.

The pupæ of beetles have free limbs, and one can see the form of the legs, wings, antennæ, and mouth-parts of the perfect insect; the legs are gathered together along the ventral side of the pupa, with the feet just each side of the median line, and pointing toward the posterior extremity of the abdomen; the wings and elytra are parted and often wrapped partially around the sides of the pupa, so that their apices are alongside the feet on the ventral side. Where the antennæ are especially long, as in certain *Cerambycidae*, they are arranged in symmetrical curves upon each side of the pupa. Often primary or secondary sexual characters disclose in the pupa the sex of the insect.

Beetles which pupate subterraneously, usually do so in a case or cocoon rounded out in the earth; many wood-borers form cocoons of rubbish or of shreds of wood; while true cocoons above ground are spun, or formed of a viscid secretion of the larva by a few *Cureulionidae*. Those beetles which construct no cocoon pupate upon the ground amongst the grass, or, as is the case with many *Chrysomelidae* and all *Coccinellidae*, suspended upon a twig or other object. The last larval skin may remain about the pupæ of some species of these last mentioned families. Pupæ found underground, enclosed in wood, or in other places not exposed to light, are mostly white, the beetles from them attaining their color shortly after emergence. The abdominal extremity of the pupa is generally movable, and pupæ of some species will whip their abdomen about with considerable activity when disturbed; this motion is about the only external indication of life in coleopterous pupæ.

Even as distinct as beetle-pupæ may seem to be from their larval condition on the one side, and their perfected imago on the other side, there are—as might be expected from the fact that egg, larva, pupa, and imago are serial developmental stages of one and the same insect—intermediate forms, gradations and variations in these stages. Under *Meloidæ* and *Stylopidae* forms will be further treated of wherein the metamorphoses have been modified by parasitism, that condition of existence which never fails to produce degradation and retrograde development.

The number of living species of *Coleoptera* in any country cannot be accurately determined; new species are being constantly added, and species described long ago are discovered to be varieties of other species; besides this the forms regarded by

one authority to be species will be only varieties in the estimation of another equally able coleopterologist. Gemminger and Harold's catalogue of the Coleoptera of the world, issued in parts between 1868 and 1876, contains 77,008 species described up to the time of issue. Counting omissions from this catalogue, and species described since its publication, the number of described species must now reach or exceed 100,000. In large collections there are, in all probability, between 20,000 and 30,000 more species still waiting description, and it would be rash to predict the number of species which will be found later in parts of the world as yet insufficiently explored. In North America, north of Mexico, Crotch's list, published in 1874, enumerates 7,450 species, and Mr. S. Henshaw, who has a manuscript catalogue of beetles of the above region kept up to date, informs me that the number is now (1884) about 8,950.

Species of insects which feed upon substances of commercial value belonging to one region are often transported, in one way or another, to other regions, where it is not uncommon that these immigrants become serious pests until their natural enemies are also imported, or until predaceous animals of their new home resort to them for a food supply. Thus the Colorado potato-beetle (*Doryphora decemlineata*) has spread from its original habitat in Colorado over the eastern United States, and its advent in Europe is so greatly feared that it has been a subject of legislation in several countries. Our troublesome carpet-beetle (*Anthrrenus scrophularia*) was probably introduced from Europe, and the asparagus-beetle of Europe (*Crioceris asparagi*) was an immigrant that landed on Long Island, near New York city, some time about 1860, and has since done considerable damage to the market gardens which supply New York city. So, too, the meal-beetle (*Tenebrio molitor*), and the grain-weevil (*Calandra oryza*) are of European origin. A few species of beetles have become, by migration, almost cosmopolitan, but the greater number of species are confined to one continent, often to some small part of a continent, although beetles are found in every part of the world that has been explored.

In geological distribution Coleoptera have been found as early as the carboniferous; they are more common in jurassic strata, and still better represented in the tertiary and in amber.

The modes of collecting and preparing beetles for the cabinet are very varied. The beginner usually depends for specimens upon lucky finds, upon captures with the net, and upon such modes of collecting as are used for all kinds of insects, and which are described in most general works on entomology, while the experienced coleopterist studies the habits of rarer insects, and uses baits and traps to ensnare them. Some of the less-known and useful ways of obtaining Coleoptera for the cabinet are the following. Beetles and their larvæ which inhabit dung, earth, or other materials heavier than water, float to the surface of water, and can be easily discovered if the earth or dung be broken up and placed in still pools, or in a trough filled with water. For killing many kinds of beetles a 'cyanide bottle' is very useful: this bottle is made by putting a few pieces of potassic cyanide into the bottom of a large-mouthed bottle — a horse-radish bottle will do very well, if no larger one can be found — and covering the pieces of cyanide with dry plaster of paris; after the plaster has been evened down by shaking the bottle a little, water should be added, best a spray from an atomizer. When the plaster sets a firm shell will be formed, which will hold the cyanide in its place, while its poisonous vapors will slowly escape through the plaster. If the moistened and subsequently hardened portion of the plaster is only about as thick as is the glass of the bottle itself, a condition of affairs which can be regulated

easily if an atomizer is used, there is little danger of the bottle cracking by the slight expansion of the plaster in setting. As potassic cyanide is extremely poisonous, great care should be taken in handling it, the bottle should be labelled "Poison," and kept in a safe place, tightly corked, and out of the reach of children. As a general means of killing insects the cyanide bottle is unsurpassed, although a few yellow or red beetles may have their colors injured by the cyanide vapor. The cyanide is best renewed in the bottles each spring, but I have had bottles that retained their killing power several years. A successful mode of wholesale collecting with the cyanide bottle is to sweep the grass, trees, blossoms, and shrubbery of all kinds with a collecting net made of stout cloth, and then to empty the whole mass from the bottom of the net into the cyanide bottle, where the insects will be killed, and can be picked out at leisure. Of course this rough mode of treatment injures some beetles, but, on the whole, it is a very productive way of collecting. In the spring leaves and rubbish from the corners of pastures, and from the woods, can be sifted, by putting them in a stout cloth bag, of which the bottom is made of wire-cloth such as is used to make coal-sieves, and shaking the bag vigorously over a piece of white cloth. The finer bits of rubbish, together with numerous torpid beetles that have hibernated beneath the leaves, will fall through the sieve upon the cloth, and the insects can be easily seen. The contents of the cloth beneath the sieve may be tied into cloth bags and taken home for subsequent and more thorough examination. In the same way the rubbish deposited by spring floods of rivers may be carried home for later examination on a surface of white paper. A single drop of strong ammonia water may be used to drive the beetles from the rubbish on the paper; too much ammonia, however, kills them, and then they are not readily found. Water-beetles are often attracted by leaving a dead mouse or other small animal to decay in shallow water; the place should be approached cautiously a number of times daily, and the insects about the bait quickly netted. Beetles which feed in bark and in toad-stools, and which run from their holes and drop when disturbed, are easily trapped in large numbers by the use of a bottle partly filled with strong alcohol, into the cork of which a small tin tunnel has been inserted. The tunnel should be held close down beside the toad-stool, the latter suddenly picked and held over the tunnel, and now and then jarred with the hand. The beetles run out, drop, and tumble directly through the tunnel into the alcohol. In this way I have taken repeatedly as many as fifty specimens, mostly *Staphylinidae*, from a single toad-stool. Many leaf-eating beetles and their larvæ, as well as other insects, are taken by holding an inverted umbrella beneath bushes and weeds, and then shaking the plants vigorously; the insects drop into the umbrella, which is still more useful if it is made of white cloth to enable one to see them distinctly. A hatchet, for winter collecting under bark, and, in summer, a trowel for digging, are useful accessories of a coleopterist's outfit.

Beetles should always be pinned for the collection through the right elytron, about one-third of its length from its forward end, and pins made purposely for insect collections should be used. These pins are slender, sharp, about one and a half inches long, thus lifting the insect up from the surface on which it is pinned, and lessening the danger of breaking the specimen. On the under side of beetles the pin should pass out between the middle and hind legs on the right side, care being taken not to have it pass through or push off any of the legs. The beetles should be slid upwards on the pin until about three-eighths of an inch of pin is left above the elytron. No specimens should ever be pinned in such a manner that the head or one side is droop-

ing; if there is any difference, the head should be slightly elevated, but not enough so as to be noticeable. Some collectors take pains to spread out the antennae, palpi, and legs of their beetles, but this is useless work, and renders these organs more liable to be broken off in handling the specimens.

Very minute beetles are gummed upon small slips of paper or of mica, and these slips then pinned in the collection. A convenient kind of slip is a narrow triangle of stiff white paper, the triangle about one-fourth of an inch long, and one-sixteenth of an inch wide at the larger end. The beetle is gummed—with a mucilage of gum tragacanth or of shellac—neatly across the pointed end of the triangle, which is then pinned through its broad end, and arranged in the collection.

The cabinets used for collections of insects vary with the taste of the collector: some use boxes arranged on shelves like books, others cases into which boxes are slid as drawers. The essential conditions are that the boxes have a depth of a little over one and a half inches, in order to admit the insect-pins erect; that the box close very tightly, to exclude museum pests, those little beetles which damage or devour specimens; and that the boxes be made with very soft wood bottoms, or be lined on the bottom, inside, with cork, felt, pith, or some soft material in which the pins can be stuck without difficulty. Specimens should not be kept exposed to light, for many of their colors fade, and in a few years the collection which has been thus exposed loses its beauty as well as its scientific value. Good taste forbids the use of bright-colored surroundings or colored paper to line boxes for an insect collection; white paper lining exhibits the colors of the specimens best. Insects should be labelled in the collection neatly, and with small labels. Anyone who wishes to study insects scientifically should add the locality of capture on the label of each specimen, and a number by which to refer to a note-book, in which may be recorded the date of capture, habits, food, and other particulars of interest concerning the specimen.

The thought of observing the habits of beetles leads one quite naturally to a consideration of rearing beetles, for by rearing them, and keeping careful notes on their habits, one not only advances science materially, but also derives beautiful specimens for the collection and pleasure from the occupation. Some beetles are easily reared, taking but a few weeks to undergo all their transformations, others require several years for their metamorphoses, and are very difficult to rear. Even in Europe, where entomology has been longest and most thoroughly pursued, only a small proportion of all the species of Coleoptera have been reared, and their earlier stages observed. In other countries still less has been done. Without elaborate directions, filling many pages, it is impossible to explain the devices used to rear beetles; the only general directions that can be given are to keep the immature beetles in conditions that are, as far as possible, the same as those in which the same species live in a free state. To establish and maintain these conditions in breeding-jars, or in other places where the different stages of the insect can be observed, requires much skill, and adds pleasure to successful beetle-raising. Fungus, bark, decayed wood, dead twigs, acorns, nuts, and in fact almost any vegetable substances collected at certain seasons of the year, and put into fruit-jars, the contents of which should be now and then somewhat moistened, avoiding an excess of moisture, which often causes mouldiness, will disclose beetles whose larvæ feed on the substances put in the jars. The leaf-feeding larvæ of beetles usually attain full growth in a short time, and are conveniently bred under a bell-glass, or tumbler, inverted over a plant-pot full of slightly moistened earth. The larvæ of water-beetles are reared, without much difficulty, in small aquaria, feeding

them with flies and other insects, care being taken that the full-grown larvæ have opportunity to crawl out of the water and into moist sand, in which latter they pupate. Carnivorous land-coleoptera are more difficult to rear. Where a large number of the same species of beetle is reared at once, specimens of each stage should be preserved in alcohol, carefully labelled, for future reference.

In bodily form the Coleoptera present every variation from long cylindrical to nearly globular, from hemispheres to extremely flattened discs, from straggling ant-like forms to compact seed-like ones, as may be seen by examining the illustrations which follow. Throughout all the diversity of form which environment has given beetles, they invariably show, with considerable distinctness, a division into three parts, portions which, at first sight, might easily be mistaken for head, thorax, and abdomen, but which more careful examination proves to be head, prothorax, or the first of the three divisions of the thorax, and a portion, covered generally by the elytra, which is composed of the mesothorax or middle portion of the thorax, the metathorax or posterior part of the thorax, and finally the abdomen. The head bears for appendages the antennæ and mouth-parts; the prothorax, the first pair of legs; the mesothorax, the elytra and middle pair of legs; the metathorax, the wings and hind pair of legs; the abdomen, only the genitalia, which are usually concealed in beetles. The prothorax moves with considerable freedom on the mesothorax, and this articulation is a character of importance in the separation of the Coleoptera from the Hymenoptera, Diptera, and other insects, in which the three divisions of the thorax are more or less firmly united together. These divisions, head, prothorax, mesothorax, metathorax, and abdomen, with their appendages, merit much further consideration.

The head of Coleoptera, both in their larval and adult states, bears the mouth-parts directly forward and slightly downward as in many Carabidæ, or directly downward toward the surface on which the insect is standing, as in many Chrysomelidæ. Laterally the head of the adult beetle bears compound eyes, usually large, and the antennæ are generally just in front of the eyes. With few exceptions, among which may be mentioned certain Dermestidæ, ocelli are absent in the imago of Coleoptera; the compound eyes are absent or functionless only in a very few cave-inhabiting species. In the larvæ, where compound eyes fail, there are often ocelli—from one to seven, usually six, on each side.

The antennæ, which are not only organs of touch, but much more olfactory organs, present considerable diversity in form in adult beetles. Often these organs are better developed on the male than on the female, becoming marked secondary sexual characters; this is especially the case with the lamelliform antennæ of some of the species of Scarabæidæ. In certain families the antennæ are not very conspicuous, and can be hidden in grooves, as in the Elateridæ; in other families, as in the Cerambycidæ, the antennæ are prominent organs, often, in the last mentioned family, exceeding the length of the insect, in some species double or treble its length. In a few families, as in the Scolytidæ, which have very small antennæ, important generic characters are found in these organs. The antennæ of beetles may have from two to thirty-four joints, but eleven is the usual number. The antennæ of most beetle larvæ have but four joints; rarely they have five, three, or two joints, and in certain cases they are represented only by a very small inarticulate tubercle.

Beetles have, without exception, biting or chewing mouth-parts. More or less concealed beneath a well-developed labrum, itself articulated to the epistoma or clypeus, is a pair of chitinous mandibles. In the males of *Lucanus* the mandibles attain

an extraordinary size, and are sometimes branched. Beneath the mandibles are the maxillæ, which are more delicate and more complex than the mandibles, and which aid the latter in masticating, apparently performing the lighter and more complicated part of the work. The basal articulation of each maxilla is termed the *cardo*, to this is attached the *stipes*, with an external scale-like segment, the *squama palpigera*; to the *squama palpigera* a multiarticulate palpus, the *palpus maxillaris*, or maxillary palpus, is jointed. Two lamellar lobes, the real chewing-organs of the maxillæ, are also attached to the upper edge of the *stipes*; these are termed, respectively, the *lobus externus*, and the *lobus internus*. In the *Cicindelidæ*, *Carabidæ*, and *Dytiscidæ*, the *lobus externus* is palpiform and usually two-jointed. The maxillary palpi generally have four joints. Beneath or behind the maxillæ is, homologically, a third pair of buccal organs, a second pair of maxillæ, the two halves of which are united together at their bases, which latter are also united above with the *ligula* or tongue, and below form the *mentum* or chin. The *ligula* and *mentum*, the last of which articulates with the lower portion of the head by the gular suture, are important in the classification of *Coleoptera*. Joined to each side of the *ligula* is a *palpus labialis*, usually three-jointed. A membranous process usually exists on each side of the *ligula* near its tip; these processes are the *paraglossæ*.

The *labrum* above and the *labium* beneath, in *Coleoptera*, as in other chewing insects, are passive in function, serving to hold the food in place while it is masticated by the mandibles and maxillæ. As the cheeks in higher vertebrates prevent a side-wise or lateral squeezing out of the food from between the teeth, so the *labrum* and *labium* of *Coleoptera* keeps the food in its position between masticatory organs which operate laterally. All the mouth-parts of adult *Coleoptera* are subject to slight modifications and reductions in certain families and genera, and in the larvæ the oral organs are not rarely considerably modified. The larvæ of *Dytiscidæ* and *Hydrophilidæ* present remarkable modifications of form and use, which, as in the case of other striking variations from the normal form of larval mouth-parts, will be described under their respective families.

The *prothorax*, the middle of the three portions into which all beetles are divided with considerable distinctness, is hollowed out in front to receive the neck or head, and is articulated behind with the *mesothorax*. The *prothorax* bears the forward legs. Its dorsal surface is often termed the *pronotum*.

The *mesothorax*, *metathorax*, and *abdomen* form the last of the three portions of a beetle, which portion is often called the trunk.

The *mesothorax* and *metathorax* are very intimately united; upon the former are borne the *elytra* and middle pair of legs, and upon the latter the wings and hind pair of legs. Both *mesothorax* and *metathorax* are hidden from view, on the dorsal side of the insect, by the *elytra*, except that in most beetles a small triangular portion of the *mesothorax* is visible between the *elytra* at their bases; this triangle is the *scutellum*. The median ventral pieces of the three different parts of the thorax are termed, respectively, *prosternum*, *mesosternum*, and *metasternum*, and the pieces which connect each of these sternal pieces at the sides with the dorsal pieces, are termed the *episterna* and *epimera*, respectively, of the *prothorax*, of the *mesothorax*, and of the *metathorax*. The sutures between certain of the above-mentioned parts may be obliterated in some cases.

The *abdomen* is broad anteriorly, is closely united with the *metathorax*, is in most cases entirely covered or protected from above by the *elytra*, and contains the sexual

and the greater part of the digestive organs. Spiracles, or breathing pores, open in the flexible membrane which connects the dorsal and ventral pieces of the abdomen. At its extremity, between the dorsal and ventral pieces, open, in a common cleft, the anal and genital orifices, and on each side are often structures of greater or less complicity, generally hidden from outside view, constituting the genitalia or genital armature. The genitalia are often more visible in pupæ, as is the case with many pupæ of Lucanidae and Scarabæidae, than in imagoes.

While the abdomen of adult beetles have no appendages except the genitalia, a few beetle larvæ, among which are those of Gyrinidae and Psephenidae, have gill-appendages borne by several abdominal segments.

Adult beetles enjoy locomotion of several sorts, flying, springing, climbing, crawling, or running; a few add swimming: their larvæ sometimes swim, but more commonly only crawl or run.

The legs of adult beetles, as well as those of their larvæ, are appendages of the three thoracic segments, and are modified according to the purposes for which they are used. In some larvæ one or more pairs of legs are reduced to the merest rudiments or entirely disappear, but in the mature beetles no such reduction takes place. The typical constitution of the legs of adult Coleoptera is as follows: the basal joint, short but of various forms, is termed a coxa, and the cavities into which the coxæ are set on the under side of the thoracic segments, on each side of the median line, are called coxal cavities. The form of the coxæ is of importance in distinguishing the families of Coleoptera. Jointed to the coxa is a piece named the trochanter; the connection of the trochanter with the next following piece—the femur—is very intimate in some beetles, in others the hind trochanters are prominent lobes upon the inner side of the femora. The femur, or thigh, is the first long piece of each leg; the tibia, another long piece, follows it, and to the latter piece is jointed a foot or tarsus, consisting of from three to five short joints, the terminal joint generally having two claws, and between the claws a small appendage, the onychium. The tarsal joints are hairy beneath, and those of the anterior (and sometimes also the middle) pair of legs of many male beetles are modified to clasp more firmly the female during copulation. The most peculiar of these modified tarsi are those of the males of the water-beetles belonging to the family Dytiscidae; their tarsi will be further described when treating of that family. The form and proportion of beetles' legs are quite varied. Legs fitted for walking and running, ambulatorial and cursorial legs as they are called, are slender, and rather long in proportion to the size of the insect. Fossorial legs, or those intended for digging, are short, stout, and flattened. Springing legs, or saltatorial legs, have generally much thickened femora. Natatorial legs, those used for swimming, are oar-shaped or paddle-shaped, and are bordered with hairs.

The elytra, which are really horny forward wings, and in which the remnants of veins often can be seen, are generally opened out nearly or quite at right angles to the body in flight, and serve to balance and to steer the beetles, while the two membranous wings, which are ordinarily hidden beneath the elytra, unfold, and, by their rapid vibrations, furnish the impulse in flight. Jousset de Bellesme thinks the elytra govern direction in flight by changing their position, and consequently altering the position of the centre of gravity of the beetle. In the Cetoniæ, a portion of the Scarabæidae, the elytra are said to remain closed in flight, the wings projecting out from beneath their bases. The inflexed outer margins of the elytra are designated as epipleura. The venation of the wings of Coleoptera at first glance appears simple, but the devices

which enable the tip of the wing to fold back, in one or sometimes more folds, without too greatly weakening its structure, are an interesting study. If one pulls open forcibly the wing of a large water-beetle (*Dytiscus*) that has been preserved in alcohol, the wing will partly close itself by its own elasticity, and such a wing furnishes an excellent object on which to study the folding mechanism.

A few beetles are wingless and cannot fly; their elytra are united to each other on the inner side, and they are said to have connate elytra. In such cases the original function of the elytra and wings, that of flight, has been superseded by a secondary function of the elytra, protection. Rarely both elytra and wings are absent, as in the females of certain "lightning-bugs" (Lampyridæ), which are thus rendered so worm-like that they are called popularly "glow-worms."

The flight of beetles is generally heavy and slow; some, however, can fly very quickly, but most rapid-flying beetles rest often from flight, and can be chased down and captured without great difficulty in an open field. A sport which children enjoy is chasing down, in this manner, the tiger-beetles (Cicindelidæ).

While the genitalia of most beetles are concealed in the abdominal segments, secondary sexual characters are so manifest in many species as to attract the attention even of careless observers. As already mentioned, the anterior tarsi of some beetles serve to distinguish the males from the females; in a few water-beetles (Dytiscidæ) fluted elytra are found in some females, while the elytra of other females of the same species are not fluted—truly dimorphic females; in many Scarabæidæ, in some Cerambycidæ, and in many other Coleoptera, the males have larger and better developed antennæ than the females have; a large number of Scarabæidæ and a few other beetles have, in the male, well-developed horns upon the prothorax, or upon the head, or upon both head and prothorax, while their females have no horns, or much less developed ones in the corresponding positions; in the stag-beetles (Lucanidæ) the mandibles of the males are excessively developed. The sex of beetles is sometimes determinable in the pupal state from their evaginated or protruded genitalia.

Beetles, or their parts, may be smooth, striate, punctate, cancellate, or may have many other modifications of surface. They may be clothed with waxy secretions, spines, hairs, or even scales. The excessive brilliancy and sparkling coloration of the so-called diamond-beetle of Brazil (*Eutimius imperialis*, of the Curculionidæ), which will be figured further on, is due to its being covered with scales: this kind of ornamentation with scales—really only modified hairs—is common among the weevils (Curculionidæ), and not rare in a few other families of Coleoptera. Beetles exhibit almost every known shade of color, and a few are iridescent with beautiful metallic hues. A little beetle (*Coptocycla aurichalceæ*) not uncommon on the wild morning-glory (*Convolvulus*), looks, when alive, like a flattened drop of the finest polished gold. The species of certain families resemble one another in coloration and figuration; the leaf-beetles (Chrysomelidæ) have, for the most part, brilliant coloration; the lady-birds (Coccinellidæ) have for prevailing colors red, yellow, and black, mostly arranged in round or roundish spots; the Tenebrionidæ are generally sombre colored, often dull black.

The internal anatomy of Coleoptera is not as varied as is that of many other insects, and the main facts can be condensed, in a general way, to the following statements.

A narrow œsophagus, into which often open salivary glands, passes into a crop, the posterior portion of which is lined, in carnivorous Coleoptera, with chitinous teeth, serving as a gizzard. Behind the gizzard the digestive tract, which has a few convolu-

tions in carnivorous beetles and more convolutions in herbivorous ones, may be designated as the ventricle. The posterior end of the ventricle is marked by the insertion of four or six long tubes, the malpighian vessels, which are urine-excreting organs. Beyond the insertion of the malpighian vessels, and ending at the anus, is the intestine, properly speaking, often showing a differentiation into small intestine, cæcum, and rectum. The malpighian tubes are usually a number of times as long as the insect itself, and are coiled about in the abdomen of the beetle in a way that makes them very difficult to disentangle without breaking. Glands open into various portions of the digestive tract, among them rectal glands into the rectum. Carabidae, Dytiscide, and some other beetles have glands opening on each side of the anus that secrete acid or strongly odorous fluids which are used by these insects to defend themselves. In the bombardier-beetle (*Beachinus*) the secretion of these anal glands is partly gaseous, or becomes aeriform immediately after its discharge.

The nervous system consists of a supra-oesophageal ganglion, from which originate the antennal and optic nerves; an infra-oesophageal ganglion which sends nerves to the mandibles, maxillæ, and labium; and a series of ganglia, connected by double commissures, just beneath the digestive tract. During the growth of the larvæ these double ventral ganglia, typically distinct and one in each segment, consolidate in various ways, so that, in the imago, Eduard Brandt has characterized four types of the nervous system, as follows: first, a system with a supra-oesophageal ganglion and a large central nerve-mass in the thorax, of which mass the forward end is the infra-oesophageal ganglion; second, a system with two cephalic ganglia, and a central nerve-mass in the thorax; third, a system with two cephalic, two thoracic, and none to eight abdominal ganglia; fourth, a system with two cephalic, three thoracic, and none to eight abdominal ganglia. Beetles have, besides the central nervous system noticed above, a somewhat complicated sympathetic nervous system.

The circulatory system of Coleoptera, like that of all insects, is not well differentiated. A so-called heart extends along the dorsum, where it pushes the nearly colorless blood toward the head; here the blood is distributed in somewhat irregular and usually ill-defined passages. Neither venous nor arterial system exists, in the full sense of the terms, although in the mouth-parts and antennæ of the larva of a water-beetle (*Hydrophilus*), when this interesting larva is seen alive under the microscope, the blood can be observed circulating in definite channels.

Respiration is by tracheæ in the imago, and the respiratory movements consist of alternate approximations and separations of the dorsal and ventral portions of the abdomen, causing renewal of the air in the tracheæ. Besides the tracheæ there are generally tracheal bulbs, or expansions of the tracheæ, which can be inflated at the will of the insect, and are thought to be useful in flight, by lessening the specific gravity of the insect. The stigmata (sometimes called spiracles), the external openings of the tracheæ, usually have more or less complete sieves to prevent dust from entering the tracheæ, and in some cases these sieves form, as in a water-beetle (*Dytiscus*), most beautiful objects for the microscope. Beetles have a pair of stigmata on the mesothorax, on the metathorax, and on each of the first eight abdominal segments; their larvæ generally have one pair of thoracic, and eight pairs of abdominal stigmata. Some aquatic larvæ have only the two stigmata of the eighth abdominal segment, others respire wholly or partly by gills.

The female sexual organs consist of numerous ovarian tubes on each side uniting in various ways to form a pair of oviducts, which latter themselves unite to form

a vagina, that opens into a more or less extensile ovipositor. The bursa copulatrix and receptaculum seminis are generally present as accessory organs of the vagina. The male sexual organs consist of from one to six testes on each side, opening into a vas deferens, the two vasa deferentia usually expand to form a pair of vesiculae seminales, and then, receiving ducts from accessory glands, unite, to form a common efferent canal into the extensible penis.

The eggs are covered with an egg-shell or chorion which is generally not very firm, and are rarely, as in the case of a water-beetle (*Hydrophilus*), deposited in a nest. A few beetles are viviparous, among them certain rove-beetles (Staphylinidae) and the Stylopidae. One species of chrysomelid (*Gastrophysa raphani*) has been shown by J. A. Osborne to be capable of parthenogenetic reproduction. Apparent hermaphrodites rarely occur as monstrosities wherein some secondary sexual character of one sex is borne by an individual of the opposite sex, but no real case of hermaphroditic Coleoptera is known. Copulation sometimes takes place between different species of a genus, and less commonly between species of different genera.

The muscular system needs no special description. The Coleoptera are among the strongest of insects, and Professor F. Plateau found that the common European dung-bug (*Melolontha vulgaris*) could exert a traction along a horizontal surface equal to forty times its own weight.

The sense organs are necessarily partly external and partly internal, that is they are made up of modified external parts to receive impressions, and nerves connecting these parts with the central nervous system. The olfactory organs, as already mentioned, are in the antennae, and by their aid dung-beetles are guided long distances to their food, and certain other beetles to their mates of the other sex. Eyes and ocelli are the organs of sight. The location of the auditory organs has not been determined with certainty, but beetles surely hear, because they are often provided with sonorific organs. The sense of touch is especially developed in the antennae, palpi and tarsi, where the fine hairs communicate with nerves at their bases. The organ of taste has not been certainly located, but possibly in beetles it is upon the hypopharynx, an extension of the pharyngeal walls just above the labium.

Allusion has just been made to the fact that beetles often produce more or less musical sounds—stridulate as it is termed by entomologists. This stridulation is produced by rubbing different parts of the body, wings, or legs against each other, and is observed very commonly among the longicorns (Cerambycidae). If one of the red and black beetles with long antennae (species of *Tetraopes*), that are so abundant on different kinds of milk-weed (*Asclepias*) during the latter part of summer and during autumn, be pinned, in the usual way, upon the cover of a cigar-box, or upon anything else that serves as a sounding-board, the stridulation can be demonstrated to a considerable audience. By pressing from time to time upon the tip of the elytra of the *Tetraopes* the sounds will be renewed vigorously at the will of the experimenter, and the prothorax of the beetle will be seen to bend rapidly forward and backwards. The sound is produced by the rubbing of a sharp angular ridge upon the prothorax against a finely striated surface on the metathorax, a mode of sonification on a small scale similar to that where a boy runs along a fence pushing a stick against the pickets. H. Landois, who studied sound production by insects, asserts that all Cerambycidae, large and small species alike, are provided with stridulating apparatus, whether one hears their tones or not, and he draws from this fact the conclusion that beetles produce sounds beyond the reach of the human ear. In the grave-digger (*Necrophorus*)

sonification is the result of rubbing striated surfaces on the fifth abdominal segment against the posterior edge of the elytra. In a dung-beetle (*Geotrupes*) stridulation is brought about by action of the hind edge of the third abdominal segment upon corrugated surfaces on the coxæ of the posterior pair of legs. Stridulating sounds are produced by many other beetles, among which may be mentioned the following: *Prionus*, by rubbing the rough inner side of the hind thighs against the lateral margin of the elytra; *Passalus* by rubbing the acute edge of the ventral segments against the inner edge of the elytra; *Polyphylia*, *Anomala*, *Trox*, *Ligyrus*, and *Anthonomus* by rubbing together corrugated surfaces of the metathorax and elytra. The three-striped potato-beetle (*Lema trilineata*) and some other *Chrysomelide* stridulate.

Luminous organs are found mostly in the family Lampyridæ, but the larva of an elaterid, probably of *Melanætes*, and the famous fire-fly of tropical America, the imago of *Pyrophorus noctilucans*, another species of Elateridæ, are luminous, and will be further noticed when treating of their respective families. The mode of production of light by beetles has been the subject of many experiments and researches. Professor C. A. Young, the astronomer, has examined the spectrum of the light of a common fire-fly (*Photinus?*) and found that it was continuous, without lines, and that it extended from Fraunhofer's line C, in the scarlet, to about F, in the blue, indicating rays which affect the visual organs greatly without the production of much thermal or actinic effect.

Beetles live sometimes singly, sometimes gregariously, and inhabit almost every conceivable substance and locality; few are found in the ocean, or in salt-springs; the deepest caves are the habitats of blind species, of which those from the caves of Kentucky and of the Pyrenees have been most investigated; certain beetles are found in nests of ants and termites, and others even in mummies; there are water-beetles which inhabit hot springs; larvæ of certain Telephoridæ are often seen on snow; a few beetles, in their larval state, are parasitic in other animals, others inhabit galls on plants. The food of beetles is as diverse as are their habitats. The rule has been considered almost universal that Cicindelidæ, Carabidæ, Dytiscidæ, Coccinellidæ, and some other families were carnivorous, while Hydrophilidæ, Chrysomelidæ, and others were herbivorous. Late researches, especially dissections by Professor S. A. Forbes, have shown that species of some of these families eat much more diversified food than had been supposed previously. Of plants even the poison ivy and poison sumac (species of *Rhus*) do not escape the attacks of insects.

Beetles are attacked or destroyed by other organisms, chiefly skunks, birds, frogs, toads, and many reptiles and fishes, among the vertebrates; parasitic flies, wasps and mites, and many predaceous arthropods, among the articulates; numerous species of internal parasitic worms, among which *Gordius* and *Mermis*—so-called hair-snakes—play important parts; many species of Gregarina, protozoan forms, especially common in the intestinal canal of Tenebrionidæ; and finally, by parasitic fungi, which sometimes kill many beetles.

To avoid some of these enemies, beetles often mimic their surroundings, plants, or other insects. A common tortoise-shaped potato-beetle (*Deloyala clavata*), in New England, looks so closely like excrescences on the leaves of the potato that few birds would notice it. Another common North American chrysomelid (*Chlamys plicata*) often deceives collectors of insects by its close resemblance to a piece of caterpillar's dung on a leaf. H. W. Bates mentions that certain longicorns (Cerambycidæ) mimic closely the ill-tasting and disagreeably odorous fire-flies (Lampyridæ), even carrying

the mimicry so far as to have yellow spots on the abdominal segments to correspond with the luminous portions of the fire-fly. Other beetles imitate sticks, seeds, and parts of plants. The cocoon of a European weevil (*Cionus scrophularia*) resembles very closely the seed-capsules of the species of *Scrophularia* on which the larva feeds.

Other common means which beetles employ to escape from their enemies are dropping to the ground and feigning death, a practice of weevils; use of disagreeable odors and secretions, as is general with lady-birds; appearing as if about to bite or to sting, or rapid running and flying.

A few beetles have been made directly useful to man; indirectly a large number of them benefit mankind. Perhaps the blister-beetles (Meloidæ) are most evidently useful to man, since from them are derived the various forms of vesicatory medicines, known under the name of cantharides. In earlier times other beetles were used for medicinal purposes. The larvæ of the palm-weevil of tropical America (*Rhynchophorus palmarum*), or of other large palm-weevils, are roasted and eaten as delicacies by numerous tribes in the tropics of both hemispheres. The Cossus, which Pliny says Roman epicures fattened with flour, probably was the larva of *Prionus coriarius*, a longicorn; larvæ of *Prionus*, as well as those of other large longicorns, are still eaten roasted in many parts of the world. Beetles of many species are used as ornaments: fire-flies, imprisoned in gauze or otherwise confined, embellish the evening coiffure of ladies, both in the East and West Indies; the elytra or whole bodies of brilliant tropical Coleoptera are formed into pictures, are used to trim dresses and hats, are even set in jewelry; and, in some cases, a beautiful chrysomelid (*Chrysocoma auratus*), common in the eastern United States upon species of dogbane (*Apocynum*), has helped adorn ladies for evening parties in this part of the world. In China the people sometimes derive amusement from beetles, which they confine in order to watch them fight, in the same way as they confine species of *Mantis* for like purpose.

The indirect benefit which man derives from Coleoptera is fully as important as are the direct uses to which he puts them. Thousands of species of beetles prey upon plant-eating insects, others remove refuse and decaying animal and vegetable matter, still others help in fertilizing flowers; many furnish food to useful birds and fishes,—but it is futile to specify further in this direction.

Few beetles are directly injurious to man; when they bite it is in self-defence; but their injuries to crops, forests, fruits, lumber, buildings, furniture, carpets, and books are notorious, and can be best noticed later.

Beetles are divided into four great groups (Cryptotetramera, Cryptopentamera, Heteromera, and Pentamera), according to the number of segments of their tarsi. This classification is not perfect, in that a few families or genera fall into groups where they would not belong on account of their tarsal characters, but into groups in which they must be included on account of other important characters. The late Dr. J. L. LeConte, an eminent authority on North American beetles, divided the Coleoptera into two parts, the genuine Coleoptera and the Rhynchophora or weevils, but this division has not yet met with general acceptance.

To the Heteromera are added, in the following pages, the Stylopidae, a family which, according to some authors, forms an order of insects, the Strepsiptera. The Strepsiptera, for they are in all probability a separate order, have from two to four tarsal joints, according to the genus.

SUB-ORDER I. — CRYPTOTETRAMERA.

This sub-order includes beetles which have tarsi of four joints, of which one joint remains rudimentary. It contains two families, Coccinellidae and Endomychidae.

The first of these, COCCINELLIDÆ, or lady-birds, are approximately hemispherical beetles, mostly with brilliant coloration, generally red, yellow, black, and white, and a pattern usually of spots. Their head and prothorax are short, the abdomen with five, rarely six, ventral segments. Their legs are short, and project but little from beneath their bodies. The antennæ are short, although of eight to eleven joints, usually of eleven. Coccinellid larvæ all have a similar general appearance, are often quite prettily colored or clothed with warts and spines, and have three-jointed antennæ. Their comparatively active life necessitates good vision, which is provided for by three or four ocelli on each side of the head. The mesothoracic and first eight abdominal segments have stigmata. Pupation takes place upon fences, walls, trunks

FIG. 346. — *Micraspis phalerata*.

of trees, and leaves, the pupa hanging by its abdomen. The larvæ of most species feed upon other insects, chiefly upon scale-insects and plant-lice. The imagos feed upon plant-lice, other insects and their eggs, pollen and spores of plants, and a few upon leaves of plants. Some species of *Coccinellidæ* are abundant on special plants, but usually because those plants harbor the species upon which they preferably feed. While pollen and spores often form a large proportion of the food of lady-birds, the latter generally prefer animal food, and are consequently to be reckoned among useful insects. When rudely handled, lady-birds emit from the joints of their legs a yellow, odorous fluid,

which is said to be the blood of the insect emitted through a pore in the joint. The eggs of lady-birds are elongate-oval, yellowish; they are deposited in groups, without covering, upon leaves and bark. Lady-birds, or lady-bugs, have received, on account of their useful habits and the attention which their pleasant coloration has attracted to them, numerous complimentary names in different languages; the Germans generally term them *Marienkäfer*, but sometimes *Kugelkäfer*, *Marienvärmeln*, and like terms; by the French they are called *raches à Dieu*, and *bêtes à bon Dieu*. Individual colorational variation within the species is carried to its extreme in the Coccinellidæ, *Harmonia picta*, one of our native species, being so variable in figuration as to appear oftentimes in the collections of beginners in entomology as several distinct species.

Genera with numerous small species, which do not generally attract much attention, are *Seymus* and *Hyperaspis*. The larvæ of a number of European species of *Seymus* devour mites and their eggs, and one species is an enemy to the gall-inhabiting form of the grape phylloxera (*Phylloxera vastatrix*), while two American species are said to destroy chinch-bugs (*Blissus leucopterus*). *Brachycantha ursina* is a common small species in America, and is hemispherical, and black with reddish-yellow spots. *Hyperaspis coccidivorus*, one of our smallest species, is said by H. G. Hubbard to colonize upon the trunks of orange-trees which are thickly infested with certain scale-insects (Coccidæ), and to entirely free them from these pests. There is little doubt that these small species do as much good in destroying insects injurious to plants as do the larger species, but their minuteness has prevented their habits from being carefully observed.

Of larger species, *Chilocorus bifulvus* is black, nearly hemispherical, with a single red spot upon each elytron. It is often to be found about orchards, upon the trunks of the trees, and its spiny, dark-colored pupæ are not rare, three or four in groups, in crevices of the bark. This species, as well as *C. caeti*, found abundantly on the Pacific coast, prey upon scale-insects, and are consequently among the most useful friends of fruit-growers. In Europe *C. bipustulatus* is abundant in all stages on a species of huckleberry (*Vaccinium myrtillus*).

Coccinella is hemispherical, hairless, and contains many pretty species, which have received oftentimes scientific names to indicate the number or nature of their spots. Among them, *C. noronnotata*, the nine-spotted lady-bird, has a black and white head and prothorax, and reddish elytra, on which are nine round black spots. The figures give a good idea of the appearance of this species. *C. septempunctata*, the seven-spotted lady-bird, one of the largest and commonest European species of this family, resembles in a general way *C. noronnotata*, and was used in earlier times, like some other species of lady-birds, as a remedy for toothache. Forskål, late as 1775, enumerates *Coccinella* in the *material medica* of Cairo, Egypt. In the accompanying figure are a few other common European lady-birds.

FIG. 347. — *Coccinella noronnotata*, pupa above.

FIG. 348. — European lady-birds. a, *Coccinella dispar*; b, *C. impunctata*; c, *Chilocorus bipustulatus*; d, *Coccinella septempunctata*, and e, larva; f, *Microspis duodecimpunctata*.

Adalia bipunctata is our most common species, and is often called the two-spotted lady-bird. Its head is black, with two yellow spots on each side above; prothorax black, with yellow lateral portions, and a few dorsal yellow spots; scutellum black; elytra reddish-yellow, each with one central round black spot. Beneath, the epipleurae are reddish-yellow; the margins of the prothorax yellow; all else black. This species hibernates in large numbers under bark, in barns, and even in houses. In early spring the two-spotted lady-birds come out of their hiding-places and lay their oblong yellow eggs in little masses upon the bark of trees, choosing localities where there is a prospect of an abundant supply of plant-lice, upon which their larvæ feed. A few of these beetles brought indoors and put upon house-plants will seek out the plant-lice, and the females, if they discover a colony of plant-lice, will deposit their eggs near

them, insuring their destruction as soon as the eggs hatch. The full-grown larvæ have a similar form to that of *Hippodamia convergens*, are black, with a yellowish spot on each side of the first, and another on the dorsum of the fourth abdominal segment. When ready for pupation the larva attaches its abdomen to some object, shortens and swells itself up so as to split its larval skin, and, thus freed from it, appears as a pupa in new colors and form. The spotted pupa, for the most part black and pink, is likewise similar to that of *Hippodamia convergens*. The imago, after it emerges from the pupa is, for the most part, very soft, and pale yellow, but it becomes quickly harder and darker-colored. *A. bipunctata* is especially abundant during the latter part of summer and in autumn on birch trees, probably attracted to these trees by the plant-lice which during that part of the year abound on birches.

Another genus, *Hippodamia*, contains species that are more elongated than those of *Coccinella*, and a number of them are common in the United States. *H. convergens* and *H. tredecimpunctata* are known to devour the eggs of the Colorado potato-beetle, while on the Pacific coast *H. ambigua* is also of economic value. *Megilla maculata*, which has a similar form and is often mentioned as a *Hippodamia*, besides eating plant-lice, preys extensively on the chinch-bug, and also eats the eggs of the Colorado potato-beetle.

Its eggs are similar to, but smaller than those of the potato-beetle and might be mistaken for them.

Epilachna borealis, the northern lady-bird, which is honey yellow with black spots, was supposed for a long time to be the sole North American species of this family which was a vegetable-feeder. The larvæ of this species feeds upon gourd, squash, and pumpkin vines, and the imago eats the same food. The larva is yellow and is clothed with black-tipped spines. The corresponding European species, *E. globosa* and *E. undecimmaculata* are phytophagous, the former often doing considerable damage to lucern, and now and then eating other plants, while the latter attacks bryony.

To the family ENDOMYCHIDÆ belong nearly four hundred described species which live, both as larva and imago, upon fungi. The species are distinguished from the lady-birds by their cylindrical palpi and long antennæ, and often by their prothorax having grooves at its base, and by their elongated head, the lady-birds having grooveless prothorax and short head. The tarsi are manifestly four-jointed in some genera of Endomychidæ. The species are numerous in the tropics, many species being found in Brazil, where, according to H. W. Bates, they hold a sort of complementary relationship to the Erotylidæ, — another fungivorous family, the species of which closely resemble Endomychidæ, although the species of the former family mostly have cryptopentamerous tarsi, — in that the Endomychidæ devour small fungi while the Erotylidæ live upon large ones. The species of both families are slow in their motions and some of them are gregarious.

Mycetina vittata, one of our most common species of Endomychidæ, is flattened, reddish-brown in ground coloration, with the sutural or median portion of the elytra black, and with a black stripe along the middle of the outer portion of each elytron. This species is often found, in groups of a few to a hundred semi-torpid specimens, under half-decayed stumps, or more rarely under boards, about mid-winter in New England.

FIG. 349. — *Hippodamia convergens*; a, larva; b, pupa.

FIG. 350. — *Mycetina vittata*.

Sometimes the antennæ of species of this family are rendered quite ornamental by dilation of the last three joints, as in the male of *Phymaphora pulchella*.

SUB-ORDER II. — CRYPTOPEPTAMERA.

This group includes beetles which in reality have five tarsal joints, one of which is abortive and hidden, giving them the appearance of having four-jointed tarsi.

The CHRYSOMELIDÆ, the so-called leaf-eaters, includes over ten thousand described species, none of which reach a very large size. They attain their highest development in the tropics, although found in fair numbers in all parts of the world. They are usually short-bodied, somewhat oval in outline, sometimes considerably flattened from above, and often have their head more or less concealed in or beneath the forward end of the prothorax. There are five abdominal segments; the trunk is generally covered by the elytra and broader than the prothorax, which latter is broader than the head. Many of the species of Chrysomelidæ are brilliantly colored, some with metallic or iridescent lustre. The antennæ are rarely as long as the body, are eleven-jointed, as a rule, but in some genera the number of joints is less. The mandibles are mostly split at the tip. The legs are seldom long, and consequently their walk is slow; wings fail in a few cases, for example in *Timarcha* and in the females of *Metacycela*.

The eggs of Chrysomelidæ are laid in many cases upon the leaves or stems of plants without being covered. They are usually elongated and yellowish. The first brood of larvæ are mostly hatched from eggs laid in spring by beetles that have hibernated under bark and leaves. The larvæ of Chrysomelidæ vary exceedingly in form and habits; the head is small; the body ordinarily has thirteen segments, of which the three thoracic ones are always provided with legs, and are generally smaller than the abdominal segments; the prothorax of many species is distinguishable by its form, color, and firm consistence of its dorsum; the terminal segment of the abdomen in many species is prolonged below to form a retractile simple or bifid process which assists in locomotion, and behind which is the anus. Lacordaire classified the larvæ of Chrysomelidæ in a way to indicate much concerning their habits as well as their structure; the following is an abstract of his divisions. First, elongated, whitish, sub-cylindrical larvæ, living at the base of aquatic plants (*Donacia*). Second, larvæ which cover themselves with their excrement. Short, oblong, brownish larvæ, without special device for carrying their excrement (*Lema*, *Crioceris*). Oval, broad, spiny larvæ, bearing their excrement upon a fork attached to the anal segment (*Cassida* and its allies). Third, miners. Elongated, sub-cylindrical larvæ tapered at both extremities (*Haltica* and other flea-beetles). Oblong larvæ, attenuated at the two ends, and having lateral warts (*Hispa*, *Odontota*). Fourth, short, thick, colored larvæ, generally provided with a false anal foot, often warty, and living exposed on plants (*Chrysomela*, *Doryphora*, *Gastrophysa*). Fifth, elongated, sub-cylindrical, warty, whitish larvæ, curved upon themselves at their posterior end, and living in cases on plants or in ants' nests (*Clythra*, *Cryptocaphidus*).

The larvæ move slowly, eat parts of plants, usually the leaves, sometimes the roots, and each species generally confines its attacks to one kind, or at most to one family of plants, both larva and imago often eating the same plant. Not only the larvæ but often the imagos are in many species gregarious. Birds do very little to reduce the number of these larvæ, many of which have disagreeable odors, while others are protected by covering themselves with their own excrement, and still others are hidden

in cases and mines, or not noticed by birds on account of their minuteness; as a result of this immunity from attack species of Chrysomelidae often become serious pests, as is the case with the Colorado potato-beetle.

The pupal state is passed, as a rule, as follows: underground, often with slight cocoon, by the first half of the larvæ mentioned in Lacordaire's second group, and by some of those of his third and fourth groups; under water in a cocoon attached to stems of water-plants, by species of his first group; in the leaf-mines by some species in his third group; upon leaves by the second half of his second group, and by most of his fourth group; and in larval cases by the species of his fifth group.

Entomologists usually divide the Chrysomelidae into tribes, divisions which, to a certain extent, coincide with the groups of larvæ before mentioned, but forms of especial interest will be discussed here in their systematic order, without further subdivision of the family.

Species of *Cassida* and allied forms are recognized by the excessively wide margins of the prothorax and elytra, and by the head being partly or wholly concealed beneath the forward margin of the prothorax, the whole insect thus presenting a flattened, roundish, scale-like aspect. Among tropical species very brilliant coloration is found.

FIG. 351.—*Mesomphalia conspersa*.

Desmonota variolosa is a round metallic-green species from South America, not rarely seen set in jewelry: its elytra are so hard as to resist the point of a slender pin. *Mesomphalia conspersa*, another South American species, which has an elevated protuberance formed by the anterior part of the elytra, is dull metallic blackish green, with velvety black in round punctures, and with six larger spots that show as burnished gold through a downy pubescence. Many of our own species which resemble *Cassida*, feed upon plants of the

potato family (*Solanacea*), upon the sweet-potato (*Ipomœa batatas*), and others of the morning-glory family (*Convolvulacea*). *Coptocephala aurichalcea*, found on the wild morning-glory, is brilliant gold-color, which is said to vary in shade with the emotions of the animal, and which disappears when the insect dies. The larva of this species was long ago described by T. W. Harris, and later by Dr. C. V. Riley; the latter added a description of the egg. The egg is about 0.04 of an inch long, of rather irregular angular form, flat, and usually furnished with spine-like appendages. They are laid singly upon the leaves of the food-plant of the larva. The larva is flat, oval, dark brown, with a paler shade upon the back, and is margined with a row of branched spines; while, by means of its anal fork, it carries over its back, as protection from predaceous animals, a parasol made of its own molted skins and excrement. Pupation takes place in a spiny, flattened pupa which is attached to the leaves of the food-plant by a sticky secretion. Unlike the pupæ of most beetles, this one does not have its legs free, although it can raise itself up at will, perpendicularly to the surface on which it is attached. The first brood of beetles emerge from their pupæ about July, having undergone their metamorphoses in a few weeks, and lay the eggs for a fall brood.

Coptocephala churuta, a common potato-beetle in New England, is very dark brown, with thin yellow margin, the transparency of which is interrupted by a dark brown patch at the anterior extremity of, and another just behind, the middle of each elytron, giving the beetle a curious turtle-like appearance, in fact the resemblance of species of *Cassida* and *Coptocephala* to turtles has given them the common name of 'tortoise-beetles.'

Chelymorpha cribraria, found on milkweed (*Asclepias*), is not as much flattened as *Cassida*, is reddish, with a number of round, black spots on the pronotum and elytra, giving it a slight resemblance to a lady-bird.

Odontota has a somewhat quadrate, or wedge-shaped form, narrowed in front, distinctly eleven-jointed antennæ, and coarsely punctured elytral striae. *Odontota scutellaris*, the flattened larvæ of which mine in the leaves of the locust, is a common species, whose devastation extends to a number of trees besides the locust. It is dull yellow, with a black stripe upon the suture between the elytra, a black head, and is black beneath. The larvæ appear in New England in July, and transform to beetles in August, after a short pupation in the leaves of the locust.

FIG. 352.—*Odontota rubra*.

Quite a number of Chrysomelidae have the hind femora much thickened, enabling them to jump. Some of the smaller species jump with great activity, and on that account have been termed flea-beetles. Once the flea-beetles were united in the genus *Haltica*, a name from a Greek word, meaning good at jumping, but they have been divided since into numerous genera. Some of the flea-beetles hibernate as larvæ, others as imagos. Many of them are seriously injurious to plants, the leaves of which they either mine or fill with small holes. In this way the leaves of tobacco are often rendered unfit for cigar-making by a species of *Crepidodera*.

Flea-beetles of the genera *Psylliodes* and *Dibolia* bore, in the larval state, in the stems and leaves of succulent plants. *P. chrysoccephala*, in Europe, devastates turnip fields, but often turns its attention to other crops. *D. arca*, a little, round blue-black beetle, often swarms in this country from May until the beginning of winter, on the plantain (*Plantago major*) the leaves of which it riddles.

The early stages of *Phyllotreta striolata*, the turnip flea-beetle will suffice to give an idea of the transformations of flea-beetles. The larva is linear, about 0.35 inch long, has an anal prop-leg; it is whitish, with head and posterior extremity light brown. The white pupa is enclosed in a little earthen cocoon beneath the ground. Pupation lasts about two weeks. The beetle is less than 0.1 inch long, black, with a wavy yellow stripe on each elytron. The larva feeds upon roots of cabbages and turnips underground, causing death of the plants; the imago eats the leaves of the same plants.

Phyllotreta nemorum, a European flea-beetle, devastates turnip-fields, while its orange-yellow larva bores the leaves of the young plants; like its American congener it eats other species of cruciferous plants. *Crepidodera cucumeris*, a black flea-beetle about 0.06 inch long, which, as its name indicates, infests the cucumber, does not confine itself to that plant, but mines the leaves of potatoes and of many other plants. *C. carinata*, a green species, sometimes injures greenhouse plants, and seems especially destructive to fuchsias. *Graptodera chalybea*, a flea-beetle usually steel-blue, and about 0.15 inch long, is a pest to grape-growers, for it not only eats the leaves, but it destroys the buds of the grape. Its larva feeds externally on the leaves, descending into the earth to pupate. The imagos hibernate, laying their orange-colored eggs in clusters on the grape leaves in the spring.

Among the large species of saltatorial Chrysomelidae, two genera, *Edionychis* and *Disonychia*, are represented by numerous species in the fauna of eastern North America, and another genus, *Blapharida*, by a single species. The species of *Disonychia* are often prettily colored. *D. alternata*, a common species on willows, is about 0.3 inch long and half as wide, has a reddish head with black eyes and antennæ, a reddish pro-

thorax with two round, black spots each side of the middle, and dull yellow elytra with sutural and marginal black line from their bases to their tips, and a black line extending from the base to near the tip upon the middle of each elytron. This species is dull red with black markings beneath. *Elyonychis* differs from *Disonycha* in having the last joint of the posterior tarsi globosely inflated at the tip. *Elyonychis thoracica* has deep blue elytra, yellowish head and epipleuræ; eyes and antennæ are black, and the yellowish prothorax bears a few black spots. *Blepharida rhois* is a yellowish beetle above with brown blotches on the elytra, which latter are also punctate with dark brown dots. The eyes, antennæ, legs, and under side of the abdomen are dark brown. Its length is about 0.25 inch; its antennæ are set wider apart than in most flea-beetles, resembling, in this respect, *Chrysomela*, from which it is readily distinguished by its thickened thighs. Its eggs are deposited, five or six together, beneath pellets of its excrement. Its yellowish larva which is, like the beetles, abundant on leaves of sumach (*Rhus*), covers itself with its own excrement by means of its extensible anus. The larva is broader than the larvæ of other saltatorial Chrysomelidae, thus approaching the form of larva in the genus *Chrysomela*.

Structurally similar to the larger flea-beetles, and like them having the antennæ set in close approximation between the eyes, but separated from them by their slender femora, are the genera *Diabrotica* and *Galeruca*; the species of the former genus have a carinate front, while those of the latter have a flat front with an impressed median line.

Galeruca xanthomelana is a species introduced into America from Europe, according to Townsend Glover, as early as 1837, and does considerable damage to the elm in both countries. The beetle is about 0.25 inch long, oblong, brownish yellow or yellow, marked with black as follows: one or two spots on the head, three on the pronotum, and, on the elytra, a very narrow sutural line, outside of which, on each side, is a broad stripe not reaching the apices of the elytra. The yellow, oblong-oval eggs are deposited on the under side of the leaves in groups of from three to twenty or more. The egg state lasts about a week. The larvæ, of which the first brood appears in May, are nearly cylindrical, yellowish black with black markings; they change their skin three times after leaving the egg before pupation, thus having four larval stages, which last ordinarily about two weeks, but under especially favorable conditions only six or eight days. The pupa is oval, with a few conspicuous black bristles, and is found in crevices of bark or of the ground, or on the ground beneath leaves. The pupal state requires from six to ten days. There are three or four broods yearly, according to climate. The beetles of the last brood hibernate, and the few survivors of the winter lay the eggs for the first brood early the next spring. Both larvæ and imagoes feed upon the elm, partly skeletonizing its leaves, but of course the greater part of the damage is done by the larvæ. Each successive brood is usually larger and more destructive than the preceding one, but the majority of the last brood each year is killed by the frost of winter. In Austria the larva, as well as the imagoes, are said to hibernate. Dr. C. V. Riley, who has investigated this species in Washington, D. C., writes of its enemies: "Among these there are *Platypus punctiformis* and *Quedius molochinus*, which feed on the full-grown larvæ when these retire for pupation, and also on the pupæ. The larva of a *Chrysopa* (probably *C. rufilabris*) feeds upon the eggs of the *Galeruca*; *Reduvius novemarius* sucks both beetles and larvæ on the leaves, while *Mantis carolina* preys upon the beetle. Of the numerous other insects found among the pupæ under the trees, *e. g.*, *Tachyporus jocosus*, sundry spiders, myria-

pod, etc., several are doubtless enemies of the *Galeruca*, though we have, as yet, no proof of the fact. Many birds were observed on the trees infested by the beetles, but the English sparrow, which was the most numerous, did not feed on the insect in any stage of growth."

Very closely related to the numerous species of *Galeruca* is *Trichabda*. *T. tomentosa*, a common insect on species of golden-rod (*Solidago*) in the eastern United States, is about 0.4 inch long, and of a dingy yellowish brown with three dull, black longitudinal stripes on the elytra, three black spots on the prothorax, and one on the head.

Probably few persons have failed to notice the small, yellow and black striped beetles, *Diabrotica vittata*, which swarm upon cucumber, squash, melon, and similar vines, almost as soon as they appear above the ground. This beetle is elongate-oval, about 0.22 inch long; the elytra are striate; the general color is straw yellow with a black stripe along the middle of each elytron, reaching from its base nearly to its tip and a stripe covering the elytral suture; head, knees, tips of tibiae, and tarsi are black. The damage, often considerable, which this beetle does to young cucumber vines above ground is slight compared with that which its larva does to the roots below the surface of the soil. At the time when these beetles are swarming about the young vines, they lay their eggs at or just below the surface of the ground on the stems of the plants. These eggs soon hatch, and the larvae feed upon or bore into the roots and stems of the plants for nearly a month, when they pupate in a little oval cavity which they form in the ground. The pupal state lasts about two weeks. The larvae are slender, cylindrical, about 0.4 inch long, and nearly white; their head is brownish, and they have a brownish spot on the dorsum of the posterior segment. This species hibernates as imago, and is said to do so as pupa; the rapid growth of its larva enables it to have from two to three broods each year. In early spring, before cucumber vines are out of the ground, these beetles attack pear, peach, and other blossoms; and I have found them especially abundant on the flowers of the shad-bush (*Amelanchier canadensis*). While the beetles eat a few cucumber plants, confining their attacks entirely to portions above ground, the larva a little later cause whole plants to wither and die. It is the practice of many farmers to sow an extra number of seeds in each hill, so that, after some are destroyed, enough will still remain; others protect their plants with muslin or other screens, both from the attack of the imagos and from their ovipositing on the plants; still others sprinkle their young plants with lime, paris green, hellebore powder, or similar insecticides. Dr. H. Shimer discovered the larva of a small parasitic fly occupying the abdomen of females of this beetle, and, having bred the fly, named it *Tachina diabroticæ*. The fly larva leaves its hosts when it is full-grown, and pupates on the surface of the ground, emerging from the pupa in less than two weeks. Parasitism of the imagos of Coleoptera by Diptera, as in *Diabrotica*, is not very common.

FIG. 353. — *Diabrotica vittata*.

Another species of *Diabrotica*, of a greenish yellow ground color, with twelve large, black spots—some of which are at times confluent—upon the elytra, is *D. duodecimpunctata*. The elytra of this species are not striate; the abdomen and bases of the femora are yellow. This species sometimes attacks cucumber, melon, and squash vines, and is said to damage the leaves of the dahlia, but I have found it most abundantly on the flowers of the golden-rod (*Solidago*). The larvæ of *D. longicornis*, another species, bores in the roots of corn.

No chrysomelid has attracted more attention or has been more extensively studied than the Colorado potato-beetle, *Doryphora decemlineata*. This species was first described by Thomas Say, an early American entomologist, in the year 1824, from specimens taken a few years before, on the upper Missouri River, near the base of the Rocky Mountains. This insect, as was later discovered, fed upon sand-bur (*Solanum rostratum*) in its native home, but as the cultivation of the potato was extended westward in the northern United States, this beetle found the latter plant so well suited to its tastes that about 1859 it began spreading over the northern United States at a rate which, until it reached the Mississippi River, did not exceed fifty miles a year, but at a steadily increasing rate, as it reached regions with denser population and more railroads, until in 1874, it reached the Atlantic coast in many places; a total average annual rate, according to Dr. C. V. Riley's estimate, of about eighty-eight miles. It is now so common in all the northern States and in Canada that the inhabitants of these regions need no figures or descriptions to recognize it, but the people of regions not yet infested may recognize the beetle and its earlier stages by the accompanying figures and a brief description. A figure is added of the nearly-related *Doryphora juncta*, a species which has been often mistaken, even by entomologists,

FIG. 354. — *Doryphora decemlineata*, Colorado potato-beetle, eggs and larva. On the right, *D. juncta*.

for the Colorado potato-beetle, although it does not attack the potato, but lives upon the horse-nettle (*Solanum carolinense*).

Both *D. decemlineata* and *D. juncta* have a brownish yellow ground color; the prothorax is marked with black spots, usually eighteen in number, but which are subject to variations of exactly the same nature in both species; upon each elytron are five longitudinal black stripes, two of which unite at the apical end of the elytron. In *D. decemlineata* it is, however, always the third and fourth stripe, counting from the outer edge of the elytron, that unite at their tips; in *D. juncta* it is always the second and third, counting in same way, that unite, while in the latter species the space between the second and third stripes is generally brownish. The legs of *D. juncta* are pale, except a black spot on the femur, while the tarsi and knees of *D. decemlineata* are black.

The female Colorado potato-beetle lays from five hundred to one thousand eggs during the season, from ten to forty at a time, in clusters on the under side of potato leaves. These eggs are oblong, about 0.06 of an inch long, fastened by one end, and are orange yellow. The eggs of *D. juncta* are lighter colored. The eggs hatch in about a week; the convex larvae are at first dark reddish brown, becoming paler and brighter in coloration as they increase in size. The full-grown larva is about 0.5 long, with the abdomen much convex above. Along the sides of the abdomen are two rows

of black spots, the head and feet are black, and there is a ring of the same color upon the second segment. The head and legs of *D. janthina* are, on the contrary, pale, and they have but one row of black dots on each side. The larvæ of the Colorado potato-beetle attain their full growth in from fourteen to eighteen days, and go under ground to pupate, where they form a naked yellow pupa. The pupal state lasts about ten days, so that only about a month is required for all stages together, from the egg to the perfect beetles. This enables these insects to have from two to four broods yearly, and as the females do not lay their eggs all at one time a succession of larvæ is produced, so that one may find the species in every stage of growth at any time during summer and autumn. Both beetles and larvæ feed on the same plant. The beetles hibernate underground and lay eggs the next spring.

The immense armies of these beetles which have at times attacked potato-fields, where they could be gathered by measure rather than by number, have rendered them a serious pest to farmers, and their actual destruction of whole fields of a vegetable almost necessary to human existence in some countries has caused *Doryphora* to be the subject of much careful investigation, and of some legislation. European nations have sometimes prohibited the importation of American potatoes, and fines have been imposed in England for possessing living Colorado potato-beetles.

The sudden spreading of *D. decemlineata* over an area of about 1,500,000 square miles has not only been accompanied by a change of food-plant from one species of Solanaceæ to others, but even to plants of other families. It will eat, when potatoes are not at hand, cabbage, common thistle (*Cirsium lanceolatum*), pigweed (*Amaranthus retroflexus*), hedge-mustard (*Sisymbrium officinale*), and numerous other plants, and when absolutely compelled by hunger it has been known to eat grass and the cultivated oat. Most all widely distributed insects are subject to considerable variation; the Colorado potato-beetle forms no exception, and the fact of its extensive distribution in so short a period as twenty-five years in portions of America having considerable diversity of climate, together with the variations consequent upon difference of food-plants to which it has accommodated itself, makes these variations of pattern, color, and size furnish, as Dr. Riley has observed, "interesting material for the close species makers," and indicates a fertile field of investigation of the variations which twenty-five years or less of changed environment can produce in a species the whole history of the spread of which is comparatively well recorded.

As *Doryphora* itself spread like a wave of destruction over the country, for the first few years its depredations in any region were scarcely hindered, but later, while man was learning how to poison it, lower animals were developing a taste for it. The lady-birds attack the eggs and larvæ; numerous species of Hemiptera, such as *Podisus spinosus* and *Harpaactor cinctus*, suck out the juices of the larvæ; a fly (*Lydeella doryphora*) lives in its larval state as a parasite within the larvæ of *Doryphora*, and has been found so abundant in places as to nearly exterminate the beetle; and the eggs and larvæ are eaten by several beetles, among which *Lobbia grandis*—once not very common—has apparently increased in numbers on account of the food-supply which *Doryphora* furnishes. The above-mentioned insects are selected from over two dozen species known to attack *Doryphora*. Among wild birds the crow, quail, rose-breasted grosbeak (*Goniapheca ludoviciana*), and cardinal grosbeak (*Cardinalis virginianus*); and, among domesticated birds, the duck, devour these beetles. In some cases chickens have acquired the habit of feeding upon them, and the common toad does good service in eating large numbers of them.

Among the many insecticides which are used to reduce the numbers of *Doryphora*, Paris green and London purple are generally considered best. Paris green, or as it is sometimes called Scheele's green, is an arseniate of copper often used as a pigment. It is extremely poisonous, and is diluted with twenty times its weight of flour and sprinkled with a sieve upon the potato-plants. London purple, which is a waste product of anilin manufacture, contains about forty per cent of arsenic, and although very much cheaper than Paris green it is still more poisonous, and is used in the same way, diluted with about thirty-six parts of flour. In all cases where these poisons are used cattle should be carefully excluded from the fields.

Severe cases of poisoning from handling the beetles themselves, in quantity, have been reported: likewise the vapor arising when they are killed by scalding is said to be poisonous. While such cases of poisoning are apparently authentic and are not improbable, yet the question of the poisonous nature of *Doryphora* is one that requires much further careful investigation than it has received.

Very closely related structurally to *Doryphora*, which is itself sometimes retained in the genus *Chrysomela*, is *C. clivicollis* and *C. scalaris*. *C. clivicollis*, which is often called *C. trimaculata*, is about 0.4 inch long, with deep blue head, thorax, antennæ, legs, and under-side, while the elytra are reddish orange with a few blotches of black upon them. Its reddish larva, which resembles in form that of *Doryphora*, feeds, like the imago, upon species of milk-weed (*Asclepias*). *C. scalaris* is one of a group of chrysomelids which have the elytra covered with curious hieroglyphic stripes and markings, whence they have been given by some authors the generic name of *Calligrapha*. The greenish-black and white imago, which is about 0.3 inch long, after passing the winter under leaves and in rubbish, appears early in the spring upon elm and linden trees and on the alder. Its eggs are deposited in May and June, and the larvæ of the first brood reach full growth by the end of the latter month. The larvæ have similar form to those of *Doryphora*, but are whitish, somewhat spotted with black. Similar species of *Calligrapha* are found on the hazel (*Corylus*), on *Viburnum*, and on willow (*Salix*).

FIG. 355. — *Chrysomela clivicollis*.

In southern Europe the larva of *Chrysomela diluta* is nocturnal, as is the case with some lepidopterous larvæ, and comes out of its hiding places where it spends the day to feed upon a species of plantain (*Plantago coronopus*) at night. The larvæ of a few chrysomelids have a habit, when disturbed, of forcing out upon the tips of spines which are arranged in rows along their bodies, little drops of a disagreeably odorous milky fluid. These drops of a secretion, which is, of course, defensive in function, can be again withdrawn into the spines when danger is past. Professor C. Claus found salicylic acid in the larva of *C. populi*, the European species in which this peculiar secretion has been most studied. In America larvæ of *Plagioderma scripta*, *P. lapponica*, and *P. tremula* have similar secretions.

Gastrophysa polygoni is an oblong beetle, about 0.15 inch long, of which the prothorax, legs, and basal joints of the antennæ are reddish brown, the rest of the insect shining blue, except in the case of females when they are much distended with eggs; then the portions of the distended abdomen which the elytra cannot cover are yellow or yellowish brown. This beetle is very abundant from April to September upon common knotgrass (*Polygonum aviculare*) both in Europe and in America. The groups of yellow eggs on the leaves of the knotgrass hatch in from eight to eleven days. The yellow larvæ resort to the ground for pupation. There are two or three

broods yearly. J. A. Osborne found that parthenogenesis sometimes occurred in *G. raphani*, a species found in England.

The most brilliant perhaps of the American species of Chrysomelide belong to the genus *Chrysochus*. This genus, and a few others associated with it, differ from *Chrysomela* and the forms just described in that they have the third tarsal joints bilobed. *Chrysochus auratus*, from the eastern United States, is oblong-oval, about 0.4 inch long, of a brilliant metallic green, which, viewed in different directions, changes to deep red or bright blue shades. During July and August this species is very common on dog-bane (*Apocynum*). In the Pacific States *C. cobaltinus*, of a changeable cobalt-blue, is very common.

Belonging in the group with *Chrysochus*, but less brilliantly colored, are *Adoxus*, *Fidia*, *Colaspis*, *Paria*, *Scalotonta*, and *Pachnophorus*. The larvæ of *Adoxus vitis* — a little pubescent black species with brownish-yellow elytra and legs, and with the first four joints of the antennæ pale — does much damage to the grape in Europe and is found in America. It is about 0.1 inch long. *Fidia viticida*, a chestnut brown species with short whitish hairs, injures the grapes in the Western States by riddling their leaves. The beetle is about 0.3 inch long. *Colaspis flarida*, a clay-yellow species about 0.25 inch long, attacks the grape, upon the roots of which its larvæ feed. *C. brunnea*, a brown species of which *C. flarida* has been considered a variety; *Paria aterrima*, a black species of about the same size as *Colaspis*; and *Scalotonta nebulosus*, an ashy gray species of like size, all feed as larvæ upon strawberry roots, the larvæ of three species being very much alike. *Pachnophorus cylindricus*, which is figured, is from Europe and northern Africa.

FIG. 356.—*Pachnophorus cylindricus*.

FIG. 357.—*Cryptocephalus confluentus*.

The species of *Cryptocephalus* are short, cylindrical, and generally small. They resemble those of *Pachybrachys*, but in the latter genus the prothorax is margined at the base and not crenulate, while in *Cryptocephalus* it is not margined at the base and is crenulate. In both genera the prothorax is nearly as wide as the elytra are, and the perpendicular head is set deeply into the prothorax; the antennæ are filiform. The larvæ inhabit little cases upon leaves of different trees. Beetles and larvæ alike have a habit of falling to the ground when disturbed, thus escaping observation. The number of species of *Cryptocephalus* and *Pachybrachys* is large, there being in the United States about forty described species of each genus. The species are usually prettily marked with colored stripes or spots. *Cryptocephalus confluentus*, which is figured, will give a good idea of the form and of one type of figuration in these genera. It is a pretty North American species, in which the general coloration is yellow, that of the thorax being tinged with brick-red, while three black longitudinal lines adorn each elytron. Two of these lines are confluent upon the elytral suture, whence the specific scientific name. Westwood mentions that the larval cases of a species of *Lamprosoma*, a genus near *Cryptocephalus* in classification, mimic with remarkable accuracy the buds upon the bark of the trees on which the larvæ feed.

In Europe there are numerous species of a genus resembling, in general, *Cryptocephalus*, but of larger insects; this is *Clythra*. In *Clythra*, however, the antennæ are serrate and the anterior coxal cavities are confluent, not as in *Cryptocephalus* separated

by the prosternum. No species of *Clythra*, properly speaking, have been found in the United States, but a nearly related genus, *Coscinoptera*, is represented by several species. The larvæ of *Clythra* and *Coscinoptera* are case-bearers, and the larvæ of *Clythra quadrisignata*, a common European species, although normally feeding on willow, has been often found in ants' nests. A part of the life-history of our most abundant species, *Coscinoptera dominicana* has been described by Dr. C. V. Riley. The beetle is about 0.22 inch long, and is, with the exception of the yellowish brown labrum, entirely black; the upper surface is densely punctate, the under side covered with ashy gray pubescence. The eggs are attached in groups to plants, and each egg is borne upon the end of a delicate silk-like stalk, thus resembling somewhat the eggs of the lacewing (*Chrysopa*). The egg is covered, as is also the case with the eggs of most species of *Cryptocephalus* and of *Clythra*, with markings formed by the excrement or by a secretion of the beetle. The eggs hatch in from fourteen to eighteen days, and each egg-shell serves the newly hatched larva for a case, into which it withdraws on the slightest disturbance. The young larva feeds on dead and decaying leaves of many kinds of trees. When its case becomes too small to accommodate its increased size, it cements pieces of earth upon the margins of the egg-shell, using saliva to make the materials adhere. Thus a ridged case is formed, in which the larva passes its life, probably requiring two years for full growth, and pupating finally in its case, after the entrance of the latter is sealed up and the whole case firmly secured to some surface.

Chlamys, of which the larvæ are also case-bearers, differs from *Cryptocephalus* and *Coscinoptera* in being covered with large tuberosities, and in having grooves in the flanks of the prothorax to receive the antennæ. The species generally have metallic coloration, sometimes dull; some of them, including our commonest species, *Chlamys plicata*, so closely resemble a piece of caterpillar's dung that birds would not pick them from a leaf. The eggs of *C. plicata* are borne upon short peduncles, and it has been discovered that, before they are protected by a coating of excrement or of secretion by the female, they are greedily sought for and devoured by the males. The larva feeds on oak, sycamore, blackberry, and sweet-fern, and inhabits a nearly smooth sub-globular case, which is formed, as in *Coscinoptera*, by additions to the egg-shell. Pupation takes place in the case, previously secured to a leaf by its oral end, and the imago, when about to emerge, cuts a lid from the aboral end of the case.

Two genera, *Lema* and *Crioceris*, the latter introduced from Europe, represent in North America another group of Chrysomelidæ. The characters of this group may be summed up as follows: prothorax narrower than the elytra, not margined; middle ventral segment not narrowed, and last dorsal segment covered by the punctato-striate elytra; prosternum very narrow; first ventral segment scarcely longer than the second.

Lema has the prothorax constricted at the middle. The best known North American species is *L. trilineata*, a common potato-beetle. It has a reddish yellow head and prothorax, and three longitudinal black stripes on the elytra. Its yellow eggs are attached to the under side of potato leaves; they hatch in about a fortnight. The yellowish larvæ have their anal opening on the upper side of their terminal segment, and they cover themselves with their soft, greenish excrement. At the end of about two weeks the larvæ descend into the ground, free themselves of their excrement, form an earthen cocoon with the aid of gummy matter from their mouth, and pupate. Pupation lasts about a fortnight.

Crioceris has a cylindrical prothorax. *C. asparagi*, the common asparagus-beetle

FIG. 358. — *Lema trilineata*.

of Europe, was introduced into America, near New York city, about 1856, and since then has been slowly spreading over Long Island and New Jersey. The beetles that have hibernated appear in early spring, and lay their blackish-brown eggs upon shoots of asparagus as soon as the latter come out of the ground. The full-grown larvæ are about 0.25 inch long, ashy gray or obscure olive green, with shining black head and legs, and a row of small warts of the same color along each side. The pupa is enclosed in a slight cocoon, just underground or beneath leaves and rubbish upon the surface. The egg state lasts about eight days, the larval stage about twelve days, and pupation about ten days. The beetle is about 0.25 inch long, and the arrangement of its colors—black, yellow, and red—is somewhat variable. The head is black; the prothorax reddish, often with two black spots above; the elytra are yellow, with a sutural stripe of black, from which stripe extends two black bands dividing the yellow part of each elytron into three portions, which vary from three dots to three broad bands, according to the width of the black sutural stripe and its branches. Beneath the beetle is nearly or entirely shining black. Recently a second European species of asparagus-beetle, *Crioceris duodecimpunctata*, has been introduced into Maryland. The upper surface is orange red, each elytron having six black dots.

Differing structurally from *Crioceris* by their very long first ventral segment, are the numerous species of *Donacia*, found upon water-plants. *Donacia* resembles, in general appearance, the longicorns (Cerambycidae); the antennæ being inserted on the front, and filiform, while the prothorax is narrow and not margined. These beetles fly quickly from one plant to another. Their coloration is generally metallic, often bronze-green above, and they are clothed with water-repelling hairs beneath. A noticeable peculiarity of species of this genus is that they are full of some corroding acid that rusts and destroys the pins on which they are mounted in collections. On this account some collectors mount them on slips of paper, as is otherwise done only with minute insects.

E. Heeger writes of *D. clavipes*, a European species, that the females, having passed the winter in water and under decaying vegetation, deposit their eggs one by one, in the daytime, upon the thick roots of the water plantain (*Alisma plantago*). Each female has only from forty to fifty eggs, which are deposited in from fourteen to eighteen days. In from ten to twenty days the larvæ appear, and feed upon the roots of the water-plantain. At the end of five or six weeks pupation takes place in a submerged, parchment-like cocoon, which is fastened to the stem of the water-plantain, and which the larvæ know how to fill with air. Pupation lasts from twenty to twenty-five days. Professor C. T. E. von Siebold states that the larvæ of *D. simplex* fasten themselves by the end of their abdomen in a hole which they gnaw out of the root-stalk of the bur-reed (*Sparaganium simplex*), while they feed upon the diatoms and algæ of the slime about them. The boring into the bur-reed is for respiratory purposes, the larvæ breathing the air of the intercellular spaces of the plant by means of its single pair of stigmata, which are in the hooks at the tip of the abdomen.

The CERAMBYCIDÆ, the so-called longicorn family, contains nearly as many species as does the family of Chrysomelidæ, and it is difficult to give any scientific characters by which to separate absolutely the two families, although collectors would rarely be in doubt as to which family to assign any given specimen. The species of Cerambycidæ are generally somewhat elongated, often cylindrical. The antennæ are usually very long, sometimes much longer than the rest of the insect—whence the name longicorn. They are mostly filiform, in some cases serrate, imbricate, or pectinate.

rarely knobbed; they are inserted in various ways, and generally have eleven joints — sometimes more, rarely fewer; they are often much better developed in the males than in the females. The elytra usually cover the entire abdomen; a few genera, however, have very short elytra. The wings are absent in a few species, and the elytra connate. The mandibles are very stout, but of variable forms. The species are often beautifully colored, metallic or velvety, and are oftentimes of considerable size, the *Cerambycidae* probably containing the longest species of beetles. Many longicorns are more or less spiny, some species closely resembling twigs, and, according to Mr. H. W. Bates, *Ethomerus lacordairei*, a Brazilian species, mimics a butterfly's pupa grown over with fungus. A curious habit of *Megaderus bifasciatus*, a species found in Texas, is to eat out the printed portions of posters. Certain species are odorous, those of *Prionus* using their odor as a sexual attraction. *Callichroma moschata*, a large European species, derives its specific name from the pleasant musky odor which it exhales, and which is noticeable at considerable distance from the insect. Sonorific organs are possessed by nearly all, probably by all, species of *Cerambycidae*.

The eggs are laid in crevices of bark and of wood; the larvæ feed in both living and decayed wood. The females of a few species girdle twigs and lay their eggs in the portion beyond the girdling; the twigs thus girdled die and are broken off by winds, thus furnishing fresh but dead wood for the larvæ. The females of certain species are said to cut off or girdle twigs by seizing them in their mandibles and flying rapidly around the twig as a centre; this mode of girdling is exceptional, if practised by any species, since longicorns mostly girdle twigs while resting on the branch below the point to be girdled. Some species lay a large number of eggs; *Prionus laticollis* has been found, upon dissection, to contain from three hundred to six hundred eggs. The metamorphoses of some species of longicorns are supposed to require as long as twenty years, but if this is the case it is exceptional, for many species attain full growth in from one to three years.

FIG. 359. — Larva of *Monohamus mus*.

The larvæ of *Cerambycidae* are long, cylindrical, or flattened whitish grubs, with distinct labial palpi, elliptical or circular stigmata, and Y-shaped anal opening. They bore, for the most part, in woody portions of trees; some, however, attack herbaceous plants. The head of the larvæ is partly retractile into the first thoracic segment, the antennæ are very small and concealed in a fold of the head, ocelli are usually absent. The larvæ are mostly legless, and when legs are present they are small, with only one claw, but the larvæ assist their peristaltic motion through their mines by means of wart-like processes upon their dorsal and ventral surfaces. The form and mode of plication of these processes are of importance in distinguishing the species of longicorn larvæ. Most of the damage done by these larvæ is in destroying timber or by killing shade trees, no less than a dozen different species being known to attack hickory. In Europe damage is said to have been done to grain by the larvæ of longicorns boring in the ears, and to vegetables such as carrots. The fleshy larvæ of *Macrotoma corticium*, cooked with rice, are eaten by natives of Madagascar; and the natives about King George's Sound, in West Australia, eat both larvæ and imagoes of *Bardistus ciliaris*.

Cerambycidae are among the more difficult beetles to classify satisfactorily, because structural characters, which are usually generic, often become only of specific value in

this family. Three sub-families are easily recognizable; the highest, the Prioninae, have the prothorax margined and the labrum comate; the other two sub-families, the Cerambycinae and Lamiinae, have the labrum free and the prothorax without margin. The Lamiinae have, however, an oblique groove on the inner side of the front tibiae, while the front tibiae of the Cerambycinae are not grooved.

Of the Lamiinae, the genus *Saperda* is perhaps best known. The species are nearly cylindrical; the prothorax is cylindrical with no spines at sides. The elytra are a little wider than the prothorax, distinctly shouldered, and cover the entire abdomen and the well-developed wings. The legs are of moderate length, and are armed with claws which point outward at right angles to the tarsus. The claws are simple, except sometimes the outer one of the anterior and middle tarsi of males of certain species

FIG. 369. — Longicorn beetles. a, *Saperda carcharias*; b, *S. populnea*; c, *Acanthocinus ordii*, male; d, female; e, *Lamia textor*.

Saperda birittata is from 0.55 to 0.75 of an inch long, is white beneath, with white face and antennae, and with two white longitudinal stripes above; the rest is light brown. It is found, in June and July, about apple, quince, mountain ash, thorn, shad-bush, and other rosaceous trees, in the wood of which its larvae feed. The beetle is nocturnal, remaining concealed by day and feeding by night, as is the case with all species of *Saperda*. The imago eats the leaves of the same kinds of trees of which the larvae eat the wood. The egg of *S. birittata* is laid in a cleft made by the female in the bark of the tree; after depositing it the female fills the cleft with a cement like secretion. The young larvae bore into the trees, and where numerous they do much damage to apple-trees. The larvae are legless, nearly cylindrical, the first segment behind the head being largest, the succeeding ones gradually narrower; the head is small, horny, and brownish. T. W. Harris writes that the larval state lasts two or three years, and that the larva penetrates during that time "eight or ten inches upwards in the trunk of the tree, its burrow at the end approaching to, and being only covered by the bark. Here its transformation takes place." Pupation lasts a month or two.

S. vestita, a species whose larva bores in linden and poplar, is from 0.5 to 0.8 of an inch long, is greenish yellow, with three black spots on the middle of each elytron. The beetles are found about the linden from May to the end of summer; they eat the bark and petioles of the leaves. In Philadelphia their larvæ have been at times so common as to do serious damage to the linden trees by penetrating the wood and undermining the bark. The larvæ are slender, of nearly the same breadth from the prothoracic region to the penultimate abdominal segment, and have three pairs of small

FIG. 361.—*Saperda tridentata*.

thoracic feet. *S. tridentata*, sometimes called *Compsidea tridentata*, is from 0.4 to 0.6 of an inch long, dark brown or gray in ground coloration, with dull red markings, as follows: a curved line behind the eyes, two stripes on the prothorax and a marginal, three-toothed, red stripe on each elytron. The legless larva, which feeds on the elm, is, according to Prof. A. S. Packard, "a little flattened, with the lateral fold of the body rather prominent; end of the body flattened, obtuse, and nearly as wide as at the first abdominal ring." The prothoracic segment is wider than the rest of the larva. The whole larva is covered with scattered hairs. Oviposition takes place in June: the larvæ, after channelling beneath the bark, and furrowing the surface of the wood during one or more years, pupate in the spring. Not only do these insects attack dead trees, but they prove very destructive to living elms. In some cases the death of elms has been attributed to leakage of illuminating gas from the street mains, when in reality the cause of death was the boring of this destructive beetle. *S. lateralis*, which somewhat resembles *S. tridentata*, but in which the lateral line does not have three teeth, also mines the inner bark of elms. Its larva is similar to that of *S. tridentata*. Of other American species, *S. moesta*, *S. calcarata*, *S. concolor* attack poplars. The last species is gray, with darker antennæ. *S. calcarata* is a large gray species, irregularly striped and spotted with yellow; it is sometimes 1.25 inches long. Its elytra end in a spur, whence its specific name. *S. moesta*, a black species, about 0.35 of an inch long, is the only North American species found on the Pacific slope, being distributed from Canada to Oregon. In Europe two common species, both living on species of poplar, are *S. carcharias* and *S. populinea*. *S. populinea* is about 0.5 of an inch long, *S. carcharias* about double as long. The male of the latter species is grayish yellow, the female is ochre yellow. *S. populinea* is greenish or yellowish gray, with three longitudinal yellow lines on the prothorax and a longitudinal row of yellow spots upon each elytron.

FIG. 362.—Larva of *Saperda calcarata*.

Differing from the species of *Saperda*, in having cleft or appendiculate claws, are the species of the genera *Oberca*, *Tetraopes*, and *Phytocia*. The species of *Oberca* are very slender, nearly cylindrical, and have the episterna of the metathorax wide, the epipleuræ distinct, and the claws broadly appendiculate. *O. tripunctata*, a species about 0.5 of an inch long, feeds as larva upon the stems of the raspberry. The beetle is black, with a yellow prothorax, on which are three black dots arranged in a triangle. It girdles the raspberry twigs in which it lays its eggs, probably in order to check the growth of the plant.

Tetraopes has a less slender form than *Oberca*, the claws are cleft, the eyes broadly divided, the prothorax dilated at the sides; the species are all bright red, marked with black spots, and all feed upon milkweed (*Asclepias*). The larvæ probably devour the

Acrocinus longimanus, Long-armed beetle.

roots of the same plants. *T. tetraophthalmus* has black legs and antennæ, four black dots arranged in a square on the prothorax, and four spots of variable size on each elytron. In Europe species of related genera, *Phytocia* and *Agapanthia*, damage various wild and cultivated plants.

Oncideres has moderately divergent claws, angulated anterior and open middle coxæ, and large front. *O. cingulatus*, a grayish-brown species, girdles and partly cuts off the twigs of hickory, pear, and other trees, in August and September, after having deposited eggs in the portion of the twig beyond the girdling. The winds of autumn break the twig from the trees, and the portion containing the eggs falls to the ground. The larvæ feed upon the wood of the fallen twig, — often when numerous reducing it to a mere shell of bark, — attain full growth the next summer, pupate and produce imagoes the following autumn, the whole transformations requiring only a year.

Pogonocherus is a genus of small longicorns, in which the front coxæ are angulated, the middle coxæ open, and the claws divaricate. The body and legs bear long hairs, and tufts of hair are found on the elytra. *P. mixtus* is one of the more common species, and feeds upon willow. It is about 0.3 of an inch long, and is mottled light and dark gray in color. Separated from *Pogonocherus* by the rounded anterior coxæ are the species of *Acanthocinus*, of which *A. adilis*, from Europe, is figured. It appears early in spring, and oviposits on many kinds of trees. *A. obsoletus*, a mottled gray and black species, about 0.5 of an inch long, is not uncommon in the United States.

Aerocinus longimanus, which is common in tropical America, is a very curious and striking species of longicorn. The beetle is from 1 to 1.5 inches in length of body. It is remarkable both for its excessively long anterior legs, of which the femora and the tibiæ are each equal to or longer than the body, and for having a large movable spine articulated upon each side of its prothorax. In coloration it is yellow, gray, and black, arranged in stripes of irregular pattern. It feeds upon the milky juice of *Ficus glabrata*, in the wood of which its large fleshy larva bores.

The species of *Monohammus* are large beetles having extremely long antennæ, especially in the males. The fore-legs of the males are much elongated. The prothorax bears a strong lateral spine and the ventral segments are nearly equal in length. *M. confusor*, which is brownish gray with the elytra spotted with black and white, often reaches a length, exclusive of the antennæ, of 1.4 inches. Its larvæ, as well as those of *M. scutellatus* and *M. marmoratus*, bore in pine wood, thus doing considerable damage to timber. Prof. A. S. Packard says of the footless larva of *M. confusor*. "Boring a hole, in outline round and regular, deep in the wood of sound, though usually in decaying trees, and doing much injury to pine timber; a large, soft, white, fleshy, nearly cylindrical grub, the segment next the head larger than the others, flattened, horny, and inclined obliquely downward and forward, the succeeding rings very short, with a transverse oval rough space on the middle above and below, pupating inside in the wood, the beetle emerging from a round hole half an inch in diameter." *M. scutellatus*, mentioned above, is shining black spotted with white, and is very abundant about midsummer in the northern United States and in British America. It is somewhat smaller than *M. confusor*, measuring from 0.5 to 1 inch in length.

Closely related to *Monohammus* are the genera *Plectrodera* and *Ptychodes*. *Plectrodera sculator* is about 1.5 inches long, of robust form, and is shining black

FIG. 323. — *T. tetraophthalmus*; above, front view of head.

mottled with cream white. *Ptychodes vittatus* is slender, about an inch long, with very long antennæ and legs, and is of a rich brown ground color, with sutural and marginal stripes of white. Both the above-mentioned species are found in the southwestern United States. In Europe a closely allied longicorn, *Lamia tector*, bores, in its larval state, in willow twigs. The beetle is from 1 to 1.25 inches long and nearly half as broad, of a dark brown color, with fine yellowish pubescence, through which glimmer little black points; its antennæ are about two-thirds as long as its body.

Psococerus supernotatus is a beetle only about 0.25 of an inch long, whose larva bores in the twigs of different kinds of currants. Its front coxal cavities are angulated, its prothorax is constricted behind and the humeral angles are distinct. The ground color of the beetle is black, the prothorax and margins of the elytra are pale brown, and there are a few white or gray spots on the elytra. Mr. William Saunders has well described the life-history of this species as follows: "Early in June the parent beetle of the native currant borer deposits her eggs upon the currant stalks, where they soon hatch into tiny grubs, which burrow into the heart of the stem and, feeding on its pith, reach full growth before the close of the season. They are footless grubs, which measure when full grown about half an inch in length. The head is scarcely half as broad as the body, is of a dark brown color, with black jaws. The body is whitish with some brown dots along each side, and is slightly clothed with very fine short hairs. When full grown and about to change to a chrysalis, the larva gnaws a channel through the woody fibre to the outer bark, so that when changed to a beetle it can make its escape by merely rupturing the bark. The cavity thus made is filled with little chips to prevent the bark from being prematurely broken, and below this stuffing the insect constructs a bed of short woody fibres, packing the passage below with a finer material resembling sawdust. Within this enclosure, which is about half an inch in length, the larva changes to a chrysalis and reposes until the fully formed beetle is ready to emerge; then, gradually drawing away the obstacles to its egress, it finds its way to the end of the passage, and gnawing a small round hole through the bark, effects its escape." As the larvæ remain in the twigs during the winter, an easy mode of destroying these longicorns is to break off the dead twigs in early spring and burn them.

FIG. 364.—a, *Clytus arictis*; b, *Aecydalis major*; c, *Dorcadion cruce*.

Dorcadion is a well-represented genus in southern Europe. The humeral angles are not prominent, and wings are absent; the palpi are slender, the support of the labium distinctly visible, the antennæ not surpassing the body in length, and the prothorax with a spine on each side. *D. cruce* is velvety black, with silvery white markings in a cruciform arrangement as seen in the figure.

Turning our attention now from the Lamiinae to the Cerambycinae, we have to deal with longicorns which have marginless prothorax, palpi never acutely pointed, and the anterior tibiae without grooves on the inner side.

The genus *Leptura* and some genera associated with it have the head distinctly narrowed behind the eyes to form a sort of neck; their front coxæ are conical; their eyes are nearly or quite round, not, as in many Cerambycidae, more or less enveloping the base of the

antennæ; the stridulating plate on the mesonotum is divided by a smooth portion or by a furrow. These insects frequent flowers, seeming to prefer small flowers which grow in clusters, such as those of *Spiræa*.

According to Le Conte and Horn's Classification of the Coleoptera of North America, from which work many of the anatomical characters of genera mentioned in this paper have been taken, the genus *Leptura* itself has acute mandibles fringed on the inner margin, long elytra, oblique or horizontal front, first joint of hind tarsi without brush-like sole, last ventral segment of the male not excavated, antennæ without poriferous spaces, and hind coxæ not contiguous. There are over seventy-five species of *Leptura* in North America, north of Mexico. Their larvæ feed upon decaying wood. *L. canadensis* is dull brownish black with the anterior part of the elytra dull red, and the antennæ yellow and black. It is about 0.6 of an inch long.

Typocerus differs from *Leptura* in having large poriferous spaces on the antennæ. *T. fugax*, a common species in the United States, has reddish brown elytra, each of which has four more or less prominent triangular yellow spots. The prothorax and body beneath are nearly black, densely clothed with yellow pubescence; the antennæ are dull black, the legs reddish brown. Length about 0.5 of an inch.

Rhagium has the first joint of the posterior tarsi hairy beneath, and the prosternum prominent between the coxæ. *R. lineatum*, the only North American species, is from 0.4 to 0.7 of an inch long, and is rusty gray, finely mottled with black. Each elytron has three slightly elevated longitudinal ridges, whence the name *lineatum*. The larva of *R. lineatum* is a flattened, yellowish-white, somewhat hairy grub, about an inch long. Its head is as large and as wide as its prothoracic segment; the mesothoracic and metathoracic segments equal in width the prothoracic segment, but are slightly wider than the abdominal segments. This larva is very common under the bark of pine logs, where it burrows about, and finally constructs a nest or cell in which to pupate. These cells, in which pupation takes place, are built of woody threads or fibres arranged in an oval ring between the wood and the loosened bark; the cell, which is usually a little over an inch in longest diameter, is lined with reddish bark-dust. The beetle emerges from the pupal state in autumn, but remains in its cell until the following spring, when it gnaws its way out: this is a somewhat exceptional mode of hibernation for Cerambycidae, most of which spend the winter as larvæ. *R. mordax*, in Europe, copulate in April and May; the eggs are deposited in clefts of bark, the larvæ reaching full growth and pupating the same year. Some of the European species of *Rhagium* attack, besides pine, the bark of birch and oak; *R. lineatum* thus far has been recorded only from conifers—from pine, spruce, fir, and hemlock. Remaining torpid as these beetles do throughout the winter, in their cells beneath the bark, they are particularly susceptible to the attacks of parasites: fungi kill a large number of them; others succumb to the attacks of mites (*Gamasus coleoptoratorum*), and specimens are not rarely found which are clothed with these parasites so as to hide the beetle entirely from view; and three species of Ichneumonidae and one of Braconidae are known to attack *R. indigator*, of Europe, a rather large number of hymenopterous parasites for a single species of beetle.

The genus *Necydalis* is characterized sufficiently by its very short elytra, from beneath which the long wings always project, never being folded beneath the elytra, as is the case in the Staphylinidae, and in a few other genera of brachelytrous longicorns. Only three species are found in the United States, and their life history is not known. *N. major*, the species figured, is European.

Differing from the foregoing genera in having simple mandibles without fringes is the genus *Desmocerus*. *D. palliatus* is found about elder (*Sambucus*) when it is in blossom. This beetle is about 0.8 of an inch long, of a deep Prussian-blue color, except the anterior portion of the elytra, which is orange yellow. It is one of the most brilliant of our longicorn Coleoptera. Its larva bores in the pith of the elder. The females of *D. auripennis*, a species found on the Pacific coast, are dimorphic, the two forms being distinguished by different size of markings and by different fineness of punctation.

FIG. 365. — *Desmocerus palliatus*.

Passing now to genera of the sub-family Cerambycinae that have the base of the antennae partly surrounded by the eyes, *Clytus* and related genera have long legs, finely granulated eyes,

a rounded or broadly triangular scutellum, tibiae not carinated and with large spurs, prothorax never spiny or tuberculated, elytra not sinuate, and intercoxal process acute. The species are generally banded with yellow, white, or black, and are active both at flight and in running. *Clytus* in its limited sense, as defined by Drs. Le Conte and Horn, is confined in North America to two species, of which the life histories are unknown. *Clytus arcticus*, a common yellow, black, and red European species which is figured on page 328, is found in its larval state in the dead wood of mulberry and sycamore trees, and in the living wood of some other trees. *C. sexguttatus*, also figured, is from Algiers.

Cyllene differs from *Clytus* in having the head proportionally smaller, the front short, the intercoxal process rounded, and the pronotum hollowed out at the sides of its base. *Cyllene robinia* is very abundant upon locust trees, the wood of which is seriously damaged by its larvæ. The beetle is brownish black, figured beneath and transversely striped above with yellow, and has reddish legs. Almost all the figuration is

FIG. 366. — *Clytus sexguttatus*.

FIG. 367. — *Cyllene robinia*.

produced by a coating of hair-like scales, the beetle being mostly black when these scales are removed. This beetle is quite common in autumn upon the blossoms of golden-rod (*Solidago*), the pollen of which it eats. In September the beetles may be seen, often in considerable number, running over the bark on the trunks of locust trees, copulating and ovipositing. The eggs are white, and are laid in crevices of the bark, five or six in a place. They hatch in a short time and the young larvæ eat a slight distance beneath the bark before winter comes on. The next spring they burrow about in the wood, throwing their refuse out of holes which they have made in the bark. Pupation takes place the latter part of July, and the beetles emerge in August and September; the entire metamorphosis of this species thus lasts only one year. *Cyllene pictus* is so nearly like *C. robinia* that it has been confounded with it, oftentimes by good observers. *C. pictus* lives as larva, however, in hickory (*Carya*), the imago appears in June, and it has slenderer and shorter antennae than are those of *C. robinia*.

Plagionotus speciosus has a form and style of marking similar to *C. robinia*, but is larger and does not have the pronotum hollowed out at the sides. Its colors are deep black, and yellow. The beetle is found in July, when it lays its eggs in the

crevices of the bark of sugar maples, in which the larvæ bore. This species is not very abundant, and, although it now and then, perhaps, kills a very young maple, its ravages are not much to be feared. *Arhopalus* differs structurally from *Plagionotus* in having filiform instead of compressed antennæ. *A. fulminans*, the only North American species, is brownish black with fine grayish markings and dark brown legs; it has a conspicuous black spot on the pronotum, and the elytra are crossed by four fine indistinct zigzag lines of gray. Its larva bores in oak and chestnut wood.

In *Collichroma* the scutellum is acute at the tip, the anterior coxal cavities are closed behind, and the prothorax has a spine on each side. A common European species, *C. moschata*, of which the odor has been already alluded to, is about an inch long, bronze green with bluish green legs and antennæ. Its larva lives in willow. *C. splendendum*, a red-bronze species from 1 to 1.25 inches long, has been found in the southern United States.

FIG. 368. — *Plagionotus spectosus*.

FIG. 369. — *Chion cinctus*.

The genus *Elaphidion* contains longicorns of medium or large size, with rounded thorax, moderately long, spiny antennæ, coarsely punctured eyes and often of clouded or rusty appearance on account of the unequal distribution of their pubescence. *E. parallelum* is one of the commoner species in the northeastern United States. It is about 0.6 of an inch long, and of an ashy brown color. The larva is a common borer in oak, and according to Prof. A. S. Packard, "may be recognized by the stout, thick thoracic feet, by the rather small prothoracic segment compared with the two hinder ones, by the absence of the ligula, by the large well-developed palpi and antennæ, and by the shape of the callosities." I have found the larva of this species to be very injurious to the hickory in northern Connecticut, where it eats away the wood beneath the bark of twigs up to an inch in diameter, causing the twigs to fall in winter, when the larva continues feeding in the fallen portion. The larva of *Catogenus rufus*, a beetle belonging to the Cuccidæ and common in the same region, devours pupæ of *E. parallelum*. *Chion cinctus* resembles an *Elaphidion* in general aspect, except that the prothorax of *Chion* has a short spine on each side, and its scutellum is triangular instead of rounded behind. In *C. cinctus* the scutellum is whitish, and there is an irregular yellowish band partly across each elytron just forward of the middle. The larva feeds in hickory.

Cerambyx heros, a not uncommon brownish-black beetle in Europe, is from 1 to 1.6 inches long, with antennæ about equal in length to the body. Its prothorax is plicate above, and armed on each side with a spine. Its large fleshy white larva feeds in the wood of oaks, the beetle requiring two

FIG. 370. — Larva and pupa of *Chion cinctus*.

years for its metamorphoses. The beetles frequent the leaves of oaks, appearing during June in France.

To the genus *Callidium*, in its less restricted sense, belong flattened species of longicorns with prothorax and elytra spineless, with eyes not embracing the base of the antennæ, and having the femora usually much thickened. Some of the species of this genus are very variable; *C. variabile*, a species common both in Europe and America, has over twenty well-defined varieties. It is often entirely brownish yellow, sometimes the prothorax only is brownish or reddish yellow, while the rest of the beetle is deep blue. Its larva feeds in oak. *C. antennatum*, of the United States, and *C. violaceum*, of Europe, are both entirely of a very deep metallic-blue color.

Both feed, as larvæ, upon conifers.

Hylotrupes bajulus is similar in form to *Callidium*, but has a broader prothorax. Its prothorax is nearly round. The entire beetle is usually black, clothed in places, especially on the prothorax and elytra, with ashy pubescence, but sometimes the elytra are brownish yellow. Its length is about 0.75 of an inch. The larvæ eat the wood of conifers, and, according to

FIG. 371.—a, *Callidium violaceum*; b, *C. variabile*; c, *Hylotrupes bajulus*.

Kirby and Spence, have done much damage to rafters and roofs in London; when the beetles arrive at maturity they even pierce sheets of lead to escape from the wood. This species is found near the coast in North and South America, where it has been introduced from Europe. *Asemum moestum*, an American species, is similar in form to *H. bajulus*, but is somewhat smaller and of a dull, dark brown color. Its larva bores in pine wood.

The last sub-family of the longicorns, the Prionine, which have a margined prothorax, are mostly insects of considerable size, with strong jaws. In some species, of which *Microtoma lethifer* is an example, the males are eight or ten times more numerous than the females, and fight among themselves for the possession of the females. In these fights the males bite off one another's antennæ and legs. In *Prionus* sexual activity is very great, the male being attracted to the female by her odor, and apparently, on the other hand, the males are attractive to the females by the same means. Copulation, as observed in *P. coriarius*, lasts scarcely two minutes.

FIG. 372.—*Prionus laticollis* and pupa.

The species of *Prionus* have three teeth upon each side of the prothorax, the antennæ are imbricated; in *P. imbricornis* the imbrication is beautifully exhibited. The antennæ have, in American species of *Prionus*, from twelve to twenty-seven joints. *P. laticollis*, one of the common North American species, is from 0.75 to 1 inch in length, brownish black in color, and both male and female have twelve-jointed antennæ. In *P. imbricornis* the joints of the antennæ of the male vary from eighteen

FIG. 373. — a, *Prionus coriarius*, and b, *Ergates fuber*.

to twenty, while those of the female have from sixteen to seventeen joints. The males sometimes have a different number of joints in the right and left antennæ. The fleshy white larvæ of *P. laticollis* bore in the roots of various plants, among which may be especially mentioned grape, apple, poplar, and pine. In Europe, *P. coriarius* is the common species; its larvæ feed in the wood of oak, birch, beech, and pine. Its eggs, which are deposited, two to eight or more in the same place, are fusiform cylindrical, from 0.16 to 0.20 of an inch long, and 0.04 to 0.05 of an inch in diameter. The eggs hatch in about thirty-seven days, the young larvæ eating the bark of the tree on which the eggs are laid.

Orthosoma brunneum (sometimes called *O. cylindricum*), a more elongated species than those of *Prionus*, is found in the eastern United States. It is from 1.25 to 1.75 inches long, of light-brown color, and has eleven-jointed antennæ. Its large fleshy larvæ, which resembles that of *Prionus*, bores in rotten stumps of pine, oak, and hemlock.

A large pitch-brown European species of Prionine, *Ergates fuber*, from 1.25 to 2 inches long, feeds, in the larval state, upon pine wood.

FIG. 374. — *Orthosoma brunneum*.

Parandru brunnea, the fleshy, cerambycid-like larva of which is an inhabitant of dead oak, ash, and beech wood, is from 0.50 to 0.75 of an inch long, of a shining mahogany-brown color, and elongate form. It has antennæ less than 0.20 of an inch long, and adult structure otherwise anomalous for a longicorn, and has consequently been put by some authors, with other anomalous allies, into the family Spondylidæ.

A large number of beetles of which the head is more or less prolonged anteriorly into a beak, and of which the larvæ have considerable resemblance to one another, were, for a long time, included in one large family, the Curculionidæ: the popular name for these insects is "weevils." Later the Curculionidæ were divided by different authors in various ways into families, the name Curculionidæ being retained for the forms having the most typically beak-formed head, while the families Bruchidæ, Anthribidæ, Brenthidæ, and Scolytidæ were separated from the rest. Later still, about 1874, Dr. J. L. Le Conte constituted of the weevils, excluding the Bruchidæ, a separate group of Coleoptera, the Rhynchophora, which was sub-divided into families. Dr. Le Conte's definition reads as follows: "Rhynchophorous Coleoptera are those in

FIG. 355. — a, *Bruchus pisi*; b, *B. rufimanus*; c, *B. granarius*

which the posterior lateral elements of the head and prothorax coalesce on the median line of the under surface of the body, so as to unite by a single suture." The Bruchidæ, a group of seed-inhabiting weevils, were excluded from the Rhynchophora and placed near the Chrysomelidæ.

In the following pages the weevils, or old family Curculionidæ, will be treated under the families Bruchidæ, Anthribidæ, Brenthidæ, Scolytidæ, and Curculionidæ.

The BRUCHIDÆ consist of rather small, roundish or subquadrate beetles, having the anterior part of the head slightly extended, the mentum pedunculate, the prosternum reaching the posterior margin of the thorax beneath, the antennæ eleven-jointed and thickened toward the tip, and the maxillary palpi four-jointed. The larvæ of Bruchidæ do much damage to the seeds of leguminous plants. The perfect beetles appear when the plants are in bloom, lay their eggs, generally one by one, in the tender seeds or upon the young pod. The larvæ, as soon as they hatch from the eggs, bore in the seed, not, however, preventing its growth. Pupation takes place in the seed, and the perfect insect emerges in autumn or the succeeding spring, according to climate and circumstances. Dr. J. L. Le Conte has well said that "as the function of the Cerambycidæ is to hold the vegetable world in check by destroying woody fibre, the Bru-

chidæ effect a similar result by attacking the seeds, and the Chrysomelidæ by destroying the leaves."

One of the most widely known species of Bruchidæ is *Bruchus pisi*, the pea-weevil, found both in Europe and in America. This beetle is about 0.20 of an inch long and 0.12 of an inch wide, is dark brown with a few white spots on the elytra and a slightly more prominent white spot just in front of the white scutellum. The tip of the abdomen, which projects beyond the apices of the elytra bears a T-shaped white mark. The females fasten their lemon-yellow, sub-cylindrical eggs with a gummy secretion upon the outer surface of the newly formed pod of the pea. The white, footless larvæ, when they hatch, bore through the pod into the developing seed within, where they continue to grow with the pea itself. In eating green peas we eat, oftentimes, large numbers of these young larvæ, a very minute dot on the surface of a pea being the only external evidence of the presence of a weevil larva within. The peas that are collected one season for next year's seed often contain a large number of these insects, which escape as imagos the next spring, when the peas are planted, and deposit eggs for a succeeding generation. United effort on the part of those who cultivate peas would do much to lessen the number and destructiveness of these weevils. Seed peas should be kept in bags made of tightly woven cloth from which the weevils cannot escape, and the beetles should be killed before the peas are planted by immersing the bags for a moment in hot water, which process will not impair the germinating power of the seeds; or weevils may be destroyed by putting seed peas into a close box and adding a little carbon disulphide. On account of the explosiveness of the vapor of carbon disulphide this mode of treatment should be used only in the absence of fire or lighted lamps. Some persons keep seed peas, after they have dried sufficiently to prevent moulding, in close vessels for two years, at the end of which time the peas will have lost very little of their germinative vitality, while the weevils will have emerged and died during the first year. Peas sown late in the season are not attacked by these weevils, because they blossom after the time during which these insects oviposit. The Baltimore oriole (*Icterus baltimore*) splits open the pods of peas to get at the larvæ of the pea-weevil, and the crow-blackbird (*Quiscalus purpureus*) is said to eat the imagos in the spring, but these weevils mostly escape the attention of other birds.

Bruchus fabæ is another common American species, much smaller than *B. pisi*, which attacks different kinds of beans, several beetles sometimes emerging from a single bean, while each *B. pisi* usually occupies a pea by itself. In Europe two similar species, *B. granarius* and *B. rufimanus*, are destructive both to beans and to peas.

Differing from *Bruchus* in having the anterior coxæ separated by the prosternum are the species of *Caryoborus*. *C. arthriticus* is an ashy-brown species, about 0.4 of an inch long, from the southern United States, where its larvæ develop in the seeds of the palmetto (*Sabal palmetto*).

The ANTHRIBIDÆ are weevils, characterized, according to Dr. J. L. Le Conte, by having the abdomen of the male and female alike; *i. e.*, composed of the same number of segments, the elytra with a distinct lateral fold on the inner surface, a vertical pygidium, — or distal end of the abdomen, — and straight antennæ.

Cratoparis lunatus, the commonest species of Anthribidæ in the eastern United States, is, about 0.3 of an inch long; its ground color is dark brown; the upper half of the head and forward part of the prothorax are cream-white, and an irregular spot near the middle of each elytron is of the same color; the rest of the insect is

finely spotted with cream-white and with black. This beetle is found in species of fungus which grow upon trunks of dead trees.

Larvæ of species of *Brachytarsus*, another anthribid genus, are parasitic in the females of different kinds of Coccidæ, where they eat the eggs of the scale-insects. This is an exceptional mode of life for weevil larvæ; the majority of them feed upon vegetable matter.

The BRENTHIDE are very elongated weevils, probably the most elongated, proportionately, of all beetles. *Brenthus anchorago*, of tropical America as far north as Florida, is about 1.40 inches long and only 0.12 of an inch wide at its broadest part. Still more peculiar than their extreme attenuation is the secondary sexual characters of their mouth-parts to accord with their functions. In *Eupsalis*, which differs from *Brenthus* in having a convex thorax without grooves, the female has a prolonged proboscis, with the mandibles at its tip, as is common among weevils; with this proboscis she bores holes into the bark of the trees which are to furnish food for the larvæ, and in each hole she deposits an egg. The male, having no such work to perform, has no proboscis, but is provided with strong, curved mandibles of the ordinary type found in beetles. The males have combats for the possession of the females; and, although they cannot injure one another on account of their hard chitinous shells, sooner or later one of the combatants withdraws, tired of the battle, leaving the other in possession of the female. While the female is occupied in boring a hole for an egg, an operation which takes about a day, the male guards her and strives to drive away any other males that approach. Mr. A. R. Wallace says of the Brenthidae, that it is interesting, "as bearing on the question of sexual selection, that in this case, as in the stag-beetles, where the males fight together, they should be not only better armed, but also much larger than the females."

FIG. 376. — *Eupsalis minuta*.

Eupsalis minuta is distributed throughout the eastern United States and Canada, although most of the Brenthidae are confined to the tropics. It is shining mahogany-brown, with fine yellow spots on the elytra, and is very variable in size, males sometimes measuring over 0.75 of an inch long, while females are now and then found that are not over 0.25 of an inch long. The elongated larva of *E. minuta*, which has been described by Dr. C. V. Riley, inhabits decaying oak wood, around which the beetles are not rare.

The SCOLYTIDE are small beetles, some of them almost microscopic, all having a similar general aspect and a nearly cylindrical form, and are, for the most part, of a brown color. The head is usually short, and imbedded in the anterior end of the prothorax; the proboscis is short, often not apparent; the antennæ are small, geniculate, clubbed; the tibiæ are usually serrate; the horizontal pygidium is undivided in both sexes, and is surrounded at its edge by the elytra. Both the mature beetles and their larvæ bore in plants, usually trees, on which they feed, often between the bark and wood, — more accurately speaking in the liber, — and their channels, revealed by pulling off the bark, exhibit many curious forms characteristic of the species or genera of Scolytidae to which they pertain. These beetles are especially destructive to Coniferae; some species attack other trees, and a few injure herbaceous plants.

The peculiar forms taken by the mines of these beetles in wood and bark are dependent upon the mode of oviposition of the different species. The males form chambers ("Rammelkammer" of K. Lindemann) in the bark, in which they await the females. After pairing, the females enlarge and prolong this copulation-chamber,

making passages out from it. The eggs are laid singly in separate niches, which the females gnaw out at regular intervals along the sides of these radiating passages. According to Lindemann, if only one female comes to the male in his copulation-chamber, then only one radiating passage is made along which to lay eggs, but if more than one female comes to the same male, then each female makes a radiating passage from the single copulation-chamber. Each larva, when it hatches, eats out more or less at right angles to the radiating passages, increasing the size of its mine to accommodate its increased growth. The different larvæ, all boring out from a common centre or channel, each species in a way peculiar to itself, produce remarkable foliate or dendriform figures, which are modified by the number of radiating channels, a number dependent upon the number of females that came to the male which originally established the colony.

The larvæ of Scolytidæ are legless, cylindrical grubs; locomotion is effected by fleshy warts which replace the legs. These larvæ have no ocelli, and very short concealed antennæ; they pupate beneath bark or concealed in plants, and thus their whole transformations are undergone out of reach of all birds except woodpeckers. The beetles themselves are nocturnal, thus escaping insectivorous birds. Besides the wood-boring habits of the Scolytidæ, which render them especially destructive to forests, the imagoes of some species eat the buds of conifers to such an extent as to kill the trees. Some entomological writers, however, claim that the Scolytidæ attack only dead or dying trees. The North American Scolytidæ number about one hundred and forty described species, of which the specific characters are minute, and of which only a few of the best-known species need be mentioned here.

The species of *Dendroctonus* are rather large, cylindrical, with five joints in the funicle of the antennæ, that is, in the portion between the basal joint, — often called the scape, — and the club or dilated end of the antennæ. *D. terebrans*, a species about 0.3 of an inch long, and common throughout the United States and Canada, feeds in pine. *Hylurgus piniperda*, a nearly allied species, attacking all kinds of pine in Europe, possesses, in both sexes, sonoric apparatus, consisting of two corrugated organs on the abdominal segments, which produce noise by rubbing against corresponding portions of the elytra.

Hylesinus includes species in which the funicle of the antennæ is composed of seven joints, and nearly or quite equals the club in length. Most of the species are clothed with flat scales. *H. trifolii*, a species that, in Europe, has done much damage by boring in the roots of clover and medic (*Medicago sativa*), has been found in the eastern United States seriously injuring the clover crops. The beetles are about 0.1 of an inch long. They pair in early spring, and, after pairing, the female gnaws a cavity in the top of roots of two-years-old clover, wherein she deposits from four to six white elliptical eggs. The larvæ, as soon as they are hatched, bore along the axes of the roots of the clover, causing the plants to weaken, and often to die. Sometimes as many as sixteen specimens are taken in a single clover root. Hibernation takes place as larva, pupa, or imago. No mode of successfully combating this enemy of clover crops has been devised. A number of European species of *Hylesinus* attack pine, others, ash, poplar, or ivy (*Hedera helix*). *H. aculeatus*, of North America, depredates on ash.

In *Scolytus*, the side margin of the prothorax is distinctly defined, a very rare

FIG. 377. — *Dendroctonus terebrans*.

character in Rhynchophora," and "the first joint of the funicle rounded, the remaining joints (five in number) closely united, forming a pedicel to the club." *S. quadrispinosus*, having deep striae, and the male of which has a spiny abdomen, has been bred by Dr. C. V. Riley from hickory (*Carya*); its length is about 0.2 of an inch. *S. figi*, another deeply striate species, of which neither males or females have a spiny abdomen, is about 0.2 of an inch long, and was bred by Mr. B. D. Walsh from beech (*Fagus*). *S. rugulosus*, a species lately introduced from Europe into the eastern United States, attacks cherry, peach, and plum trees; and, as is so often the case with imported insects, does more damage in its adopted country than it did in its native land.

The CURCULIONIDÆ, the true weevils, are generally compact beetles, of firm structure, often having elytra so hard as to be penetrated with difficulty by an insect pin, and are provided with a proboscis pointing forward and downward, produced, as in other weevils, by the anterior prolongation of the head, and bearing upon its sides the antennæ, which are straight in some sub-families, geniculate in others. The mouth-parts, mostly somewhat abortive, are at the end of the proboscis; the labrum is wanting in many species. The ventral segments are five in number, although the first and second are often more or less united, frequently to such an extent as to partly obliterate the suture. In some sub-families the sexes are distinguished by the presence in the males of an additional anal segment; in certain species the females have a longer proboscis than the males, the proboscis being used in boring holes in which to lay eggs. Many species can produce creaking sounds, by rubbing the abdominal segments against the inner surface of the elytra.

FIG. 378. — *Balaninus nucum*; side of head beneath.

The Curculionidæ are remarkable for the great diversity of mode in their ornamentation; pubescence, punctate and striate surfaces, alone or in combination, highly polished or excessively warty surfaces, surfaces clothed with pollen-like waxy secretions (as in *Lixus*), all modes of ornamentation common to most families of Coleoptera, are aided in many species of Curculionidæ by scales, which often surpass in brilliancy those that furnish material for the color-patterns on the wings of Lepidoptera. Especially resplendent under the microscope are the scales of the diamond-weevils (species of *Entimus*) from South America; of species of *Chlorophanus* and *Polydrosus* from Europe, and of species of *Ecophthalmus* and *Eudiagogus* from warmer parts of North America. The larvæ of Curculionidæ are short, cylindrical grubs, mostly legless or with very rudimentary legs. A few have ocelli.

With very few exceptions, species of Curculionidæ are phytophagic; one species, *Eirirhinus infirmus*, is said to have been reared from the bodies of dead insects. Scarcely any portion of plants escapes injury by larvæ of weevils; many species live in seeds, in grain, in nuts, in rolled-up leaves, in catkins, in fruit; others bore in wood or pith; others feed exposed upon leaves or mine in their parenchyma; a few make galls or gall-like excrescences upon stems or roots, while a number have been observed to feed in plant-galls made by hymenopterous insects; a few breed in fungi. Weevils are found in all kinds of situations; eyeless species live in caverns or subterraneously;

one species, at least, *Phytobius velatus*, rarely seen on water plants both in Europe and America, can swim fairly well. Of another species, *Lissorhoptrus simplex*, which attacks rice in the eastern United States, Dr. C. V. Riley writes, "The beetle is just as much at home under water as out of it, though not surrounded by an air-bubble, as in Hydrophilidae, Elmidae, *Psiphennus*, and others."

A large number of adult weevils imitate their usual surroundings, bark, leaf-buds, and other parts of plants, so successfully that they are well protected from attacks of birds. In their earlier stages most of them are hidden, and the pupæ of some (*e. g.* *Cionus*) that pupate in exposed situations so closely resemble seed-pods of the plant on which the larvæ feed that they are not molested by birds.

Guibourt, in 1858, called attention to a sugar which figures in the materia medica of Persia, under a name meaning nest-sugar, which is obtained from swellings, as large as olives, that are produced by a species of *Larinus* upon a plant of the genus *Echinops*, in Syria. According to Hambury, another species of *Larinus* from the same region makes a cocoon containing saccharine matter.

The number of described species of Curculionidae exceeds ten thousand. This family is here divided into sub-families, which correspond in limitations and characters to the similarly designated families in Le Conte and Horn's Rhynchophora of America north of Mexico.

To the sub-family Apioninae belong those species which have straight antennæ, the abdomen of the male and female alike, horizontal pygidium, and the elytra with a lateral fold on the inner surface. Most of the species are quite small.

Apion, the typical genus of this sub-family, is well represented in North America, but the species are not yet carefully studied. Many of these little weevils feed in seeds. In America *A. rostrum* feeds in seeds of *Baptisia leucantha*; *A. scynipes* in seeds of *Tephrosia virginica* and of *Astragalus*. In Europe, Heeger found the larvæ of *A. curvirostre* in the stem of mallow (*Malva*). The females, after pairing several days with different males, lay their eggs, to the number of fifty or sixty, in holes which they bore into the stem of the mallow. The larvæ attain full growth in from thirty to forty days, the beetles develop in from ten to fourteen days more, and gnaw their way out of the stems.

The sub-family Calandrinae contains species which have a steep or vertical pygidium, and geniculate, clubbed antennæ. The species range from very large to very small weevils.

Three species of the genus *Calandra* are distributed in North America, two of which have been introduced from Europe. They are small, and have an oval antennal club. *C. granaria* is a pitchy red weevil about 0.12 of an inch long. The striate elytra do not reach the tip of the abdomen; the coarsely punctured thorax is nearly half as long as the whole insect. The females lay their eggs on stored grain, in which the larvæ feed. By rapid multiplication and immense numbers they sometimes do great damage to grain in store. *C. oryza*, a beetle similar in form to the preceding species, but a trifle smaller, being generally about 0.1 of an inch long, differs from it also in having one or two large red spots on each elytron. It attacks rice, wheat, and corn (*Zea mays*), ovipositing on rice while growing. This beetle is said to have been distributed by commerce to nearly every part of the world. The other North American species of *Calandra*, *C. remotepunctata*, resembles *C. granaria*, but has much more coarsely striated elytra. Like the introduced species of the genus, *C. remotepunctata* feeds on grain.

Species of *Sphenophorus* are larger than those of *Calandra*, and have a wedge-shaped antennal club. Their general form is similar to that of *Calandra*, although the prothorax is not quite as large proportionally. The species of *Sphenophorus* are not easily distinguished. Several of them have been found to injure corn by eating into the young plants and leaves just after they come up out of the ground, and Mr. L. O. Howard found the larvæ of *S. robustus* boring in the pith of cornstalks near the ground.

Rhynchophorus is the genus in which are included the large palm-weevils; its species are distinguished from the other Calandrinae by having wide side-pieces of the metathorax. *R. ferrugineus*, which is figured, is the well-known Javan palm-borer, found throughout the East Indies. *R. cruentatus* is common in the southern United States, where it feeds upon the palmetto. It is about 1.25 inches long, of a deep shining black, marked with mahogany-red. Its form is similar to *R. ferrugineus*. *R.*

FIG. 379. — *Rhynchophorus ferrugineus*.

palmarum, of similar general appearance to *R. ferrugineus*, has been taken in southern California, although its regular habitat is further to the south in tropical America. The large, fleshy, white larvæ of the three above-mentioned species of *Rhynchophorus* bore in the stems of palms; and Kirby and Spence write as follows of them:— "Ælian speaks of an Indian king, who, for a dessert, instead of fruit set before his Grecian guests a roasted worm taken from a plant, probably the larvæ of this insect, which he says the Indians esteem very delicious,— a character that was confirmed by some of the Greeks who tasted it. Madame Merian has figured one of these larvæ, and says that the natives of Surinam roast and eat them as something exquisite. A friend of mine, who has resided a good deal in the West Indies, where the palm-grub is called *grugru*, informs me that the late Sir John La Forey, who was somewhat of an epicure, was extremely

fond of it when properly cooked." In Demarara a species of *Rhynchophorus* attacks the sugar-cane.

The largest sub-family of the Curculionidæ is the Curculioninæ, which contains weevils in which the male has an appended anal segment more than the female possesses; in which each elytron has an acute lateral fold on the inner surface; in which the antennæ have a solid or annulated club, the tarsi are dilated, and the usually pincer-shaped mandibles are without a scar, that, in the next sub-family, Otiorhynchinæ, is caused by the falling off of an appended mandibular piece.

Balaninus is readily distinguished from all other weevils, in fact from all other Coleoptera, by having mandibles that move vertically; each of these mandibles, which are at the tip of a slender proboscis, has its condyle and consequently its axis of motion on its upper side. Sometimes the proboscis is longer than the body, not rarely twice as long as the body in females, since they use it to bore holes in which to oviposit. As these holes are bored in nuts having very thick husks, the proboscis of the female must be correspondingly long. Few persons have failed to notice the so-called worms in chestnuts. These worms, when in American chestnuts, are the footless

FIG. 380. — *Balanus nasicus*.

larvæ, or grubs, of *B. caryatipes*. They reach full growth when the chestnut ripens, and then gnaw their way out of the nut in order to pupate in the ground. Some of the beetles appear the same autumn, and hibernate as imago; others, probably the larger number, appear the succeeding spring. The beetle itself is dark brown, densely covered with yellow compressed hairs, which are somewhat irregularly distributed in spots upon the elytra. Its length is about 0.3 of an inch. *B. nasicus* lives in hickory nuts, and *B. rectus* in acorns; both species have a close resemblance to *B. caryatipes*, and also to *B. nuceum*, the European species figured, which attacks both acorns and hazel nuts. The larva of *B. villosus*, another European species, feeds upon the inner portions of the apple-formed galls of *Cynips terminalis*, on oak.

FIG. 381. — *Balaninus nuceum*.

Trichobaris trinotata, a black weevil about 0.2 of an inch long, receives its specific name from three impressed, shining black spots near the base of the prothorax. It is common in the middle and western United States, where its larva is a serious potato-pest. The female weevil oviposits in oblong slits which she bores in the stems of the potato, and the larvæ, upon hatching, penetrate downward toward the root of the plant, causing its death. The larva is a legless white grub. It pupates in the stem of the potato, the beetle emerging about the beginning of September.

A small weevil that causes considerable injury to grapes is *Craponius iniquidis*. This insect is only about 0.1 of an inch long, of broad, almost circular, outline, grayish black, the elytra striate with large punctures; the legs reddish. In June and July this species lays its eggs in grapes, causing a change of color of the berry near the point of puncture. In August the larvæ drop to the ground, in which they pupate, the beetle emerging the next month.

Analeis fragaria is about 0.15 of an inch long, of a deep chestnut brown, with the elytra slightly lighter colored; the thorax is deeply punctured. The female oviposits in the crown of strawberry plants, and the larvæ bore down into the strawberry root. *A. foreolatum*, a black species with yellowish spots, is abundant upon the evening-primrose (*Oenothera biennis*).

FIG. 382. — *Conotrachelus umphar*.

Probably the weevil most injurious to agricultural interests in America is the so-called plum-weevil, or plum-cureulio, *Conotrachelus umphar*. This beetle is oblong-oval, about 0.18 of an inch long; dark brown, spotted in places with black, yellow, and white. The head is small, and when at rest is drawn back so that the eyes are nearly hidden by the forward edge of the prothorax, and the proboscis is received into a groove on the chest. The elytra bear interrupted ridges, and cover the entire abdomen.

Beneath, the sutures are curved, the coxæ are contiguous, the thighs bidentate, and the claws divergent and toothed. This species is distributed throughout the Atlantic slope of North America. It hibernates as imago, and when the plums, cherries, and other stone-fruit begin to develop in the spring, the female

makes punctures with her proboscis, — which, as in most weevils, is functionally an ovipositor, — just beneath the skin of the fruit, and deposits an egg in each puncture. When the female has thus oviposited, she makes a crescent-formed cut in the surface of the fruit about the egg, so that the egg itself remains in a sort of flap. The footless, fleshy, white larvæ, which hatch from the white eggs in from four to eight days, bore into the fruit, where they eat the fleshy portion just around the stone. The larval state lasts from three to five weeks. The disturbance made by the larva generally causes stone-fruit to fall to the ground; there the larva, as soon as full-grown, deserts the fruit in order to pupate a few inches beneath the surface of the ground. The full-grown larva is about 0.4 of an inch in length, yellowish-white with a light brown head, and is legless. Pupation lasts about three weeks, when the beetles emerge, hibernating later beneath leaves, under bark, and in other secluded nooks. This weevil is said by Dr. C. V. Riley to attack the fruit of “the nectarine, plum, apricot, peach, cherry, apple, pear, and quince, preferring them in the order of their naming.” The remedies that thus far seem best in order to lessen the numbers of the plum-weevil are to destroy the fruit that has fallen to the ground, and to capture the beetles by jarring the trees. Of course an application of the first remedy will not give any visible result the first year, because only larvæ will be destroyed, but the beetles will be less numerous succeeding years, and if all fruit-culturists would unite in thus destroying these weevil-larvæ in the fruit, their injuries would rapidly decrease. Fallen fruit, containing these and other larvæ, can be gathered, carted from the orchards, and destroyed; but often a much more convenient and profitable way is to let hogs into the orchards, where they can eat the fruit promptly as it drops from the trees. The capture of the beetles by jarring them from the trees depends upon the habit which nearly all weevils, in common with many other insects, have of dropping to the ground when suddenly disturbed. Dr. Hull, an Illinois fruit-grower, has contrived an apparatus for capturing the weevils by jarring. This apparatus is, essentially, a large white umbrella inverted over a wheelbarrow. Into that side of the umbrella which is directly opposite the person pushing the barrow a slot extends nearly to the middle, where, upon the front end of the wheelbarrow, a pad is fastened to prevent bruising the trees. The wheelbarrow is pushed suddenly against the trunk of each tree, the slot admitting the trunk, and allowing the umbrella to pass beneath the tree, and the jar which the tree receives from the padded barrow shakes the weevils into the inverted umbrella below.

Passing now from a species especially noteworthy for the agriculturist, the next species to be considered, *Cionus scrophularia*, attacks plants of little value to man, but is interesting to naturalists on account of its peculiar mode of life. The beetle itself, which is common in Europe, and has been taken in America, is nearly globular in form, and about 0.15 of an inch long. Its elytra are dark gray, spotted with black and white, its prothorax yellowish-white; beneath, the abdomen is black, the legs and anterior portions gray; on the elytral suture, a little in front of the middle, is a black spot. The species commonly inhabits *Scrophularia nodosa*, although often feeding on other plants. Its larva feeds exposed upon the leaves of the plant, and covers itself with a sticky secretion which is discharged from a wart upon the basis of the twelfth segment, and which enables it to adhere to the leaves. When ready for pupation, the larva spins a parchment-like cocoon with its secretion. This cocoon is wonderfully similar to the seed-capsules of the *Scrophularia*, and is generally attached to pedicels of these seed-pods. This is a most striking case where a cocoon mimics, for

protection, a part of a plant. The larvae and cocoons of *Phytonomus*, of *Phytobius*, and of a few other genera of weevils are not greatly unlike those of *Cionus*. *C. serophularia* remains in the pupal state only from six to eight days; it escapes from its chrysalis by cutting a round lid out of one end of the cocoon.

Anthonomus quadrigibbus is a reddish-brown weevil, from 0.12 to 0.20 of an inch long, having a proboscis in the female longer and in the male shorter than the body; this species, which is found in the eastern United States, is easily recognized by its having two protuberances, one behind the other, near the tip of each elytron. Its larvae feed in apples, pupation taking place within the fruit.

The genus *Liens* includes rather elongated weevils, in some of which the tips of the elytra are prolonged into a spine. The species are usually covered with a yellow or reddish pollen-like powder, which is easily rubbed off. *L. concavus*, a common species in parts of the eastern United States, is found upon a kind of dock (*Rumex orbiculatus*); its length is 0.6 of an inch, and it has spineless elytra.

Pissodes strobi, the three states of which are sufficiently recognizable from the illustrations, is

FIG. 383. — *Pissodes strobi*; larva, pupa, and adult.

about 0.3 of an inch long, and is dark brown, spotted with white. It inhabits the eastern United States, where its larva attacks the leading shoots of young pines. In Europe five species of *Pissodes* are known to attack pine. Quite closely related, systematically, to *Pissodes*, but larger (0.27 to 0.40 of an inch), and dark brown, with a few scattered yellowish dots, is *Hylobius pales*; this species is found in the same regions as *P. strobi*, and, like it, attacks pines.

FIG. 384. — *Hylobius pales*.

Phytonomus punctatus, probably introduced into America from Europe, where its food habits and life history had not been carefully recorded, has become, in parts of New York state, an important clover insect. It is an oval beetle, about 0.4 of an inch long, with short proboscis; its ground color is dark brown; the sides of the elytra, and often the elytral suture, are lighter brown, as are also three longitudinal lines on the smooth thorax. The elytra are punctate in lines. The eggs of this species are oblong, yellow, and are deposited in clusters in the hollow stems or other parts of clover plants. The larvae hatch in about ten days; they are yellowish white at hatching, but become greenish as they approach full growth. They are legless, but travel upon the stems and leaves of the clover by means of fleshy tubercles upon their ventral side, aided by a gland in the anal region, which secretes a sticky fluid. Many of the larvae cease feeding during the day-time, remaining concealed near the plants, and all except very young larvae drop to the ground when disturbed, so that one cannot readily observe them upon the plants. When ready to pupate, the larva spins a loose cocoon just below the surface of the ground, or in rubbish upon the ground. The duration of the pupal state apparently varies from ten to thirty days, according to climate.

Lepyrus is similar in form to *Phytonomus*. *L. colon*, an ashy-gray European species, about 0.45 of an inch long, is found in Hudson's Bay Territory, and is very common on the stunted willows near the summits of the White Mountains in New Hampshire.

Ithycerus noveboracensis is a gray weevil, dotted with black, and has a yellow scutellum; its antennæ are straight, not geniculate; its length is about 0.5 of an inch.

FIG. 385.—*Ithycerus noveboracensis*.

Although the larvæ breed in the tender twigs of bur-oak (*Quercus macrocarpa*), the adult beetles eat the tender shoots and bark of the apple. It is found from Canada to Texas.

In the United States *Bruchus pisi*, of the Bruchidæ, is generally termed the pea-weevil, but in England *Sitona lineatus*, the mystery of whose life history has been lately solved by Mr. T. H. Hart, is the pea-weevil. It is a brownish-gray beetle, rather slender, and only about 0.15 of an inch long. As imago it has been long known to eat the leaves and stems of beans, peas, and other leguminous plants, often totally ruining fields of young peas; lately the larvæ have been discovered to attack the roots of the same plants.

The weevils of the sub-family Otiorynchinae differ from those of the Curculioninae in having mandibles that are provided in the pupal state with a piece which is regularly deciduous in the early part of the imago state, and which, consequently, leaves a scar upon the mandibles.

Many species of Otiorynchinae are beautifully ornamented with scales. The most brilliant species belong to the South American genera *Lordops* and *Entimus*. *E. imperialis*, the diamond-beetle, is from 1 to 1.25 inches long, really of a black ground color, but its surface is deeply punctate, and the punctures are lined with brilliant scales, the predominant color of which, as seen against the black background, is bright green. These scales are so numerous that the beetle appears green instead of black. If some of these scales be scraped off with a fine-pointed knife and examined under the microscope, most of them will be found to be oval, about 0.006 of an inch long; by transmitted light the scales are red, blue, and yellow,—chiefly red; by reflected light they have colors complimentary to those seen by transmitted light, consequently mostly green, thus explaining why the scales on the black background furnished by the beetle appear green. The peculiar, changeable nature of the colors indicates that the coloration of these scales may be only optical, not produced by pigment within them. That the color is produced by interference of luminous waves is easily shown by putting a drop of chloroform on the scales upon a microscope-slide, when the colors will vanish only to reappear when the chloroform has evaporated, an experiment that may be repeated an indefinite number of times with the same scales.

FIG. 386.—*Entimus imperialis*.

Aranigus fulleri, an oval black weevil, lightly covered with dark brown scales, and about 0.25 of an inch long, does much damage, both as larva and imago, to roses in greenhouses. The larvæ devour the roots; the imago disfigure the leaves and flowers, and even eat into the unopened buds. This species is distributed from New England to California, and in the latter locality attacks several kinds of out-door shrubs.

The sub-family Attelabinae includes weevils which have the abdomen alike in the male and female, the elytra without lateral fold on their inner surface, the labium wanting, and the mandibles stout and pincer-shaped.

Attelabus rhois, a reddish pubescent weevil, quite robust, and about 0.2 of an inch long, with short proboscis, is quite common on the hazel (*Corylus*) in the northeastern United States. The species of *Attelabus* roll up the edges of the leaves of their food plant to form a protecting cell for their eggs and larvae.

The weevils belonging to the sub-family Rhynchitinae differ from the Attelabinae in having flat mandibles, which are toothed on both outer and inner edges.

Rhynchites bicolor is about 0.2 of an inch long, and is shining black and red. In New England specimens the elytra, prothorax above, and head as far as the eyes, are red. Specimens from other localities vary in the distribution of the red, but the prothorax above and the elytra are always red. This species is abundant throughout the United States, on wild roses.

FIG. 387. — *Apoderus longicollis*.

SUB-ORDER III. — HETEROMERA.

The Heteromera have the anterior and middle tarsi five-jointed, while the posterior tarsi have only four joints. Besides some anomalous families containing but few species, this group of beetles includes the Meloidae, Stylopidae, Mordellidae, Anthicidae, and Tenebrionidae.

The MELOIDE, oil-beetles or blister-beetles, have been used in oriental medicine as early as history gives any account of the mode of treating diseases, but, however curious medical properties they have, they are, to the naturalist, still more curious on account of their remarkable life history, and the strange modifications which parasitism has produced in the larval stages of many of them. The beetles themselves are generally of medium or large size; the vertical head is abruptly narrowed behind into a neck, and is not set into the prothorax; the antennae are generally eleven-jointed, and not long; the thorax has no lateral suture, and is narrower than the elytra; the hind coxae are large and prominent; the coxal cavities are open behind; the claws are cleft or toothed; the elytra are sometimes small, and overlap each other at the suture, although they often fail to cover the abdomen.

Species of *Meloe* exude a yellow fluid from the knee-joints when disturbed. This fluid is of a disagreeable odor, and contains, according to P. Magretti, uric acid. Leydig states that, as in the similar fluid from Coccinellidae, this is only the blood of the insect. Among the curiosities of the anatomy of Meloidae, may be mentioned the eyeless genus *Meloe typhlus*, from Peru, and the proboscis which is present in some species of *Nemognatha*. Dr. Hermann Müller has described the proboscis of one South American *Nemognatha* which is as long as the insect itself, and is made up of the two maxillae hollowed out on their insides and pressed together laterally, forming a tube for sucking honey, exactly as is the case with the proboscis of the Lepidoptera.

The blistering properties of cantharides, which gives them their value as a medicine, is due to the presence in all parts of the insect of a substance called cantharidin. Ordinarily, cantharides are used for making blister-plasters in the form of a powder, made by simply grinding the dried beetles, but as the cantharides, both before and after grinding, gradually lose their strength, on account of the action of other substances in them upon their cantharidin, and as they are likewise subject to destruction by museum-pests (*Anthrenus*) and by other insects, it is better to extract the

pure cantharidin for use in preparing medicines. Pure cantharidin ($C^5H^6O^2$) is insoluble in water, sparingly soluble in alcohol, and readily soluble in ether; with the latter fluid it can be extracted from cantharides, and then purified by separation from the accompanying oils and by crystallization. Cantharidin crystallizes in colorless, four-sided prisms or laminae. Although *Lytta vesicatoria* (the so-called Spanish fly) is the species generally used in medicine, other Meloidæ—among which may be mentioned species of *Mylabris*, *Epicauta*, and *Macrobasis*—have been used, and give a larger percentage of cantharidin than is obtained from *Lytta vesicatoria*. Probably all species of Meloidæ are vesicant to a greater or less degree. In preparing Spanish flies for the market, they are killed by heat, and then rapidly dried. The extent to which these insects were used in early times is indicated by the eighty-five citations, given by Jördens in 1801, of works in which considerable mention of cantharides is made.

FIG. 388. — *Epicauta vittata*.

Species of Meloidæ are injurious as well as useful; a number of species devour potato-leaves, both in this and in other countries. In Italy *Lytta erythrocephala* sometimes devastates potato-fields; in this country *Epicauta cinerea*, *E. pensylvanica*, *E. vittata*, and *Macrobasis unicolor* attack potatoes in addition to other plants. *E. vittata* and *M. unicolor* are, however, known to prey at times upon the larvæ of the Colorado potato-beetle.

The mode by which the Meloidæ develop from the egg to the imago has been termed hypermetamorphosis. In brief, it is as follows: The egg, which is laid in the ground, hatches into an active larva, called the triungulin, from the name *triungulinus* given to it by Dufour in 1828. These triungulins, or first larvæ, run actively about; some of them ascend plants, others live in sand, their mode of life varying according to what their subsequent history will be. The triungulins which climb plants, as do those of *Meloe*, remain about the flowers, attaching themselves to flies, bees, and wasps that visit the flowers for honey, and were described by several early naturalists as bee-lice. The triungulins of *Meloe* are sometimes so abundant, according to Dr. C. V. Riley, on hive-bees, as to worry them to death, although he believes these triungulins "cannot well, in the nature of the case, breed in the cells of any social bee whose young are fed by nurses in open cells." Those triungulins that attach themselves to such wild bees and wasps as are fitted to further their development are carried by these Hymenoptera to their nests, wherein they go from the bee to its egg in a cell, and devour the egg, after which a moult takes place, and the triungulin, formerly so active, is converted into a clumsy second larva, which feeds upon the honey provided for the young hymenopteron. The second larva then partially moults, remaining, however, within its skin, and becomes a pseudo-pupa. A third larva follows by similar partial moulting of the pseudo-pupal skin, and finally a true pupa and imago. Certain triungulins, or first larvæ, which wander about the ground, as do those of *Epicauta* and *Macrobasis*, have been found by Dr. C. V. Riley to feed upon the eggs of the Rocky Mountain locusts (*Caloptenus spretus*) and upon eggs of *C. differentialis*. The triungulin which devours locust eggs moults to enter what Dr. Riley has called, on account of its resemblance to larvæ of Carabidæ, the "carabidoid stage of the second larvæ;" another moult transforms it to what the before-mentioned author has termed, because of resemblance to larvæ of Scarabæidæ, the "scarabæidoid stage of the second larva;" still another moult produces what, following Dr. Riley's nomenclature, is the "ultimate stage of the second larva." Leaving now, for the first time, the

egg-mass of the locust, this larva forms a cavity in the ground, partially moults, and enters the pseudo-pupal (sometimes termed coarctate larval) stage. Usually hibernation takes place in this stage. The third larva is revealed in the spring by a shedding of the pseudo-pupal skin. The third larva burrows about the ground, without feeding, soon pupates, and the imago emerges shortly after. The stages of the Meloidæ parasitic upon bees, and of those which are devourers of locust eggs, can be more easily understood and compared with the ordinary metamorphoses of Coleoptera by a glance at the following tabular arrangement:—

BEE-PARASITES.

Egg.

Triungulin (1st larva): Active, often a plant-climber; bee-parasite, and egg-eater.

Second larva: Sluggish, and a honey-eater; usually with two moults.

Pseudo-pupa: Coarctate larva, is a resting stage.

Third larva: Again active, but does not feed.

Pupa.

Imago.

DEVOURING EGGS OF ORTHOPTERA.

Egg.

Triungulin (1st larva): Active, running about the ground; an egg-eater.

Second larva: An { carabidoid stage.
egg-eater. { scarabæidoid stage.
ultimate stage.

Pseudo-pupa: Coarctate larva, is a resting stage.

Third larva: Again active, but does not feed.

Pupa.

Imago.

Lytta vesicatoria, the Spanish fly, is a bronze green species, about 0.75 of an inch long, and is found in middle and southern Europe and in southwestern Asia, where it feeds upon ash (*Fraxinus excelsior*), lilac, and other trees. Curiously enough, the

FIG. 389. — *Lytta vesicatoria*, Spanish fly.

life history of this insect, which was so long used for medicinal purposes, remained almost unknown until 1879, when J. Lichtenstein published an account of rearing the imago from the triungulin, which latter fed upon eggs of *Ceratina chalcites*, a hymenopteron. The triungulin, which is, of course, very small, has strongly protuberant eyes, and two long caudal appendages. In five or six days the triungulin changes to the second larva, a little white grub, with six feet. The mandibles, sharp in the triungulin, are short and blunt in the second larva, which feeds on honey. After five days the second larva moults, the mandibles are still more blunt, and the eyes less prominent. At the end of a second five days' period another moulting takes place, the eyes entirely disappear, and the larva becomes scarabæidoid. The larva now descends into the ground, where, in a small cavity, it pupates in about five days. The pseudo-pupa is similar to the well-known pupæ of Muscids, but has four little protuberances or warts upon the head and three pair of warts in place of feet. The color is yellowish white; and from time to time a clear fluid is exuded from pores of

this pseudo-pupa. In this pseudo-pupal state hibernation takes place, and the next spring the pseudo-pupa bursts open, and the third larva appears. This larva, which otherwise closely resembles the scarabaeidoid form before mentioned, has rudimentary mouth-parts and poorly developed, two-jointed feet. After about two weeks, during which time this third larva does not leave the cavity in which it emerged from the pseudo-pupa, it changes into a normally formed beetle-pupa, and in about twenty days more the beetle appears.

Epicauta cinerea, *E. pensylvanica*, and *Macrobasis unicolor* eat potato-leaves as imago, but as larvæ they are useful to man by destroying locusts. The Rocky Mountain locust lays its egg-masses just beneath the surface of the ground, and these species of *Epicauta* oviposit near the locust eggs, in a hole which the female *Epicauta* digs for the purpose, afterwards covering her eggs by scratching dirt over them with her feet. The

FIG. 390. — *Epicauta cinerea*.

eggs hatch in about ten days, and the light brown triungulin, if the weather is warm, soon begin searching out locust eggs for food; if it is cold weather they remain closely huddled together until warmth induces activity. Dr. C. V. Riley observes: "Should two or more triungulins enter the same egg-pod, a deadly conflict sooner or later ensues until one alone remains the victorious possessor." After devouring about two eggs, that is, at the end of about eight days after beginning to feed, a moult takes place, and the second larval form appears, the form designated as carabidoid. The carabidoid form lasts about a week, the succeeding scarabaeidoid form about a week; after reaching the ultimate

stage of the second larva, it feeds about a week, then leaves the remnants of the locust's egg-mass, and rounds out for itself a smooth cavity in the ground. After being in this cavity about four days, a moult takes place, but the skin is not entirely shed. The soft skin quickly hardens, and the insect is now a pseudo-pupa. After hibernating as pseudo-pupa, the skin again bursts, and the third larva appears. This third larva burrows about in the ground, and in a few days the true pupa is formed, from which, in five or six days, the imago appears. The functional significance of the third larva, which, in these insects as in *Lytta vesicatoria*, eats nothing, is not yet understood.

The genus *Myglabris* includes over two hundred and fifty beetles in which the elytra cover the entire abdomen, the mandibles are short, the antennæ are gradually enlarged toward the apex. The species are often black or blue-black, banded with yellow, and of considerable size. No true *Myglabris* is found in the United States. *Corilygospasta fulleri* from Nevada, with eight-jointed antennæ, is an allied form to *Myglabris*.

Sitaris differs from *Myglabris* in having wings partly exposed, and the rudimentary elytra narrowed rapidly behind, and not reaching the tip of the abdomen. The first to describe all the different stages of any species of Meloidæ was J. H. Fabre, who, in 1857, published his account of the metamorphoses of *Sitaris humeralis*, a French species, which is parasitic on bees of the genera *Anthophora* and *Bombus*. Fabre's account of the life history of *S. humeralis* is briefly given as follows: The males and females, as soon as they have emerged from the pupæ, pair in the subterranean nests of the bees upon which they are parasitic, and the female lays soon after about two thousand eggs, near the entrance of the nest. The triungulins, which hatch in about a month, hibernate, without feeding, among their egg-shells, and the next spring attach themselves to the hairs upon the thorax of the male bees, from which they probably pass over to the females during the pairing of the bees. Thus

far the history of their life is sufficiently strange, but the next change of habitat is still more curious. At the moment when the female bee deposits her egg upon the surface of the honey in her cell, the active young triungulin passes from the bee to the egg, upon which the larva rides, as upon a boat, thus avoiding drowning in the honey about it. The bee's cell is sealed, and then the triungulin begins eating into the egg of the bee; the contents of this egg just suffices as food for the larva about eight days, when it moults and appears as the second larva. This second larva, unlike the triungulin, is not in danger of drowning in the honey about it, and feeds upon it. In the latter part of summer the second larva attains full growth, and enters the pseudo-pupal state. Most of these insects hibernate as pseudo-pupæ, although a few appear as imagoes about the beginning of September. The pseudo-pupæ which hibernate go through the third larval and the pupal stages from June to August of the next year, appearing as beetles about the middle of August.

Hornia minutipennis, an American species allied to *Sitaris*, was found by Dr. C. V. Riley to be parasitic upon *Anthophora sponsea*, but its life history is still incomplete. The imago is about 0.5 of an inch long, with no wings, and the elytra are so extremely rudimentary as to be scarcely noticeable.

Among other genera of Meloidæ of which more or less is known concerning their life history is *Zonitis mutica*, a French species, whose hypermetamorphosis takes place in cells of *Osmia tridentata*.

Meloe includes wingless beetles, which have very short, imbricated elytra that do not nearly cover the abdomen. *M. angusticollis* is a steel-blue species common in the eastern United States. Its length is from 0.40 to 0.75 of an inch. The females of *Meloe* are very prolific, and sometimes lay as many as from three to four thousand eggs. The life history of *Meloe* has not been as well studied as has that of *Sitaris*, but there is no doubt that its earlier stages are passed, in analogous mode to those of *Sitaris*, in the nests of bees.

The STYLOPIDE are insects of very abnormal structure and habits, and are regarded by some naturalists to be a separate order, Strepsiptera, and by others are assigned to this position next the Meloidæ. The males have rather peculiar form, small, partially rolled up elytra, and very large wings which fold like a fan. Their eyes are large, coarsely faceted, and, in *Stylops* and *Xenos*, are mounted upon pedicels. In the adults of both sexes the mouth-parts are rudimentary. Prothorax and mesothorax are short; the metathorax is, on the contrary, greatly developed. Sexual dimorphism is carried to its extreme degree among the Stylopidae, and although the males are capable of locomotion and possess good eyes, the adult females are wingless, eyeless, and legless parasites, remaining buried between the abdominal segments of wasps, bees, and ants, there enclosed in their pupal-skin which they

FIG. 392. — *Xenos pecki*; a, Elytra.

FIG. 391. — *Meloe angusticollis*.

never shed, and pushing out into open air only their anterior end between the segments of their host. Their eggs, which drop directly from the ovaries into the body-cavity, develop in the latter place, possibly parthenogenetically at times, although

pairing has been often observed. The larvæ are hatched in the body-cavity; the Stylopidae are consequently viviparous. These hexapodous larvæ, which are very active and have eyes, escape by a dorsal opening from their mother, and, running about on the female bees, are transported to the nest, where they quickly bore into and bury themselves in bee-larvæ. Once inside a bee-larva, the larva of the *Stylops* moults in about a week, and appears as a footless grub which feeds upon the fatty portions of the bee-larva. When the bee-larva pupates, its parasite pupates within it. In becoming an imago, the female *Stylops* only bores out through the end of her own pupal skin, and through one of the soft folds of the abdomen of the bee, protruding her head and thorax between two segments of her host, but never leaving her pupal skin. The males leave the pupal skins, search out females, pair, and die, usually in a few hours. Each female is supposed to bear about two thousand young larvæ, many of which, on account of their strange mode of life, die without finding a suitable place for further development.

FIG. 393. — *Xenos rossi*, female.

There are but few genera and species of Stylopidae, among which the following genera are perhaps best known, — *Xenos*, with four-jointed antennæ and four-jointed tarsi; *Stylops*, with six-jointed antennæ and four-jointed tarsi; and *Haliectophagus*, with seven-jointed antennæ and three-jointed tarsi.

Westwood has described a pupa, which he regards as belonging to the Stylopidae and which was found in the abdomen of a hemipteron, under the name of *Colacina insidiator*; and the same author has also described a species, under the generic name *Myrmecolus*, which is parasitic on ants in Ceylon.

The RHIPIPHORIDÆ, a family containing only about a hundred described species, includes insects, like so many other heteromerous Coleoptera, remarkable both for abnormal adult structure and for parasitical earlier stages. The larvæ of some are parasitic on Hymenoptera, of others on Orthoptera. The beetles are all comparatively small and generally wedge-shaped, the anterior portion of the prothorax and the posterior portion of the abdomen usually diminishing gradually in size. The head is vertical, and has large eyes; the mouth-parts are well-developed, and the antennæ have usually ten, in some females eleven joints, and are pectinate or flabellate in the males, and often serrate in the females. The elytra are usually shorter than the abdomen, often acutely pointed behind and dehiscient, sometimes very minute; a few females resemble larvæ, and want both wings and elytra. The beetles inhabit flowers.

Some discussion has arisen as to the actual food and mode of life of the larvæ of Rhipiphoridae in wasps' nests, but the following brief abstract of statements made by Mr. A. Chapman in an account of the life history of *Rhipiphorus (Metæcus) paradoxus*, a common European species which develops in the nests of *Vespa germanica* and *V. vulgaris*, are probably the facts of its mode of life. The female beetle probably lays its eggs outside the wasps' nests; the young larva, which has ocelli and is not unlike the triungulin of the Meloide, comes into the nest, possibly without help, and enters the cell of a wasp-larva. Before the cell of the wasp-larva is closed up the *Rhipiphorus*-larva bores in between the second and third dorsal rings of the wasp-larva. Later the *Rhipiphorus*-larva, after feeding a while in the wasp-larva, breaks out through the fourth ring of its host, moults immediately, and becomes a grub with poorly developed legs. The parasitic larva now fastens itself firmly upon the fourth ring of the wasp-larva, where it later moults again; soon after this moult the parasite has

sucked the juices entirely out of the wasp-larva, and pupates in its cell. The whole process requires from twelve to fourteen days, and the beetle emerges two days later than the wasps in the same row of cells. *Myodites subdipterus*, another European species, has been reared from nests of *Haliectus sexcinctus*. *Rhipidius*, a European genus, has larviform females without wings or elytra; its larvæ are parasitic in the abdomen of cockroaches.

The MORDELLIDÆ are beetles similar in general appearance to those of the last-described family, but they differ from those of that family in having a distinct lateral suture of the thorax, and in having filiform antennæ. The larvæ of the Mordellidæ are not parasitic as are those of the three preceding families, but live in fungi or twigs; the larvæ have short legs, on which the joints are not distinctly indicated. The beetles themselves are of small size, and, like the Rhipiphoridae, are found on flowers.

FIG. 394. — *Mordella ornata*.

FIG. 395. — *Mordella octopunctata*.

Very few of the American species of this family have been reared. Mr. V. T. Chambers has reared a species of *Mordella* from a larva feeding in pith of *Veronica*, and mentions the occurrence of similar larvæ in the galls of *Gelochia gallusolidaginis* on *Solidago*.

The ANTHICIDÆ, a family of beetles mostly of small size, are generally found on flowers, although some species are inhabitants of sandy places near the water. These beetles have the head constricted behind the eyes, the lateral suture of the narrow prothorax is wanting, the rounded elytra cover the entire abdomen. In *Notocus* and *Anthicus*, two genera with numerous species, the head is deflexed and narrowed behind the oval, coarsely-granulated eyes. In *Notocus* the prothorax extends out over the head in a sort of horn; in *Anthicus* there is no prothoracic horn; and in the ant-like genus *Formicomus*, which is closely related to *Anthicus*, wings are absent. But little is known of the life history of the Anthicidæ. *Tamartheus salinus*, from the Colorado desert-lands, and from Utah, runs and flies along the salt mud much in the same way as do species of *Cicindela*.

The family of the TENEBRIONIDÆ, as usually limited, includes between four and five thousand kinds of beetles, mostly of rather sombre coloration, although a few species are marked with red or are bronzed. Le Conte and Horn say that, "This family contains a large number of genera, possessing in common very few characters, yet linked together by such gradual changes in structure that their classification presents almost insuperable difficulties." The beetles of this family have, according to the above-named authors, simple claws, anterior coxal cavities closed behind, five ventral segments which are in part connate, and the penultimate joint of the tarsi not spongy beneath. They may be divided into three sub-families. These are the Tenebrioninæ, having the third and fourth ventral segments with a coriaceous posterior margin; the Asidinae, having the ventral segments entirely corneous and the middle coxæ with a distinct trochantin; and the Tentyriinæ, having the ventral segments entirely corneous, as in the Asidinae, but the middle coxæ without trochantin.

The larvæ of Tenebrionidæ are elongated, often resembling, in a general way, the so-called 'wire-worms,' the larvæ of Elateridæ. The larvæ have four-jointed antennæ, five-jointed legs, are provided with from two to five ocelli on each side of the head, and often have a pair of anal appendages to aid in locomotion. The larvæ feed upon

fungi, upon dead animal and vegetable matter, upon dung, and upon plant-galls; the larvæ of *Hypophloeus ferrugineus* devour the larvæ of *Tomicus stenographus*, and the larvæ of *Tribolium ferrugineum* and of *T. castaneum* are museum pests. The larvæ as well as the imagos of the Tenebrionidæ are usually abundantly parasited by intestinal Gregarina; of some species of Tenebrionidæ one cannot find an individual, upon dissection of large numbers, that does not harbor one or more species of these parasites.

The geographical distribution of the Tenebrionidæ is somewhat remarkable. On the eastern coast of North America the family is poorly represented, but the number of genera and species in the fauna increases toward the west, until, upon reaching California, they are among the most abundant Coleoptera. They are especially abundant also along the western coast of South America, and in Europe.

The uses to which Tenebrionidæ have been put are comparatively few. The larvæ of *Blaps mortisaya* are said to be roasted and eaten by Egyptian women, and the larvæ of *Tenebrio* and *Alphitobius* have been reared in zoological gardens as food for amphibians and insectivorous birds.

Among the beetles belonging to the sub-family Tenebrioninæ are those of the genus *Illops*. In *Illops* the tarsi are slender, the abdomen not pedunculate, and there is a coriaceous band above the labrum; some of the species are wingless, and their form varies from oblong to oval. Some of the species of *Illops* are beautifully striped longitudinally with changeable bronze lines. This is especially the case with *Il. micans*, found in the northeastern United States. The larva of *Il. striatus*, a European species, has been found living in decayed coniferous wood, feeding not only upon the wood but upon the excrement of wood-boring longicorn larvæ. *Il. pullus* has been found in Illinois about apple and peach trees that had been attacked by borers.

Bolitotherus bifureus is a curious rough beetle not uncommon in the northeastern part of the United States and in Canada about species of *Polyporus* and other fungi upon trunks of trees. It is from 0.4 to 0.5 of an inch long, and dull brown, the lateral margins of the prothorax are flattened and extend forward each side of the head; two protuberances upon the dorsum of the prothorax are short in females, but in males extend upward and forward to form veritable horns, which are of variable length, are flattened out from above and below, and are fringed with light brown hairs around their margins. The antennæ are short and ten-jointed. The larvæ feed in holes which they burrow in fungi. They are about 0.75 of an inch long when full grown, long and narrow, with the abdomen ending in two spines. Pupation takes place within the fungus. *Eledona agaricola*, a European species closely related to *Bolitotherus*, has similar habits.

FIG. 396. — *Bolitotherus bifureus*.

Diaperis has a short, oval form, smooth surface, and the first joint of the hind tarsi not exceeding the second in length. *D. hydni* is about 0.25 of an inch long, the elytra are red spotted with black, the rest of the insect is black; it is very common upon *Polyporus betulinus*, a large fungus that attacks dead white-birch trees, and in which the larva of the beetle feeds. *D. boleti*, from Europe, is a trifle larger than *D. hydni*, and has a broad, irregular black band across the middle, and a similar band near the apex of the elytra; its habits are like those of *D. hydni*. *Hoploccephala* differs generically from *Diaperis* in having the first joint of the posterior tarsi as long as the second and third joints. *H. bicornis*, a smooth beetle, only about 0.15 of an inch long, and of a

metallic-green color with brownish legs, is very common on various kinds of small fungi growing on bark of dead trees and stumps. The male is distinguished from the female by two slender horns that surmount the head; the female has the general aspect of a small species of Chrysomelidae. The species of *Platydema* are oval, somewhat flattened beetles, and have the first joint of the posterior tarsi longer than the second and third joints. Their larvae feed upon fungi under bark.

In the genus *Tenebrio* are included black, elongated, winged beetles, in which the antennae are gradually thickened toward the tip, the epipleurae entire, the legs slender, and the entire insect of a dull-black color. The larva of *T. molitor* is the well-known meal-worm, and all stages of the insect are found about granaries and bake-houses, where they are very destructive to stored grain and all farinaceous matter. Some of the species of *Tenebrio* are found about decaying wood, and Chapuis and Candèze write that these, as well as other larvae of Tenebrionidae, may be distinguished from the larvae of Elateridae — the wire-worms — which they so closely resemble, "by the structure of their mouth-parts, that is by the attachment of the lobe to the basal piece of the maxillae, and by their visible clypeus and labrum."

FIG. 397. — *Tenebrio obscurus*.

Upis ceramoides, a black beetle with slender legs, common in the eastern United States, is about 0.75 of an inch long. Its thorax is finely punctate when examined with a lens, although it appears smooth to the naked eye; its elytra are deeply and irregularly indented. It is found under bark, as is also *Iphthimus opacus*, a beetle of about the same size, which has both thorax and elytra coarsely punctured. *Nyctobates pennsylvanica*, found in the same regions as *Upis ceramoides*, resembles the latter in form and size, but has elytra upon which fine punctures are arranged in very regular striae.

In California and Arizona are three genera — *Stenotrichous*, *Cratidus*, and *Amphidora* — which, contrary to the general rule in Tenebrionidae, are densely pubescent with long, erect hair; the species are all wingless. One of the largest of these pubescent species is *Cratidus osculans*, which is about 0.6 of an inch long, black, densely punctate, and out of each minute depression arises an erect brown hair.

FIG. 338. — *Blaps mortisaga*.

Blaps and *Eleodes*, two well-known genera of the Tenebrionidae, belong to a group in which the connate elytra partly embrace the body, and in which the tarsi are spinose or setose beneath. *Blaps* is a genus containing numerous species distributed over Europe, northern Africa, and western Asia. *B. mortisaga*, a common European species, has been introduced into America, and is abundant at Alexandria, Va. It is about an inch long, entirely black, and is found in cellars, caverns, and other obscure places, where it feeds upon animal refuse. The larva of *Blaps* is similar to that of *Tenebrio*, but larger, and lives in obscure nooks. *Eleodes* contains about fifty species, which are all found in the western United States, where they devour excrement and dead matter, and seem to fill the place occupied in the eastern hemisphere by *Blaps*. Some of

the species of *Eleodes* are quite large, *E. obscura*, a robust species, and *E. gigantea*, a slenderer species with long legs, being about 1.25 inches long.

Dr. G. H. Horn stated in 1867 that certain Californian species of *Eleodes*, when disturbed, elevate the abdomen nearly vertically, and if seized discharge an oily fluid from the abdomen. An analogous disagreeably odorous secretion is used as a defence

by *Blaps mortisaga*, *B. obtusa*, and others of the same genus. The odorous fluid, both of *Blaps* and of *Eledes*, is secreted by two glands, one on each side, near the anus, from which it is ejected, sometimes in the case of *Eledes longicollis* to a distance of three or four inches. Mr. C. F. Gissler, who has examined the secretion of *Eledes*, states that it has an acid reaction, stains the skin brown and causes lachrymation; has a very penetrating, indescribable odor; is soluble in water, alcohol, and ether; and sometimes crystallizes on a glass, forming an orange-colored magma of minute crystals. *Blaps obtusa*, according to Hornung and Bley, contains a red pigment, volatile and fatty oil, resin, formic and uric acids, and wax, besides chitin and other substances. Kirby and Spence write that, "Pliny tells us of a *Blatta*, which, from his description, is evidently the darkling-beetle (*Blaps mortisaga*), and which he recommends as an infallible nostrum, when applied with oil extracted from the cedar, in otherwise incurable ulcers, that was an object of general disgust on account of its ill scent, a character which it still maintains."

The sub-family *Asidiinae* contains numerous genera, among which *Asida* is well known since it is represented by numerous species in the European fauna and by over thirty species, all from west of the Mississippi River, in the United States. The species of *Asida* inhabit desert regions. They are apterous and have an ovate body.

The sub-family *Tentyriinae* contains, with few exceptions, apterous species. The only species of the *Tentyriinae* found in the northeastern United States is *Phelopsis obovata*, which is found from Maryland to Canada. It is about 0.55 of an inch long and one-third as wide, is dark brown, is roughened by deep punctures and prominent elevations, and has the anterior portion of the prothorax winged laterally. It is found upon fungi in localities similar to those frequented by *Bolitotherus bifoveus*, which its color and rugosity recall.

SUB-ORDER IV. — PENTAMERA.

The Pentamera, the group of beetles normally having tarsi with five joints, includes all the Coleoptera to be described hereafter in this work, and probably contains about one half the known species of Coleoptera. Omission is made of some of the smaller and less interesting families in order to allow more space for those families which are of most importance.

The family *LYMEXYLOIDE* contains but four genera and a limited number of species, but the destruction of ship-timber in western Europe by *Lymexylon navale*, and Linnæus' application of a remedy by immersing the timber during the time of oviposition of the beetle, early called the attention of naturalists to this species. The species of this family have a deflexed head, which is narrowed behind; the eleven-jointed serrate antennæ are inserted on the sides of the head; the coxæ are all contiguous in the three American genera, but in *Atractocerus* the anterior coxæ are separate; the legs are slender. *Lymexylon* has entire elytra and the abdomen with five ventral segments. The species generally resemble those of certain Elateridæ, or spring-beetles, later to be described. The larvæ of *L. navale* are slender, six-legged grubs; the head is small, the first segment enlarged, and the last segment bears a leaf-like appendage above. These larvæ make long cylindrical burrows in oak wood. None of the *Lymexyloide* are sufficiently abundant in America to cause damage. *Micromalthus debilis*, a minute but interesting species, has been reared by Mr. H. G. Hubbard, from decayed wood found in Detroit, Mich.

The species of *PRINIDE* are generally small; their antennæ are variable in form and place of insertion, and have from nine to eleven joints; the head is quite retractile, so much so as to be often protected by the prothorax; the elytra are entire. The food-habits of this family are very diversified; both larvæ and imagos show a preference for dead animal or vegetable matter, although living plants do not escape their attacks. The larvæ eat drugs, even devouring capsicum, tobacco, allspice, and other material not generally acceptable to insects; they also bore in both living and dead fungi, bark, twigs, roots, and wood of many kinds; and one species, *Catorama zea* from the Barbadoes, lives somewhat after the manner of *Bruchide*, in maize.

A common beetle belonging to this family, that attacks apple trees in the middle United States, is *Amphicercus bicaudatus*, which is about 0.3 of an inch long, of a cylindrical, slender form, and of a dark-brown color. Its specific name is derived from the fact that the males have two small thorns projecting from the posterior end of the body. This species does not, in all probability, breed in young twigs of apple, although it may often be found in them, head downward, in burrows which occupy one or two inches of the pith of the twigs, and extend downward from an opening by which the beetle has entered the twig. These burrows are used only for hibernation, and the larval history of this beetle is not yet known. Similar injuries to those which *A. bicaudatus* cause in apple twigs are also produced by the same species of beetle in pear, peach, and grape twigs. In Europe beetles of the genera *Apate* and *Linocylion*, closely related forms to *Amphicercus*, attack grape twigs, as well as the bark and wood of numerous trees.

Lasioderma serricorne, a small species of this family, eats, as larva, capsicum and dried tobacco. *L. laev* attacks stems and leaves of dried tobacco, often doing much damage to them. The former is found in both Europe and America; the latter is European. *Catorama*, of which one species has been mentioned as eating maize, differs from *Lasioderma* in not having serrate antennæ. *C. tabaci* attacks cigars in Cuba, and *C. sallei*, from the West Indies, undergoes its metamorphoses in the pods of a plant closely like Saint-John's-bread.

In *Anobium* the form is elongated, somewhat cylindrical; the eleven-jointed antennæ are inserted just in front of the eyes, and the metasternum is deeply excavated in front. These little beetles, which are generally black or brown in coloration, and about 0.25 of an inch long, have received the name of death-watch on account of a peculiar ticking sound which they produce in the wood of houses, a sound which was supposed, by superstitious people, to presage death to some member of the household where it was heard. The sound itself consists of from six to twelve sharp, distinct ticks, at nearly as regular intervals as the ticks of a clock; then a pause of a minute or more occurs, and the sound is repeated, often in another locality from that where it was first heard. As this ticking is generally emitted when there is no other disturbing noise, often in the stillest part of the night, one can scarcely wonder that people who do not know its cause should listen to it, perhaps while watching at the sick-bed of a friend, with hushed breath, and should associate its sounds with death. The sounds are really, however, only signals by one beetle to discover another of its species; probably, as in many other insect-noises, they have a sexual significance, and serve to guide one sex to the other. At any rate, by deftly imitating their call by snapping with the finger-nail upon a piece of hard wood, the beetles can be deceived into repeatedly answering your telegraphic message. The mode by which the beetle produces its sound was first observed by Swammerdam, the distinguished Dutch

anatomist, over two hundred years ago, and has since been described by several naturalists. The rapping is caused by a forcible hammering of the hard wood with the head of the beetle, and it is noticeable that the beetle selects places where the wood will act as a sounding-board for its curious sonification.

The larva of *Anobium* is cylindrical, short, often slightly dilated toward the posterior extremity, and has six legs; it has no ocelli, short antennae, a labrum which reaches nearly to the extremity of the short, stout mandibles; its anal opening is longitudinal. The larvæ sometimes develop in one year, and sometimes require longer. Both beetles and larvæ often do much damage to furniture, books, drugs, and provisions. Linnaeus found that *A. portinæ* destroyed his chairs; Kirby and Spence complain that *A. striatum* has the same habit, and also injures picture-frames and the boards of floors. Both of these species of *Anobium* attack books, not only for the leather with which they are bound, but also for the paste used in their binding. Spence mentions wholesale destruction of oaken beams used to support floors in the old mode of building houses in Belgium, necessitating renewal of these beams at great expense.

Nitidorepa panicea, a cosmopolitan species often mentioned under the name of *Anobium paniceum*, differs from *Anobium* by not having the metasternum excavated in front. It is a brown beetle densely covered with light brown pubescence, and about 0.12 of an inch long. The earlier stages of this beetle were described in 1721 by Frisch, who found the larvæ devouring the inside of a piece of rye-bread. Later the same author writes that this insect injures books, and attacks many kinds of dead animal matter. Prof. A. S. Packard mentions finding this species in wasps' nests preserved in museums, where it probably ate the dried wasps left in the nests. Dr. H. Shimer has raised this species from larvæ feeding in red beads "made of some kind of colored paste."

The genus *Ptinus*, of which *P. fur* is a widely diffused representative, differs from *Anobium* both in form and in having the long filiform antennae inserted closely together upon the front. *Ptinus fur* is of a uniform brown color, and is pubescent; it is only about 0.1 of an inch long. De Geer described and figured the preparatory stages of this species in 1774. This species is known as a museum pest, attacking insects and other animals preserved in collections. I have found it swarming in barrels of wool which had been clipped off the fleece and thrown aside because it was full of sheep's dung and other dirt. According to E. Perris the female of *P. dubius*, a French species, oviposits in the male blossoms of *Pinus maritima*. The larva grows rapidly, feeding upon the pollen of the pine, and forms its cocoon of pollen-grains cemented together by a mucilaginous secretion. *P. brunneus*, a species found in Europe and in the United States, sometimes attacks the binding of books.

The diversity of habits of the larvæ of Ptinidæ can be easily seen by the above selections from what is known of their life history. They are generally easily destroyed by subjecting the materials in which they feed to heat, or to the action of benzine vapor in a closed tin box. A convenient way of destroying these and other insects in books, in such drugs as are not injured by subjecting them to a dry heat of 100° C, in clothing, and in

FIG. 399. — *Ptinus fur*.

FIG. 400. — Larva of *Ptinus fur*.

many other substances, is to put the goods containing insects into a loosely covered tin box or pail and to set this for a time into boiling water, taking care that the water does not boil over into the box containing the goods.

The family of CLERIDÆ includes over seven hundred species of beetles, of which many have beautiful coloration, and a general aspect somewhat ant-like. This ant-like appearance is due to their prominent eyes, their short antennæ, their generally long legs, and their elongated prothorax, which is often much narrower than the elytra and slightly narrower than the head. The antennæ, which are usually eleven-jointed, have the apical joints enlarged, forming a more or less compact serrate club. The posterior coxæ are flat, and the tarsi have membranous lobes. The larvæ of Cleridæ are mostly predaceous, inhabiting the burrows of xylophagous coleoptera, or the nests of bees, and feeding upon the living larvæ which they find in these situations; a few (*Corynetes* and *Necrobia*) eat decaying animal matter. Many species of Cleridæ, as imago, frequent flowers, but a large number of them, especially species of *Thanasimus*, can be found running quickly over dead pine bark, and piles of freshly-cut pine wood furnish the agile insect-collector numerous species.

The species of *Necrobia* which have been introduced into America from Europe, are small pubescent carrion beetles of which the outer three joints of the antennæ form a club. The last joint of the palpi is long and truncate. *N. violacea* is about 0.15 of an inch long and deep steel blue, rarely greenish, in color. *N. ruficollis* is a trifle larger than the last-mentioned species, and its legs, prothorax and the anterior portion of its elytra are dull red. *N. rufipes* differs from *N. violacea* in having brown legs. The larvæ of *Necrobia* frequents the same places as does the imago; it is of a light brownish-red color, and its abdominal segments increase in size posteriorly, so that the tenth segment is over one-fourth wider than the fourth segment.

Thanoscerus sanguineus is a pretty red species in which the light red elytra are densely punctate, and the brownish-red prothorax is covered with long pubescence. Its life history is unknown. *Chrus ornatus* is a beautiful species from the western coast of North America. Its length is about 0.4 of an inch; its elytra are yellow, marked with very dark shining blue, its prothorax is blue, clothed with long yellow hairs, and its legs are blue.

In *Trichodes* the club of the antennæ is somewhat triangular, the last joint of the labial palpi is dilated, that of the maxillary palpi only slightly larger than the penultimate joint. *T. apiarius*, a well-known European species, is about 0.6 of an inch long. Its ground color is deep blue, but three broad bands of yellow extend from the outer nearly to the inner edge of the elytra; the head, prothorax, and legs are clothed with long pubescence. The larvæ of this species lives in the nests

FIG. 401. — *Corynetes ruficollis*.

FIG. 402. — *Thanoscerus sanguineus*.

FIG. 403. — *Chrus ornatus*.

FIG. 404. — *Perilypus carbonarius*.

FIG. 405. — *Trichodes apiarius*.

of wasps and wild bees, and at times in ill-kept hives of honey bees, where it eats not only such half-dead bees as come within its reach, but nests in the honey-comb and

devours the larvæ and pupæ of the bees. The imago is found from May to July; the larva remains from July until the next year in the bees' nests. In America *Trichodes nuttalli* is not rare in August upon flowers of *Spiræa alba*, but its larval habits have not been studied. It is about 0.4 of an inch long, and somewhat resembles *T. apicarius* in color and markings. The genus *Aulicus*, which has the apex of both labial and maxillary palpi dilated, is found on the western coast of North America, as is also the very slender *Perilypus carbonarius*, in which the posterior thighs are elongated.

FIG. 406. — *Aulicus nero*.

The larvæ of *Tillus trifasciatus*, a European species, live in dried grape twigs, preying upon larvæ of *Anaspis maculata* and *Apanteles scedentata*; and finally pupating in the twigs. It is probable that *T. collaris*, from Georgia, has analogous habits.

The family of MALACHIDÆ is often united with the next succeeding family (Lampyridæ) from the species of which the members of this family differ in having only six free ventral segments, and in the insertion of a separate piece between the front and the labrum.

The genus *Malachius*, and a few of its allies, has excited the attention of many observers on account of its protrusion of two evaginable processes from each side. In *Malachius aneus* each anterior process is trilobed, and is pushed out on each side from beneath the anterior angles of the prothorax; each posterior process is bilobed and originates between the metathorax and first abdominal segment. These processes are of a delicate red or reddish-yellow tissue; they were shown by Dr. H. Liegel to be evaginated by filling with the blood or body-fluid of the insect, and to be retracted by muscles within them. The function of these organs is unknown.

Malachius aneus, the beetle just mentioned, is about 0.2 of an inch long; the anterior angles of its prothorax and the outer portion of its elytra are dull red, the rest of the insect is bronze green. It is found both in Europe and

in the United States, having been introduced into the latter country.

The beetle eats the pollen of grass and other plants, and is possibly sometimes carnivorous; the larva lives beneath the bark of trees, where it hunts out and devours the larvæ of other insects.

The LAMPYRIDÆ are beetles of soft texture and medium or small size; the head is sometimes hidden by the front of the prothorax, and sometimes prominent and exposed; the antennæ are generally serrate, and usually eleven-jointed; the elytra, usually quite soft and yielding, may be short or even wanting in the females of certain genera. The larvæ are flattened, often dark-colored and velvety, and have an ocellus on each side the retractile head; they are generally

FIG. 408. — *Malachius affinis*.

FIG. 407. — *Malachius marginicollis*.

carnivorous, living under stones and bark, or upon the ground, where they devour snails and larvæ of insects. Sometimes the velvety larvæ of certain species of

Telephorus wander about upon the snow, giving rise to stories of showers of worms.

This family is often divided into three sub-families. The species that have the middle coxae contiguous, the epipleurae narrow at the base, and the episterna of the mesothorax not sinuate on the inner side, belong to the sub-family Telephorinae; the species of the sub-family Lampyrinae differ from those of the Telephorinae in having the corresponding episterna sinuate and the epipleurae usually wide at their bases; while the species of Lycina have no epipleurae and have the middle coxae distant.

Of the sub-family Telephorinae the genus *Telephorus*, which has an exposed head, is well represented in North America. *T. bilineatus*, a species of which the elytra are blackish brown, finely margined with light brown, and the prothorax brownish red with a longitudinal black spot each side of the median line above, has been reared. The larva is found early in the spring under stones where it pupates in time to disclose the imago in May; the larva is about 0.5 of an inch long, the imago about three-fifths as long. The imago is said to feed on birch leaves.

The genus *Chauliognathus* differs from all other North American Lampyridae in having an extensible fleshy filament attached to each maxillary lobe. The function of these filaments is probably to lap the honey and pollen from the flowers on which the beetles feed. *C. pennsylvanicus* is common in the eastern United States; it is about 0.5 of an inch long, and is yellow and black, as follows: the head, antennae and legs are black, and there is a black patch upon the yellow prothorax, and an elongated black spot occupies the middle of the apical portion of each yellow elytron. Although these beetles eat pollen and honey, frequenting flowers of thistles and golden-rods (*Solidago*) for the purpose, during late summer, their larvæ are carnivorous and aid the farmers in the suppression of many noxious insects. The larvæ of *C. pennsylvanicus* are known to devour the larvæ of the plum-weevil (*Conotrachelus nemphar*).

FIG. 409. — *Chauliognathus pennsylvanicus*.

The sub-family of Lampyrinae is noted for the luminosity of most of its species. The spectrum of the fire-fly was alluded to in the general remarks concerning the Coleoptera, but the results which numerous experimenters and investigators have obtained in working upon the luminous organs of beetles are worthy of further notice here.

These luminous organs differ in distribution on the abdominal segments of different kinds of Lampyridae, and Motschulsky, in 1853, used the position of the luminous spots, which are yellow on the beetles, in the separation of genera. In finer anatomy the luminous organs, which are homologically parts of the fat-body of the insect, consist of the luminiferous cells wrapped about by capillary anastomoses of the trachea. The larvæ, as well as the imagos of Lampyridae, are luminous, and it has been asserted further that the eggs emit light. As Wielowiejsky, who has lately studied the histology of these luminous organs, rightly says, the eggs can be luminous only on account of some external substance which they derived from their mother, or on account of light-giving power of the developing larvæ within them. Matteucci, Jousset de Bellesme, and others have experimented on the conditions which favor or hinder light-production in *Lampyris*. Decapitated specimens retain their power of giving off light, either with or without being subjected to electrical excitement, for four days. High temperature fails to stimulate the action of the luminous organs. In pure oxygen the light is increased in intensity, while no light is emitted in pure

hydrogen, carbonic dioxide, or nitrogen, proving that, whatever is the form of combustion, it is an oxydation. Crushing the luminous organs, as is generally known, temporarily increases the intensity of their light by admitting more oxygen to them: ordinarily their oxygen supply is brought to them by their tracheal capillaries. Entire destruction of the cells of these organs by pulverizing them in a mortar, however, results in producing no light, because the supply of luminiferous matter ordinarily formed by the cells ceases upon their death. In beetles killed by sulphuretted hydrogen the cells are likewise killed, and no further light can be obtained from them.

FIG. 410. — Glow worms. *a*, *Lampyris splendidula*, male; *b*, female; *c*, larva. *d*, *L. noctiluca*, male; *e*, female; *f*, larva.

Apparently, then, the living cells of the luminous organs secrete, under direct control of the nervous system, a substance, possibly phosphuretted hydrogen, which is luminous when acted upon by the oxygen that reaches these cells through their enveloping tracheal anastomoses. In some species the light is continuous for a considerable time; in other species the light is often interrupted. Mr. A. E. Eaton has observed that, in *Luciola lusitanica*, the flashes are repeated as often as thirty-six times a minute, the duration of each flash being from one-fourth to one-third of a second. When one sex of any species of Lampyridæ emits intenser light than the other sex, the less luminous sex has, as a rule, the best developed eyes; this is especially marked in the case of the large eyes of males of species in which the female is luminous, but apterous.

FIG. 411. — *Photuris pennsylvanica*.

A common species of fire-fly in the eastern United States is *Photuris pennsylvanica*. It is about 0.5 of an inch long, and both sexes have wings and long elytra. The color is yellowish, striped with a few ill-defined lines of black or brown. Its luminous larva has a brush-like anal leg. In Europe the common species of fire-flies are *Lampyris noctiluca* and *L. splendidula*. The females of these species are wingless, each elytron being replaced by a small scale, and these females, as well as the larvæ, are termed glow-worms. The larvæ devour snails. In parts of the Mississippi valley the common fire-fly is *Photinus pyralis*, which has brownish-black elytra margined with pale yellow, and a yellow prothorax with a black spot on its centre. The larva of *P. pyralis* lives in the ground, where it feeds upon soft-bodied insects and upon earth-worms (*Lum-*

bricus). *Photinus corruseus*, a species varying from 0.35 to 0.60 of an inch long, dull black in color, except two curved red lines extending from each side of the

anterior projection of the prothorax, which shields the head, back to near the posterior angles of the prothorax.

Among the insects of the sub-family Lycine, of which the species are diurnal in habits, and wander about plants in search of insect food, *Coleopteron reticulatum* may be chosen as a representative. This species has the elytra gradually widening from the base to near the tip, and covered with a fine net-work or reticulate surface; its flat serrate antennae and its under surface are black, as well as the middle of the prothorax, and the apical end of the elytra. In the form which was once known as *C. terminale*, but which is now regarded to be a variety of *C. reticulatum*, the anterior two-thirds of the elytra are yellow, while in other specimens there is a patch of black near the base of each elytron. These insects vary from 0.40 to 0.75 of an inch in length. Their larvæ are clay-yellow, prettily marked with black, and are found under logs and stones, where they eat other insect larvæ.

FIG. 412.—*Coleopteron reticulatum*.

The ELATERIDÆ, including with them the EUCNEMIDÆ and CERRIONIDÆ, which are often regarded as distinct families, comprise considerably more than three thousand species of described coleoptera, which are quite distinctly separated by a few marked characters, of which the following is an abstract from Drs. Le Conte and Horn's work, to which reference has been so often made: The antennæ are usually serrate, sometimes pectinate or flabellate, and are often inserted in grooves upon or under the front; the five (rarely six) ventral segments are free, and the first of them is not elongate; the hind coxæ are contiguous, and sulcate for the reception of the thighs; the front coxæ globose, and contained entirely within the prosternum; the prothorax loosely articulated to the mesothorax, and the prosternum prolonged behind. The greater part of the Elateridæ are popularly known in America as snapping-beetles and spring-beetles, and in England as click-beetles and skipjacks, because of their power of jumping up into the air when placed upon the back. Dr. Le Conte says this jumping "is effected by extending the prothorax so as to bring the prosternal spine to the anterior part of the mesosternal cavity, then suddenly relaxing the muscles so that the spine descends violently into the cavity, the force given by this sudden movement causes the base of the elytra to strike the supporting surface, and by their elasticity the body is propelled upward." Without the aid of this mechanism, these short-legged beetles would find difficulty in regaining their foothold when they had fallen on their backs, which might often occur, because of their habit of dropping to the ground, with legs retracted and feigning death, upon the slightest disturbance. If a beetle fails to regain his proper position by the first jump, the springs are repeated until success results, each spring, especially if upon a hard surface, is accompanied by a distinctly audible click.

The habits of the Elateridæ are quite diverse, many sit upon leaves of plants and upon grass, others are abundant under bark, and many species live concealed beneath stones. The larvæ usually live in decaying wood; some of them, however, do not confine their attacks to dead vegetable matter, but are known as seriously injurious to living plants and to cultivated crops; a few of these larvæ are carnivorous, the larvæ of *Drasterius amabilis*, in the United States, being known to devour locusts' eggs. Many elaterid larvæ, because of their cylindrical form and very firm, smooth, glutinous exterior, are known as wire-worms. The larvæ have six legs, no ocelli, and their antennæ are very short and three-jointed. Wire-worms have sometimes destroyed potatoes and cabbage roots by riddling them with their burrows. Some of these larvæ

develop under favorable circumstances in a year, but many of them require several years to attain full growth.

The Elateridae not only show their relationship to the Lampyridae by anatomical characters, but also by the possession of luminous organs in a few species, these luminous organs being found in the larvæ of a number of species, and being long since observed on the imago of *Pyrophorus*.

FIG. 413.—Stages of an Elaterid (*Hauz*).

The true Elateridae have the posterior coxæ laminate, and the labrum visible and free. *Melanactes piceus* is a very shining, black species, about one inch long, found upon the Atlantic coast of North America as far north as Massachusetts. *M. morio*, a somewhat smaller species with striate elytra, is found in the same regions. Larvæ, supposed to belong to *Melanactes*, are quite brilliantly luminous.

It is, however, to the genus *Pyrophorus*, which contains about a hundred species of Elateridae, all from tropical America, that we must turn for the most brilliant forms of luminous insects. *Pyrophorus noctilucus*, common in the West Indies and Brazil, and in common with a few allied species called the *cucuyo* by the West Indians, is from 1.50 to 1.75 inches long. Its color is a rusty brown, approaching black. Upon each side of the prothorax, near its basal angles, is a convex, oval lantern, which,

when not illuminated, is yellowish white in color; but which, when illuminated, gives out a light exceeding in brilliancy that of the Lampyridæ. The species of *Pyrophorus* fly in much more direct lines and give out their light longer and more constantly than do the Lampyridæ. During flight a luminous organ situated beneath, between the metathorax and first abdominal segment, emits even more light than do the prothoracic lanterns. In Vera Cruz these beetles are so much used as toilet ornaments that they are an

FIG. 414.—*Ludius attenuatus*.

article of trade. The Indians capture them by waving about in the air a stick, to which they have attached a burning coal, the light of the coal attracting the beetles in the same way as they are attracted to each other by their own luminosity. They are preserved in boxes made of wire netting, are fed each evening with pieces of crushed sugar-cane, and are bathed twice a day in tepid water to keep them in good health. The emission of light by *Pyrophorus* seems, like that of Lampyridæ, to be entirely dependent upon the will of the insect; when feeding, and during sleep, no light is given off, the greatest intensity of the light being reached during flight and activity.

Corymbites is a large genus, numbering in the United States over seventy species, and the species vary greatly in form, size, and coloration. *C. resplendens*, common in northern New England, is shining bronze green with reddish reflections, and is about 0.5 of an inch long. *C. cylindriciformis*, a brown species which is quite elongated, varies in length from 0.45 to 0.80 of an inch.

The genera *Athous*, *Limoniüs*, *Melanotus*, *Elater*, and *Cryptohypnus* are all represented by numerous species in the United States, but many of these species are difficult to distinguish without elaborate descriptions or figures, and little is known of their life history. *Melanotus communis* is one of the most common species of snapping beetles in the northeastern United States; it is brown, pubescent, and about 0.5 of an inch long.

FIG. 416.—*Alaus oculatus*.

Alaus oculatus, not only on account of being one of the largest species of North American Elateridæ, but also on account of its peculiar markings, has attracted the attention of almost every beginner in entomology. Its length is a trifle over one and a half inches, and its coloration black and white. The two velvety black spots upon the prothorax, the white rings around these spots, and all the white dots scattered over this insect are produced by scaphoid scales densely set upon the surface. The larvæ of *A. oculatus* live in decaying wood, often in that of apple or pine, and are much broader proportionally than snapping-beetle larvæ usually are. The length of the larva of this species is 2.5 inches; its width about 0.4 of an inch across the middle of the body. The head is brownish, the rest of the larva reddish yellow.

The species of *Chalcolepidius*, another genus of large snapping beetles closely allied to *Alaus*, are partly clothed with scales, as the generic name indicates. *C. rubripennis*, from southern California, is 1.5 inches long, the striate elytra reddish brown, the black prothorax converted to bronze green by a coating of microscopic scales.

FIG. 415.—*Pyrophorus noctilucus*.

The family of BUPRESTIDÆ includes a large number of beetles which somewhat resemble the Elateridæ, but differ from them in not possessing the power of springing when placed upon the back, and consequently they do not have the prothorax very freely movable upon the mesothorax. They also differ from the Elateridæ in having the first and second ventral segments connate. The eleven-jointed antennæ of the Buprestidæ are almost invariably serrate; the head is small and retractile to the eyes in the prothorax; the posterior end of the body is tapered off to a point; the ornamentation is usually with metallic colors, and the surface is often highly polished. In *Polybothris*, a genus found in Madagascar, the coloration during life is glistening metallic, which, as in *Cassida* of the Chrysomelidæ, disappears upon the death of the insect. The tropical species of Buprestidæ are often large, *Euchroma gigantea* from Brazil reaching a length of 2.75 inches, and a breadth of over an inch; the size of the species becomes gradually less in approaching the temperate and

FIG. 417. — *Euchroma gigantea*.

colder regions. These insects frequent flowers or sit upon bark, and are most active in bright sunlight; upon approach, many kinds fly away with great rapidity, others retract their short legs and drop to the ground, feigning death.

The larvæ of Buprestidæ usually bore elliptical passages in living and dead wood; a few, like those of *Trachys*, mine in leaves, and still fewer (*e. g.* *Diphucrania auriflua*) live in galls. The larvæ have a very characteristic form due to excessive enlargement and partial chitinization of the prothoracic segment, into which the head is retractile. There are no ocelli and no feet, the latter organs being represented in a few species by little fleshy tubercles; the antennæ are very short and formed of two or three joints. Larval life varies in duration; in *Trachys minuta*, which mines willow leaves, Radow found two generations yearly; Perris found that many species completed their metamorphoses in a year, while Ratzeburg states that two years are occupied in the cycle of metamorphoses. Pupation takes place in the burrows made by the larvæ.

The small, flattened, ovate, somewhat angular species of *Brachys* are found upon leaves of different plants, and their larvæ are leaf-miners, like those of the related genus, *Trachys*. *B. tessellata* is only about 0.15 of an inch long, and nearly black in coloration; it is found in the eastern United States. *B. aruginosa*, a species of about the same size, and found in the same region, mines in the leaves of the beech.

FIG. 418. — *Brachys tessellata*.

The numerous species of *Agilus* are elongated, and have the antennæ free, not received in grooves as in *Brachys* and *Trachys*. *Agilus ruficollis* is quite injurious to raspberry and blackberry patches in the eastern United States. The beetle is narrow, about 0.25 of an inch long; its head and thorax is a beautiful coppery bronze, the elytra are black. The larvæ, which are about 0.5 of an inch long, and pale yellow, with a brownish head and black mandibles, bore about in the sap-wood of the black-

berry and raspberry stalks, until they reach full growth, when they pupate in the pith. Their presence in stems of the plants can be readily detected by the gall-like swelling that they produce. On account of the spiral course of the burrows of the larvae, the part of the stalk above these galls generally dies. The best mode of destroying these insects is to burn, during early spring, the stalks which have galls upon them.

The species of *Aemathera* are not as elongate as those of *Agrius*, and their scutellum is indistinct. *Aemathera culta*, a black species with yellow spots on the elytra, and only 0.25 of an inch long, is common in eastern North America, on the flowers of star-grass (*Hypoxys erecta*). *A. gibbula* is a western form.

FIG. 419.—*Aemathera gibbula*.

A large number of species of medium-sized Buprestidae which are of a dark green, coppery, or black-shining bronze color, and are covered with impressed dull spots, are grouped in the genus *Chrysobothris*. Of these species *C. femorata*, a greenish-black species that varies from 0.4 to 0.6 of an inch in length, and two-thirds as wide, besides being, as larva, injurious to oaks and other forest trees, damages peach and pear trees, and often causes serious fatality to apple trees. These beetles are found from May until the end of summer.

FIG. 420.—*Chrysobothris femorata*.

Their pale yellow, thin-shelled, ribbed eggs are laid, singly or a few, in groups, in crevices of bark. The young larvae, upon hatching, bore into the bark and live beneath it, in flattened channels, soon girdling small trees. Later, as its jaws become stronger, it attacks the solid wood, but always again comes to the surface before pupation. After cutting a passage almost through the bark it retreats, packs its debris and excrement about it, and pupates. Upon emergence, the beetle, which has feebler jaws than its larva, has no difficulty in reaching the open air. *C. harrisii*, one of the smallest beetles of this genus, being only about 0.3 of an inch long, is a somewhat rare but brilliant species. Its larva lives in pine twigs, and the brilliant metallic-green beetle may be found, during June and July in New England, sparkling in the hot sunlight on the tips of white-pine boughs; on account of its shyness and rapid flight it is not easily captured.

Similar in form to *Chrysobothris*, but having a broader front, is *Melanophila*. *M. fulvoguttata*, of a brassy black color from 0.30 to 0.45 of an inch long, has three yellow dots upon each elytron. This species frequents pines throughout the northern United States.

FIG. 421.—*Melanophila fulvoguttata*.

In *Buprestis*, a genus numbering, as at present limited, over fifty species, many of which are beautifully colored, the beetles are rather larger than in the preceding genera. *B. rufipes* is a North American species, of which the earlier stages are unknown. *B. fasciata* is one of the most brilliant species of this genus. It is from 0.60 to 0.75 of an inch long, of a brilliant metallic-green with golden reflections, with a small yellow spot near the tip of each elytron, and a band of yellow nearly across each elytron just in front of the apical spot. The larva probably feeds in willow or pine wood, and it inhabits the northern United States.

FIG. 422.—*Buprestis rufipes*.

Dicera diraricata, which is of a coppery-bronze color and about 0.75 of an inch long, is easily recognized by the prolonged and divergent tips of its elytra; it is common in the eastern United States. Its larva attacks peach, maple, cherry, and beech trees.

The species of *Chalcophora* resemble, in form and mode of indentation of the

elytra, the species of *Chrysobothrys*, but are generally larger and have a distinct sixth ventral segment. *C. liberta*, from the eastern United States, is light copper-bronze in

FIG. 423. — *Chalcophora virginensis*.

color, the elevated portions of the surface being polished while the depressed parts are dull. It feeds, as larva, in pine woods, as does also *C. virginensis*, which is generally a little darker colored and somewhat larger; the former species is from 0.75 to 1.10 inches long. The larvæ of both species inhabit pine wood. *Gyascutus* and *Psiloptera* are genera only represented by a few large species, from western North America, of which the earlier stages are unknown; they are separated from *Chalcophora* by their having the mentum rounded in front; they are distinguished from one another by the first joint of the posterior tarsi being elongated in *Gyascutus*, and not elongated in *Psiloptera*. Near these genera in classification are the giant South American species of *Euchroma*, of which *E. gigantea* has been already mentioned, and the brilliant oriental and African species of *Chrysochroa*, the latter generic name being compounded from two Greek words meaning "gold" and "skin." *Chrysochroa ocellata*, a large species from the East Indies, is beautiful shining green, with elytra marked with golden and yellow spots, and three-toothed at the apex. *Sternocera*, another Asiatic and African genus, contains large and brilliant species, in which the sternum is prolonged forward and downward as a horn. *Sternocera chrysis*,

FIG. 424. — *Gyascutus planicosta*.

a large species with chestnut-brown elytra, lays elliptical white eggs that are 0.36 of an inch long and 0.24 of an inch in shorter diameter, and from which the larvæ at hatching are about 0.45 of an inch long.

FIG. 425. — *Chrysochroa ocellata*.

The described species of SCARABEIDÆ number over seven thousand. They are readily separated from all other Coleoptera by the form of their antennæ, in which the outer joints—usually three, sometimes as many as seven in number—are flattened lamellæ capable of close approximation to form a club, and by their fossorial legs. The antennæ, which are inserted beneath the sides of the front, have from seven to eleven joints; the first joint is always elongated, and the second thicker than the third. On account of the form of their antennæ, beetles of this family are often called lamellicorns. There are no very minute species of Scarabæidæ; the family, on the other hand, contains some extremely large insects, the veritable elephants among Coleoptera. The lamellicorns, of course, reach their greatest development, both as to number and size of species, in the tropics, but species of considerable size are not wanting in the temperate zone. These beetles attract the attention of people not generally interested in natural history, not only on account of their large size, but also because of their curious habits, sometimes useful to man, as are those of the dung-beetles, one of which (*Ateuchus sacer*) was long recognized as sacred by the Egyptians.

Quite a number of genera are wingless, although the greater part can fly. A large number produce sounds, either by stridulation, by the motions of the wings, or in some cases by the rapid passage of air in or out of the stigmata. Sonification is not confined to imagos, for many lamellicorn larvæ stridulate by rubbing the maxillæ against the

mandibles. The imagoes of one portion of this family are mostly vegetable feeders, often living upon leaves; those of another portion feed upon the excrement of higher animals; a few eat fruit, flowers, or honey, even, exceptionally, entering bee-hives to steal honey; certain species also lick the sap from wounded places on trees; and a very few (*e. g.*, *Trox*) feed upon decaying animal matter. In their sexual relations, some species of lamellicorns have strange habits. *Elaphocera bedouii*, a common species in the sand dunes of the Bay of Cadiz, copulates only during storms; at other times the beetles remain concealed in the sand. In *Bolboceras gallicus*, a French species, the two sexes inhabit neighboring burrows a foot deep in the ground, and the male digs a passage out from his own burrow to that of the female. The males of *Polyphylla variolosa*, from the eastern United States, have been seen vigorously scratching the ground above places where females were about to emerge from their pupæ, presumably guided to them by the sense of smell, a sense which has reached a high degree of development in the lamellicorns. The aid which certain male dung-beetles give the females in their maternal duties will be more fully noticed further on. The males of lamellicorns are usually much larger than the females, and are often easily distinguishable from the latter by horns upon the prothorax or head, by better-developed antennæ, or by modifications of the legs.

The larvæ of the Scarabæide are rather robust, white grubs. Their anal end is curved around under their body so that they cannot walk on a flat surface, but are only able to use their six well-developed legs in locomotion when surrounded by the substances in which they live. The head is corneous and resistant, with four-jointed antennæ and without ocelli. The rest of the larva is covered with a somewhat tough skin, and widens posteriorly so that the apical half of the abdomen is broader than its base. All lamellicorn larvæ live concealed, some in the ground, feeding upon roots, others in decaying wood, in excrement, or in other substances which they devour. The coprophagous species undergo their metamorphoses rapidly, but the other lamellicorns often require two or three years to pass from the egg to the imago. Several nematode worms inhabit the capacious digestive tract of certain lamellicorn larvæ; but, besides these, the larval stage of *Echinorhynchus gigas*, an acanthocephalous worm which lives as adult in the intestinal canal of swine, has been found in the grubs of the European May-beetle (*Melolontha vulgaris*). The swine eat the May-beetle grubs, thus infecting themselves with worms, and the dung of the swine furnishes the May-beetle grubs the eggs of the worm — a curious interrelationship between hog, worm, and insect. The larvæ of certain lamellicorns are subject also to fungus parasitism by species of *Torrubia*, of which the fructification stems grow out from the grubs killed by the fungus, often to the height of several inches, giving rise to stories of grubs changing into plants.

Dr. Le Conte has divided the Scarabæide into three sub-families, according to the position of the abdominal stigmata. In the lowest sub-family, the Scarabæide pleurosticti, the abdominal stigmata (except the anterior ones) are "situated in the dorsal portion of the ventral segments, forming rows which diverge strongly;" the last pair of stigmata is visible behind the elytra.

Osmoderma has the thorax considerably narrower than the elytra and usually rounded at the sides; the posterior coxæ are contiguous, and the outer lobe of the maxillæ is corneous. *O. scabra* is about 0.9 of an inch long, with a roughened but shining coppery or brownish-black surface. Its larva lives in decaying rosaceous wood, and pupates in an oval cocoon made by cementing together fragments of the

wood in which it feeds. *O. crenicola*, a slightly larger, smooth, dark-brown species, has habits similar to those of *O. scabra*. Not far from *Osmoderma* in classification is *Inca*, the species of which are found in tropical America, and are large and bronze colored.

In the species which belong to the old genus *Cetonia*, which is now subdivided into numerous genera, the scutellum is visible, the mandibles are feeble and often membranous, the epimera of the mesothorax is visible from above, and the anterior coxæ prominent. During flight the elytra of these beetles remain closed, the wings extending out from beneath the base of the elytra. Some of the species eat honey, others soft fruits, still others lick sap from wounds of trees. Thus the mandibles, having no hard work to do, are feeble. *Tropinota hirtella*, a small European species which is black, somewhat marked with white, and densely pubescent with brownish hairs, injures fruit-blossoms by eating away their anthers and styles.

Euryomia inda is the most abundant species of cetonian in the northeastern United States. It is about half an inch long, light brown, marked with irregular black spots. Its thorax is covered with yellowish pubescence. This beetle has been found feeding upon the kernels of young corn; but it is doubtful if the beetles, with their soft mouth-parts, are really guilty of attacking the corn. It seems more probable that they only eat the juices of kernels which have been already bitten into by birds or by other insects.

FIG. 426. — *Euryomia inda*.

These beetles are, however, known to eat into ripe peaches, and to feed upon the sap from corn-stalks and from cotton-bolls. I have found the same species very abundant, devouring sap which exuded from wounds in the bark of oak trees; and I presume that, in their reported attacks upon apple-tree bark, they are only eating the sap flowing from wounds caused by other animals. This species is found in early spring, before the snow is all melted from the ground, making as much noise as bees and buzzing about in warm sunny spots. This beetle has a peculiar acid odor, resembling vinegar, when handled. This acid is probably readily volatile, as it does not rust, to any great extent, the pins used in mounting these insects in collections. *Cetonia aurata*, a common metallic-green European species, is also quite odorous. The larvæ of *E. inda* are not yet known.

Allothina nitida is nearly an inch long, velvety green usually with a yellowish margin along the sides of the prothorax and elytra, and is abundant in the southern part of the Atlantic slope of the United States. Its larvæ, according to Dr. C. V. Riley, attacks strawberry roots; and, because its curved body would cause it to travel clumsily on its legs, it turns over upon its back and moves along as rapidly as an ordinary caterpillar.

The cetonians attain their maximum size in the genus *Goliathus* from western Africa. *G. giganteus* measures about four inches in length and two inches in width, and is one of the largest beetles

FIG. 427. — *Dynastes fitzingeri*, male.

known. This species is subject to considerable variation, and several varieties have been described as species. It is usually chalky white, marked with velvety black, prominent among the black parts being six black lines radiating from near the anterior part of the prothorax towards its posterior part. These giant beetles live upon the sap of trees.

Dynastes hercules, Hercules beetle, male and female.

The genus *Dynastes* includes, in another group of beetles, even larger species than are those of *Goliathus* among the cetoniids. In *Dynastes* the tarsal claws are equal and the anterior tarsi elongated, the anterior coxae transverse and not prominent, the prothorax and head armed with horns or tubercles. *D. tityus* is one of the largest, possibly the largest, species of Coleoptera found in the United States, and occurs in the southern part of the country as far north as Philadelphia. It is about two inches long and one inch wide; is of a general greenish-white color, with black legs and brownish black spots upon the elytra. In the males the anterior portion of the prothorax is provided with a downward-curved black horn that approaches at its tip a similar upward curved horn from the head. The larvæ of this and other species of *Dynastes*

FIG. 428. — *Megasoma elephas*.

live in decaying wood. *Dynastes hercules*, from tropical America, reaches a length of six inches, of which the curved prothoracic horn makes nearly one-half. The elytra are light olive green, spotted with black; the rest of the beetle is shining black. The prothoracic horn is lined with yellow hairs beneath; and below it, as in *D. tityus*, is a shorter upturned horn from the head. The articulation between the prothorax and head allows these horns to be separated and brought toward each other like the two halves of a pair of forceps. *D. neptunus*, a species of about the same size as is *D. hercules*, also inhabits tropical America. Closely allied to *Dynastes*, but separated from it by its glabrous prosternal process, is *Megasoma*. *M. elephas*, *M. typhon*, and *M. actæon* are all large species from Central and South America. *M. thersites* is a Californian species.

The genera *Strategus*, *Xyloryctes*, and *Oryctes* comprise species not quite as large as those of the foregoing genera, having horns or tubercles on both sexes, and with the anterior feet not elongated. In *Strategus*, the prothorax usually has three horns in the males and three tubercles in the females. *S. anteus*, a shining dark-brown species about an inch in length, is found near the Atlantic coast of the United States as far north as Massachusetts. In *Xyloryctes*, the head is horned in the males and tuberculate in the females. *X. satyrus*, which is deep brown, has striate elytra, and is a little over an inch in length, resembles *Oryctes nasicornis*, a common European species. *X. satyrus* is found in the same regions as is *Strategus anteus*. *O. nasicornis* frequents tanners' refuse used to surround hot-beds in northern Germany.

FIG. 429. — *Oryctes nasicornis*.

Cotalpa has the claws of the tarsi unequal, the elytra without a membranous margin, the thorax margined at the base, the clypeus separated from the front by a suture, and ten-jointed antennæ. *C. lanigera*, the so-called goldsmith beetle from eastern North America, is nearly an inch long, and light yellow in coloration. The female lays her eggs singly in the ground. The eggs are waxy white, semi-transparent, and oval, and measure about 0.1 of an inch in length. The larva, upon hatching, is about 0.3 of an inch long. It probably requires two or three years to reach full growth, feeding, meanwhile, upon roots of plants. Pupation finally takes place in an oval subterranean cavity. The imago frequents many kinds of trees, but is especially fond of willows, among the leaves of which it nestles during the day, since it is nocturnal in habits.

In *Pelidnota* there is no suture between the clypeus and the front. *P. punctata* is a well-known beetle about grape-vines in the eastern United States. It is brownish yellow above, marked with black as follows: the posterior and lateral portions of the head, the scutellum, a dot upon each side of the prothorax, and three dots near the outer margin of each elytron. Beneath, the body and the legs are shining greenish black. The larva of this species lives in the decaying roots of trees, but is with difficulty distinguished from other lamellicorn larvæ. These beetles fly mostly at night, remaining concealed about grape-vines during the day. They eat grape-leaves and those of *Ampelopsis*, but are rarely abundant enough to do real damage.

FIG. 430. — *Pelidnota punctata*.

FIG. 431. — *Anomala lucicola*.

Separated from *Cotalpa* and *Pelidnota* by the possession of nine-jointed antennæ and by having elytra with a membranous margin are the species of *Anomala*, of which *A. lucicola* is a serious foe to grape-culture in some parts of the United States. Its colors are somewhat variable, some specimens being yellowish brown, others black, and still other combinations of these two colors. The larvæ of *Anomala* have not been carefully studied. The beetles often eat away the flower-buds and blossoms of the grape, and also are very abundant upon flowers of species of sumac (*Rhus*). In Europe *A. vitis* and other species damage grapes.

Hexodon montandoni is a curious oval species, about 0.6 of an inch long, which

inhabits Madagascar. Its form and the pattern of its coloration, the elytra being black striped with white, recall those of the Chrysomelidae. Its life history is unknown.

The second sub-family of the Scarabaeidae, the Melolonthinae, have the abdominal stigmata "in part situated on the superior portions of the ventral segments, the last one usually visible behind the elytra." The rows of spiracles diverge slightly.

In *Polyphylla* the club of the antennae is many-jointed, and in the males is very large, the third antennal joint is long, the lateral pieces of the metathorax are wide, the anterior coxae are not prominent, the last pair of stigmata open in the suture between the fifth ventral segment and the propygidium. *P. variolosa*, found abundantly in parts of the United States, is nearly an inch long, and is brown covered with small irregular patches of white. *P. fullo*, the largest European May-beetle, frequents sandy plains covered with conifers. Its length is from 1.25 to 1.50 inches, its color chocolate brown, spotted with irregular patches of white scales and hairs.

Melolontha closely resembles *Polyphylla* and is represented by quite a number of species in the eastern hemisphere. *M. vulgaris*, the common May-beetle of Europe, is about an inch long, and the antennal club of the males is composed of seven lamellae, while that of the females has only six shorter lamellae. The pygidium is prolonged into a sharp point. In the common form the antennae, legs, and elytra are brown, the rest of the insect being black, and different parts are more or less densely clothed with fine white scales or hairs. On the lateral parts of the abdominal segments these hairs are so dense as to produce a white triangular spot upon the side of each segment. Varieties are numerous. The metamorphoses of *M. vulgaris* require three or four years, according to climate, and their appearance in large numbers is periodical. Reiset writes that in 1865 the beetles defoliated the oaks and other trees in parts of France. The next year the young larvae hatched from these beetles devoured the roots of garden vegetables so extensively that the loss in the department of the Lower Seine was estimated at over five million dollars. These larvae passed the winter of 1866-7 at about sixteen inches beneath the surface of the ground. A thermometer kept in the ground at the same depth indicated that the larvae must have been frozen during the winter, thawing out again in the spring. In June, 1867, the full-fed larvae pupated about a foot below the surface, emerging as beetles during October and November of the same year. These beetles, however, remained in the ground until April and May of the succeeding year (1868), thus, in France, completing their metamorphoses in three years. The tufted lark (*Alauda cristata*) is said to feed its young almost exclusively with larvae of this and of related lamellicorns, thus doing good service to agriculturists.

Lachnosterna differs from *Polyphylla* in having the lateral pieces of the metathorax narrow and the third antennal joint not elongated. There are many species of this genus on the Atlantic slope of North America, while only two species are known from the Pacific slope. *L. fusca* (often mentioned as *L. quercina*) is very common in parts of the United States and Canada; it is about 0.9 of an inch long, and of a dark-brown color. The beetle, which is often called the June-bug, attacks the leaves of various trees, having a preference for those of plum and cherry. The larva, known as the white grub, lives upon roots, and has habits quite similar to those of *Melolontha vulgaris* in Europe. Turf is often ruined by larvae of *L. fusca* associated with other larvae of the genus, and they sometimes cut off strawberry roots. *Tiphia inornata*, a hymenopterous parasite, has been reared from these larvae. In Europe numerous species of *Rhizotrogus*, a genus very similar to *Lachnosterna*, are termed June-bugs.

One of the best-known species of lamellicorns in the eastern United States is *Macroductylus subspinosus*, erroneously called the "rose-bug." It is about a third of an inch long, of a dull yellow color, and has long brown legs. These beetles appear in June, often suddenly and in immense numbers, and devour roses, and the flowers and young fruit of grapes, apples, pears, cherries, and many rosaceous trees. They are also abundant upon flowers of sumac (*Rhus*), elder, ox-eye daisy (*Leucanthemum vulgare*), and species of *Spiraea*; but when the above-mentioned plants fail, they will eat almost any kind of green vegetation. Their most serious injuries to agriculture consist in their eating fruit-blossoms and young fruit, although they have been known to strip the leaves from fruit-trees and grape-vines. In 1825 the Massachusetts State Board of Agriculture offered a premium for the best essay on this insect, its natural history, and efficient means of destroying it. Dr. T. W. Harris, the well-known entomological writer, was awarded the premium for an essay, from which the following account of the life history of this insect is condensed: Each female deposits about thirty nearly globular whitish eggs from one to four inches beneath the surface of the ground. The larvae hatch in about twenty days, and immediately begin to feed upon tender roots. They attain full size in autumn, being then nearly 0.75 of an inch long, and about 0.12 of an inch in diameter. They are of a yellowish-white color, with a tinge of blue towards the hinder extremity, which is thick, and obtuse or rounded. In October they descend below the reach of frost, and pass the winter in a torpid state. In the spring they again come near the surface of the ground, where, in May, they pupate in little oval cells, the beetles emerging in June. The most practicable mode of capturing these beetles, when they attack fruit-trees, is to shake or jar the trees, after spreading sheets beneath them. This should be done, as suggested by

Mr. J. A. Lintner, in the cooler parts of the day when the beetles, which are always clumsy, are quite inactive. The captured beetles may be killed by scalding, and fed to chickens.

FIG. 432.—*Serica vespertina*.

The genus *Serica* contains quite a number of robust brownish species, with striate, often iridescent, elytra. The last pair of abdominal stigmata are in the fifth ventral segment, which is separated by a suture from propygidium. The labrum is connate with the clypeus. *S. vespertina* is common, during June, in New England, upon the sweet-briar rose. It is light brown in color, and from 0.3 to 0.4 of an inch long. With it may be found usually *S. sericea*, a very dark-brown iridescent species, of about the same size.

In *Hoplia* the last pair of stigmata is between the fifth ventral segment and the propygidium which are connate, the middle coxæ are contiguous, and the tibiae have but one spur. The species are usually found on flowers, and the sexes often differ greatly. Most of the species are more or less clothed with scales; and the *H. cœrulea*, a European species, is of a beautiful metallic blue, due to shining scales covering its otherwise brown surface.

The species of *Lichnanthe* are hairy insects, with poorly developed elytra, which are divergent at the tips, and do not reach the tip of the abdomen. *L. vulpina*, distributed throughout the United States, is about 0.5 of an inch long, dark brown, and nearly the entire surface except the elytra is densely clothed with long, light-brown hair.

In the third sub-family of the Scarabæidæ, the Scarabæidæ laparosticti, the abdominal stigmata are situated in the membrane which connects the dorsal and ventral

segments, the posterior pair of stigmata being covered by the elytra. The antennae have from nine to eleven joints, of which the outer three only, in all genera except *Pleocomia*, form a compact club. The species of this sub-family mostly live in excrement, a few in other decomposing matter.

The species of *Trox* have five ventral segments visible, and the epimera of the mesothorax do not reach the rounded coxae. The numerous North American species of this genus are oval beetles, mostly with rough surface. They feed upon dried decomposing animal matter, and many species are found about the refuse of tanneries, and upon the hoofs and hair of decaying animals.

The species of *Geotrupes* have the antennae eleven-jointed with lamellate club, the mandibles well developed, and the abdomen exposing six ventral segments to view. Most of the species are black, some with a bluish or greenish tinge; a few species have brilliant metallic coloration. The elytra are usually striate, the prothorax sometimes armed with horns or tubercles, as in *G. typhaceus*, a species common in Europe. The larvæ of *Geotrupes* develop in masses of excrement which the parents bury in the ground, and in each of which the female deposits an egg. Seven species of this genus have been described from North America. Several of them are quite common, and can be found by digging in the earth about cow-dung during late summer and autumn.

FIG. 433. — *Geotrupes typhaceus*.

The large genus *Aphodius* numbers over fifty described species in North America. Their antennae are nine-jointed, the posterior tibiae have two spurs, the front tibiae are strongly toothed on the outer margin, the epimera of the metathorax are not visible, and the elytra are striate. The species of this genus are mostly of small size, *A. fossor* being one of the largest species. Their larvæ feed in excrement and develop rapidly. Heeger found that the larvæ of *A. fietens*, a common European species, hatched from the egg in from ten to twenty days; the larvæ moulted three times, attaining full growth in from four to five weeks; and pupation lasted from fourteen to twenty days. Chapman observed that *A. porcus*, another European species, destroys the eggs of *Geotrupes stercorarius*, and uses the passages of the latter insect for its own oviposition. Species of *Aphodius* have been found near the crater of Vesuvius, where the sandy lava had a temperature of 182° F.

FIG. 434. — *Aphodius fossor* and larva.

Six of the species of *Aphodius* that are found in the United States were introduced from Europe. Among these *A. fossor* is large and entirely black; *A. fimetarius* is about 0.3 of an inch long, and black with red elytra; and *A. inquinatus* is about 0.2 of an inch long, black, with portions of the elytra yellowish.

Among the dung-beetles of robust form and moderate or small size, the genus *Onthophagus* includes a large number, of which but a few are found in North America. They have nine-jointed antennae and no scutellum, the third joint of the labial palpi is obsolete, and the distal end of the middle and of the posterior tibiae is dilated. One of the commonest kinds in the eastern United States is *O. lutebrosus*, a brownish black species about 0.25 of an inch long and nearly 0.20 of an inch wide. From the posterior end of the prothorax to the front of the head is over one-half the total length of this insect. In the males a broad, almost bi-lobed, horn extends out from the fore part of the prothorax and shelters the head.

The species of *Phanaeus* are sometimes of considerable size, and are often of metallic or bronzed coloration. They have broad three-jointed labial palpi, the anterior coxae short but prominent, and the first joint of the antennal club is hollowed out to receive the other two joints. *P. carnifex*, from eastern North America, frequents human excrement, especially when left in sandy places. Its prothorax is coppery bronze, its elytra metallic green; both are roughened, the latter being also striate. In the males the head supports a horn, which curves gently backwards, and, when long, rests between two slight elevations on each side of the prothorax. In *P. damon*, from Mexico, these elevations on the prothorax are prolonged into wing-like processes, while the cephalic horn is largely developed.

Copris differs from *Phanaeus* in having the lamellæ of the antennal club alike.

FIG. 435. — *Atuchus variolosus*, surrounded by scarabæi.

The species are black, with densely punctate prothorax and striate elytra, and the elypeus is broadly expanded and covers the mouth-parts. The males generally have a horn upon the head and tubercles upon the prothorax. *C. carolina*, a species about an inch long and 0.7 of an inch wide, is found along the Atlantic coast of the United States as far north as Massachusetts. *C. anaglypticus*, a species about 0.6 of an inch long, and *C. minutus*, about 0.4 of an inch long, are found in the eastern United States.

Species of *Canthon*, *Atuchus*, and allied genera are remarkable for their peculiar mode of rolling about a globular mass of dung, in which they finally deposit an egg, and then bury in the ground. *Canthon* is distinguished from *Copris* by its having slender curved middle and hind tibiæ; the head and prothorax are hornless in both sexes; the epipleuræ are narrow. *C. lavis* is a common species in parts of the United States. It is from 0.5 to 0.6 of an inch long, nearly smooth when examined only with the naked eye, and of a dull-black color.

SCARABÆID BEETLES.

1. *Hexodon montandoni*. 2. *Canthon hudsonius*. 3. *Osmoderma scabra*. 4. *Phyllophaga fusca*. 5. *Onthophagus manrus*. 6. *Inca clathratus*. 7. *Lichnanthe vulpina*. 8. *Cotalpa lanigera*. 9. *Ateuchus sacer*. 10. *Phaneus carnifex*. 11. *Copris carolina*.

At the head of the Scarabæidæ stands *Atuchus* (or *Scarabæus*) *sacer*, the *scarabæus* of the ancients, of which figures are found carved in stone on the monuments of ancient Egypt, and which is often termed the sacred beetle of the Egyptians. It is a somewhat flattened, dull-black beetle, a little over an inch in length. Its elytra are scarcely striate, although some of the beetles carved by the early Egyptians had elytral striae, and may have been made with *Atuchus laticollis*, an allied species, for a model. The species of beetle which the Egyptians intended to represent is known not only from their representations, but from specimens preserved with mummies. These beetles dig out pieces of the excrement of various mammals, using their shovel-formed head for the work. With their legs they form these masses of excrement into a ball, which they gradually increase in size until it is nearly two inches in diameter. Now begins the curious process of rolling this ball to a hole, a foot or more in depth, which has been made for its reception. One of the beetles pushes the ball from behind, seizing it in his hind legs, which are fitted for the purpose by their curved tibiae, and, with lowered head, moving backwards. Another beetle aids by pulling at the opposite side of the ball, using the fore-legs as hands. Thus rolled along, the ball, at first plastic and irregular, is covered with particles of earth, and acquires solidity and an almost perfectly spherical form. This ball, which contains a single egg and excrement just sufficient to feed the larva during its growth, is put into the hole in the ground, and the hole filled with earth, after which the parent insects go about repeating the process of making more balls. As each ball is the nest for only one of their offspring, the industry with which these beetles labor for the propagation of their kind is remarkable. They are not rare near the coast around the whole Mediterranean, and their value as scavengers is considerable. But what happens within the balls which they bury? The egg hatches, the larva eats the food-supply so carefully stored away by its parents, pupates, and the next season emerges as imago.

All the subterranean metamorphoses of these sacred beetles remained unknown to the Egyptians, who considered them as generated by males alone, for they supposed that all these beetles were males. With the Egyptians, as Kirby and Spence write, this beetle was a symbol "of the world, as P. Valerianus supposes, on account of the orbicular form of its pellets of dung, and the notion of their being rolled from sunrise to sunset; of the sun, because of the angular projections from its head resembling rays, and the thirty joints of the six tarsi of its feet answering to the days of the month; and of a warrior, from the idea of manly courage being connected with its supposed birth from a male only. It was as symbolical of this last that its image was worn upon the signets of the Roman soldiers: and as typical of the sun, the source of fertility, it is yet, as Dr. Clarke informs us, eaten by the women to render them prolific."

FIG. 436. — *Lucanus taurus*.

The LUCANIDÆ differ from the Scarabæidæ but little in structure. They are lamellicorn Coleoptera, in which the lamellæ of the antennal club are not capable of being brought compactly together. The pygidium

is always covered by the elytra, and the beetles are usually somewhat elongate. Although the species belonging to this family are generally nearly monochorous — usually shades of brown in temperate regions — in tropical species the colors are often greater in number. Some of the species have stridulating organs. The larvæ of the Lucanidæ resemble closely those of the Scarabæidæ; they live in decaying wood, on the juices of which the imago also feed.

In *Lucanus* the mentum is entire, and covers the ligula and maxillæ, the antennæ are geniculate, the eyes emarginate, the anterior tibiæ toothed on the outer edge. *L. dama*, from the eastern part of North America, varies from 0.9 to 1.5 inches in length. It is of a dark chestnut-brown in color, and the mandibles of the male, as is usual in species of *Lucanus*, are much enlarged, and have a single tooth on the inner side. *L. elaphus*, whose mandibles are branched in the male, and often 0.75 of an inch long, is called, on account of its antler-like mandibles, the stag-beetle. It closely resembles *L. cervus*, the European stag-beetle, which latter is, however, somewhat larger. The larvæ of *Lucanus*, which inhabit dead wood, have six well-developed legs, antennæ of four joints, and the anus in a longitudinal cleft.

FIG. 437. — *Lucanus dama*.

Differing from *Lucanus*, in having an emarginate mentum, are the species of *Pasalus*, which are numerous in some tropical regions, but of which only one is found in the United States. This species, *P. cornutus*, is flattened, cylindrical in form, about 1.25 inches long, and of a very dark-brown color. Its surface is highly polished, the prothorax being smooth, the elytra striate. These beetles, with their white larvæ, are often found in great numbers in half-decayed logs, and when taken between the fingers emit a peculiarly delicate squeaking sound. Their larvæ are readily recognized by their very poorly developed posterior legs. They further differ from those of *Lucanus* in having a slenderer form, three-jointed antennæ, and the anus in a transversal cleft. The intestines of *P. cornutus* furnish a rich field for the microscopist. Prof.

Joseph Leidy has described protophyta, protozoa, and nematode worms from this insect.

The PARNIDÆ include a small number of beetles which are united in one family more by their resemblance as larvæ than by the structure of their imago. The beetles have in common the following characters: the dorsal segments of the abdomen are partly membranous, the first to the third ventral segments are connate, the last joint of the tarsi is long and the claws large. The body is very finely pubescent, and a film of air adheres to this pubescence when the beetles are beneath the surface of water, for they are all aquatic in habits.

The larvæ of the Parnidæ are, according to Friedenreich, flattened oval in form, and most of them adhere to stones under water by using their entire ventral surface as a sucker. They consist of twelve segments, of which the first one later forms the head and prothorax of the imago. The aquatic species have closed stigmata, and respire by gills, from which air is distributed through a closed tracheal system. The gills are tubular, and consist of a motile trunk, to which are attached filamentous branches. These gills are beneath the fourth to the ninth or the fifth to the tenth segments, and have no relation to the stigmata. The internal tracheæ are moulted through the closed stigmata. One species which lives in moist air has eight pairs

of perforate stigmata. Pupation takes place beneath the flat oval shell of the larva.

In *Psiphenus* the abdomen has more than five ventral segments. *P. lecontei* has a wide distribution over the eastern United States. Mr. H. G. Hubbard writes of this species: "The males and unimpregnated females are very active, and in the heat of the day collect upon stones in mid-stream, which barely break the surface of the water, and are occasionally washed by a ripple. Over these stones they run in ceaseless activity, chasing each other like flies at play, and making occasional short flights over the surface of the water, but never plunging beneath it, nor suffering themselves to be submerged even for an instant. They are at such times exceedingly wary, and, unless approached very cautiously, they vanish before the observer can get near enough to use his net. They leave the stone with a flight so swift that it cannot be followed with the eye, but they will invariably be found all together and at play upon another stone at no great distance. The gravid females are found in July or August engaged in laying their eggs on the underside of submerged stones in shallow brooks. When so engaged they are very sluggish, and never attempt to escape. The eggs are of a bright orange color, and are deposited in irregular clusters." The larva of this species, which is very abundant in some streams, is especially common in the rapids above Niagara Falls. This larva was originally described as a crustacean under the generic name of *Fluricola*.

FIG. 438. — *Psiphenus lecontei*.

Elmis has only five ventral segments and rounded anterior coxæ. *E. condimentarius* is said to be used in Peru for flavoring food.

FIG. 439. — *a*, *Anthrenus muscorum*; *b*, *Ptinus fur* (see page 356); *c*, *Attagenus pellio*; *d*, *Dermestes lardarius*.

The DERMESTIDE are small oval or elongate beetles, some of which are the most troublesome insects of houses and storerooms. Systematically they are recognized, according to Le Conte and Horn, by their having the dorsal segments of the abdomen partly membranous, the ventral segments free, the mentum moderate or small, the palpi approximate at the base, the posterior coxæ not prominent, the antennæ moderate in length and capitate, the body usually scaly or pubescent. Most of the

genera (except *Dermestes*) have an ocellus on the front. These beetles, together with their larvæ, feed upon a variety of substances, both animal and vegetable. Some of the species are the most dangerous of museum-pests; others attack food in the pantry, store, or warehouse; drugs do not escape their attack, species devouring even cantharides and tobacco; woollen and silk goods, feathers, and furs are ruined if left long exposed to their depredations; and one species is accused of biting young doves. The Dermestidæ feign death, and do it so skilfully and for so long a time that they are sometimes left for dead, only to escape and renew their depredations. Their oval larvæ, which do more injury than the beetles, are usually covered with long brown hair, and in some cases these hairs are beautiful spear-like objects for microscopical examination. The larvæ moult a larger number of times than is commonly the case with beetle larvæ, probably eight or more times.

Dermestes lardarius, the bacon-beetle, which is about 0.3 of an inch long, is brownish black, except the anterior half of the elytra, which are gray, spotted with black. This beetle has become cosmopolitan. It eats wool, silk, hair, horn, hoofs, and other substances, and often attacks neglected collections of insects. Its larva is about 0.45 of an inch long, and tapers somewhat from the anterior toward the posterior end. This larva was first described by Goedart, in 1667, and has been redescribed since that time by many entomologists.

The species of *Attagenus* are generally smaller and less elongated than those of *Dermestes*. They have an ocellus on the front, the middle coxæ are near together, the prosternum is not lobed anteriorly, and the antennæ are eleven-jointed. *A. pallio* is about 0.2 of an inch long, and dark brown with a white dot near the middle of each elytron. The abdomen of its larva ends in a pencil of long hairs. *A. megatoma*, and possibly at times other species of the genus, are the cause of a kind of felting of pillows and bed-ticks that is often a puzzle for housewives. These insects, having gained access to the inside of a bed-tick, breed in it, and bite off pieces of the feathers. These pieces, on account of the rolling and tumbling to which they are subjected in the bed, are driven, basal end first, into the ticking, where they are retained by the barbed nature of their tip, all of the branchlets pointing backwards. What is curious about this felting, which resembles mole-skin, is its remarkable evenness and beauty. A piece, from which I saw a sample several years ago, was made up into a lady's cloak, and suggested the possibility of producing this kind of dress-goods by using flock-cutters and fulling-mills to replace the slow processes by which this piece was made.

Anthrenus has been long well known to most collectors of plants and animals, and has lately introduced itself in America to the unwilling recognition of housewives. Two species, *A. rarius* and *A. muscorum*, neither of them much larger than a good-sized pin-head, are the best-known museum-pests. They are gray spotted with light brown. The beetles gain access to collections, and deposit their eggs upon insects, stuffed animals, and other dried animal matter. The larva when hatched bores into the specimens, often-times completely riddling or ruining them, and finally pupates within them. Their presence in collections of insects is betrayed by the débris which falls from

FIG. 440. — *Anthrenus muscorum*, larva and pupa.

the specimens attacked. To keep museum-pests from collections, resort is made to camphor, carbolic acid, naphthalin, and many other substances, which are kept

in the boxes with the specimens. These generally prevent the females from entering the boxes for the purpose of oviposition, but are not always to be relied upon as remedies when museum-pests are introduced. My own collection of insects is kept free from museum-pests by observing the following precautions. The collection is kept in closely shutting boxes, in a room which is not carpeted and which is solely devoted to the collection. No new insects are introduced into this room until they have been subjected to a disinfecting-box. This disinfecting-box is made of tin and is sixteen inches square and twelve inches deep. The perpendicular edges of its tin cover dip into a deep water-channel which surrounds the top of the box, a mode of water-sealing employed in gas-works purifiers which suggested the plan of this box. Whole boxes of specimens, when suspected or found to be infested with museum-pests, are put into this box, a little benzine poured into the bottom of the disinfecting-box, and the whole covered and left for a day or two.

Anthrenus scrophularia, probably lately introduced into America from Europe, has received the name of carpet-beetle and buffalo-bug in the eastern United States, on account of its habit, both as larva and imago, of destroying carpets. This beetle is somewhat larger than the last-mentioned species, measuring about 0.08 of an inch in length. Its colors are black, brick-red, and white, which are easily seen, with a lens of moderate power, to be scales arranged in mosaic-like patterns over a brownish-black surface. This insect, like the

other species of *Anthrenus*, feeds, out-of-doors, upon the pollen of plants, and often swarms upon flowers of different kinds of *Spiraea*, and upon those of the shad bush (*Amelanchier canadensis*). In-doors it attacks not only carpets and all kinds of woollen goods, but also collections of objects of natural history, plants, furs, hair, raw-

FIG. 41. - *Anthrenus scrophularia*, carpet-beetle, pupa and larva.

hides, and like materials. Its larva, which, as usual with insects, does more damage than the perfect insect, is oval, about 0.25 of an inch long, and covered with long, brown hairs. In some parts of this country these insects have already become so abundant that carpets are a costly luxury, requiring constant care, and replacement every few years. A few people have adopted what seems at present the only practical remedy, the use of oiled floors covered with rugs, which latter, because they can be often removed and shaken, are not very subject to destruction by carpet-beetles and moths. The waxed hard-wood floors, often of pretty patterns, which are admired by American travellers in Europe, are the results of the solution of the problem of how to get rid of carpet-destroying insects by our artistic transatlantic brethren. To keep carpet-beetles out of clothing requires frequent examination and shaking of the goods. I have found that clothing can be freed from insects by a few days treatment in the disinfecting-box, in the same way as described for removing museum-pests from specimens. After such treatment, clothing can be safely packed away in closely shutting tin boxes in dry places.

Trogoderma differs from *Anthrenus* in having the mandibles and labrum not covered by the prosternum. *T. tarsale* is a common museum-pest in parts of the United States.

The CRYPTOPLAGIDÆ are beetles of small size, and usually of short, convex form. On account of their minuteness, these beetles attract little popular attention. Some of the species feed on fungi, some live in ants' nests, and others eat plants. The larvæ of *Cryptophagus cellaris*, a European species, live in the cells of wild bees (*Anthophora retusa*) upon the excrement of the young bee-larvæ. *C. quercinus*, also a European species, lives in the nests of ants in oak trees. Professor A. S. Packard writes that he has found the larvæ of *Antherophagus ochraceus* in the nests of humble-bees (*Bombus*) during July and August. It is likely that the species of *Antherophagus*, which are frequenters of flowers, are carried into bees' nests by the bees themselves, since Perris has observed a *Bombus montanus*, to the antenna of which an *A. nigricornis* firmly clung. The genus *Atomaria* is made up of extremely small beetles, as its name indicates; these are oval, convex, and pubescent. Several species of *Atomaria* are myrmecophilous, others are destructive to plants. *A. linearis* has been known to ruin young beet-plants.

The family CURCULIDÆ includes a small number of Coleoptera which are remarkable for their excessively flattened, usually elongate form. Their abdomen has five free ventral segments which are equal in length; the antennæ are eleven-jointed and often enlarged apically; the prothorax is usually narrower than the elytra. The larvæ are elongated and depressed; some have five ocelli upon each side of the head, others none. The feet have each a simple claw. The tip of the abdomen is armed with a pair of curved horns. Both larvæ and beetles are found beneath the bark of decaying trees; some of them (*Prostomis*) live in society with ants; the larva of one species, at least, is carnivorous.

The species of *Brontes* have striate elytra, the sides of the prothorax serrate, and its anterior angles prolonged, the antennæ with the first joint elongated, the anterior coxal cavities open behind, and the maxillæ exposed. *B. dubius* is about 0.25 of an inch long, dark brown in color, and is not rare under bark of dead chestnut trees in the northeastern United States. In Europe *B. planatus* is found under bark of dead oaks.

FIG. 442.—*Cucujus clavipes*.

In the genus *Cucujus* the hind-tarsi are only four-jointed in the males; the prosternum is narrow, and the hind-angles of the head are prominent. *C. clavipes* is scarlet above, with black antennæ and eyes; its upper surface is finely punctate. I have found this species under decaying butternut bark, where its larva probably lives.

Catogenus differs from *Cucujus* in having its maxillæ covered by corneous plates, which are broad and rounded in front; the first tarsal joint is short. *C. rufus*, which varies from 0.25 to 0.50 of an inch long, is deep brown, and is found in the eastern United States. In parts of Connecticut it is common beneath the loose bark of the trunks of hickory trees, and I have reared its larva, which fed upon a pupa of *Elaphidion parallelum*, a borer in hickory.

In *Sylvanus* the anterior coxal cavities are closed behind, the tarsi without lobes beneath, the outer three joints of the antennæ are enlarged. *S. surinamensis* breeds in grain, and, like most grain insects, has become widely distributed over the globe. It is dark brown, marked with yellowish pubescence, and is only about 0.1 of an inch long.

The family COLYDIDÆ comprises quite a number of very small, elongate, mostly cylindrical beetles, of little popular interest on account of their small size. Some of them live in fungi in the ground, or under bark of trees; a few are myrmecophilous,

and, according to Monflet, the larva of a species of *Bothrideres*, found in Guadaloupe, is an internal parasite of larvæ of *Lagochirus araneiformis*, a cerambycid beetle.

The usually flattened species of NITIDULIDÆ have antennæ of eleven joints; these antennæ are inserted under the front, and have an apical club of three (rarely two) joints; the tarsi are variable, but more or less dilated, and their first joint is not short; the anterior coxæ are transverse and not prominent, the posterior ones flat and not sulcate; the labial palpi are approximate at the base; the ventral segments are free, and the legs short. These beetles and their larvæ feed in decomposing animal or vegetable matter, in fungi and higher plants of soft texture, under bark of decaying trees, on pollen, and an Australian species, *Brachypeplus auritus*, eats the wax in nests of bees of the genus *Trigona*.

The species of *Ips* have the antennal club made up of three joints, the labrum connate with the epistoma, the anterior coxæ open, and the thorax not margined at the base. *I. fasciatus*, common throughout the United States, is shining black, with a band or spot of yellow across the base, and another just behind the middle of each elytron. It eats decomposing animal and vegetable matter, being especially common in autumn upon decaying pumpkins or cabbage-stalks which have been left in the fields. *Ips ferrugineus*, of Europe is said to feed upon larvæ of *Hylesinus piniperda*. Species of *Ips*, and of other Nitidulidæ, also frequent stumps of freshly-cut birch and maple trees early in the spring, in order to eat the sap which oozes from them.

FIG. 443. — *Ips fasciatus*.

FIG. 444. — *Nitidula bipustulata*.

In *Omosita* the labrum is entire and free, the head horizontal, the prothorax not margined at the base, the tarsi moderately dilated, and the front not lobed over the antennæ. *O. colon* is found in the eastern United States and in Europe. It is about 0.12 of an inch long, much flattened, is deep brown, spotted upon the elytra with light brown; it frequents decomposing animal and vegetable matter. *O. discoida*, a slightly more elongate form than *O. colon*, inhabits Europe and the western United States.

Of similar form to *Omosita*, but differing from it structurally in having strongly dilated tarsi and feebly emarginate labrum, are the species of *Nitidula*, of which *N. bipustulata* is found in Europe and the eastern United States. This species is about 0.2 of an inch long, and dark brown with a light-brown spot near the middle of each elytron. Its

habits are similar to those of *Omosita*.

Dr. G. H. Horn writes of *Carpophilus*, "Labrum bilobed. Antennæ eleven-jointed, terminated by a flattened-oval, three-jointed club, grooves moderately deep, convergent. Legs moderately robust, tibiæ slightly broader at tip, spurs moderate. Tarsi dilated, claws simple. Two, sometimes three, dorsal segments visible beyond the elytra; abdomen beneath with segments 2-3 short, 1-4-5 longer." *C. hemipterus*, a species about 0.15 of an inch long, distributed over most parts of the globe. It is dark brown, with pale spots upon the elytra.

FIG. 445. — *Carpophilus hemipterus*.

In *Conotelus* the abdominal segments are greatly prolonged, so that the abdomen projects far beyond the elytra, as it does in the Staphylinidæ. *C. obscurus*, a black

species with brownish legs and antennæ, and about 0.2 of an inch long, is often very abundant in flowers of the wild morning-glory (*Calystegia sepium*) in the northeastern United States.

Separated from the species of the preceding family by their slender tarsi, of which the first joint is short, are the TROGOSITIDÆ. Of this family there are two groups readily distinguished by their form. The species of the first group are elongate insects with the prothorax narrowed behind. *Trogosita mauritanica* is a cosmopolitan species of this group. It is deep brown, flattened, and about 0.4 of an inch long. The species of *Trogosita* are often found under decaying bark, but certain of them have proved to be very injurious to grain, and to other articles of commerce. *Thymalus*

FIG. 446. — *Trogosita mauritanica*.

fulgidus is a common representative of the second group of the Trogositidæ, which contains oval species. This is a nearly round, somewhat flattened species, about 0.2 of an inch long, which abounds on *Polyporus betulinus*, a large, white fungus that is parasitic on trunks of dead birch trees. The beetle is a slightly shining bronze color, and is both punctate and pubescent. Its larva is 0.3 to 0.4 of an inch long, somewhat flattened, and has the anal extremity armed with two parallel, acute, corneous processes, along the sides of which are a few sharp, short

branches. The larva, which is of a hyaline white with a yellowish head, has five ocelli on each side of the head. The larvæ generally destroy the tough tissue of the above-mentioned fungus during the early spring, in the eastern United States, and pupate in the remnants of their food-plant, the beetles emerging during the summer.

A considerable number of small beetles that are, for the most part, round, hard, and seed-like in appearance, and generally live upon decaying animal or vegetable matter, are united in the family HISTERIDÆ. They differ systematically from the Ni-

FIG. 447. — *Hister arcuatus*.

FIG. 448. — *Hister bimaculatus*.

FIG. 449. — *Onthophilus alternatus*.

tidulidæ in having geniculate antennæ. Most of the Histeridæ are black, a few have red spots, and a small number are metallic in coloration; all their tibiæ are usually dilated; the elytra are truncate behind, leaving two abdominal segments exposed; the upper surface is striate, the position and nature of the striae being generally of value as specific characters. The larvæ of the Histeridæ are elongated, with corneous head and prothorax, and have no ocelli. Some species of this family inhabit ants' nests, a few live under bark. *Hister belluo* is known to eat larvæ of *Agdistica alni*, and *H. pustulosus* drags the larvæ of *Agrotis*, a noctuid moth, from their holes and devours them, in company with others of its species that hasten to the repast.

In the species of *Suprinus* the head is bent downward and retracted; the prothorax is truncate anteriorly, and has cavities at its side for the reception of the antennæ, which are inserted beneath the front. There are nearly sixty North American species

of this genus; most of them are found about carcasses; the species are difficult to distinguish.

In *Hister*, another large genus, well represented in North America, the prosternum is lobed anteriorly, the antennal club is broadly oval and distinctly annulated, the labrum trapezoidal, and the cavities for the reception of the antennae are anteriorly situated, and open in front. *H. arcuatus* is one of the largest North American species, being about 0.35 of an inch long, and marked with a curved red stripe upon each elytrum. *H. bimaculatus* is found both in Europe and North America. Closely related to *Hister*, but having a truncate antennal club, and a transverse labrum, is *Tribalus*. *T. scaphidiiformis*

FIG. 450. — *Sappinus mauritanicus*.

FIG. 451. — *Hololepta fossularis*.

is found in Algiers and Portugal. In *Oonthophilus* the antennal cavities, which are beneath the angle of the prothorax, are open below and closed in front, and the prosternum is scarcely lobed in front. *O. alternatus*, a small species, not over 0.1 of an inch long, is from the eastern United States.

The species of *Hololepta* are quite different, in general appearance, from all the other Histeridae. They are very much flattened, the head and mandibles are prominent. *H. fossularis* is about 0.4 of an inch long, shining black, and is found in the eastern United States beneath the bark of decaying trees.

The SCAPHIDE contain a small number of very shiny beetles of similar form and coloration to the Histeridae, but easily distinguished from the latter by their clavate antennae, which are not geniculate, and by other structural characters. The larvae are said to have long antennae.

The family of PHALACRIDÆ is small, and consists of only four genera of little convex shining beetles, that live upon flowers or under bark. *Phalacrus*, *Olibrus*, and *Litochrus* are represented in the North American fauna. *Tolyphus granulatus*, which is here figured, belongs to the only other genus, and is from southern France and northern Africa.

FIG. 452. — *Tolyphus granulatus*.

FIG. 453. — *Trichopteryx atomaria*.

The TRICHOPTERYGIDÆ are the smallest known beetles. The antennae are verticillate with long hair, and the wings are fringed with hair. A few are apterous. The larvae are active and carnivorous, those of some species feeding on Poduridae. Pupation lasts but a few days. Quite a number of the Trichopterygidae are myrmecophilous, others live under bark. *Trichopteryx atomaria* is found both in Europe and in America.

The typical carrion-beetles belong to the family SILPHIDÆ. These beetles are often of considerable size, and have clavate antennae. The characters which Drs. Le Conte and Horn give to separate the beetles of this family from others having clavate antennae are as follows: dorsal segments of the abdomen partly membranous, ventral segments free, mentum moderate or small, palpi approximate at their bases; anterior coxae large, conical, and prominent; posterior coxae more or less conical and prominent; eyes finely granulated, sometimes

absent. While most of these beetles live upon carrion, attacking by preference decaying animal matter, a few have mixed habits and attack decomposing and even living vegetation, while some are known, when pressed by hunger, to eat living insects, not sparing their own species. *Leptinus testaceus* has been found in Normandy by Mr. A. Fauvel in the nests of mice, where it is supposed to feed on fungi. Mr. M. Girard has described an eyeless species, *Scotocryptus melipona*, from the nests of bees (*Melipona scutellaris*) in Brazil. Other eyeless forms (species of *Leptoderus*), together with others (*Adelops*) that have very small eyes, inhabit caves. In *Arimimelus lebioides*, from Japan, there is an ocellus behind each compound eye. Some species of *Catops* inhabit ants' nests. Species of *Necrophorus* stridulate. Many kinds of Silphidae emit nauseous fluids, and their odor remains disagreeable after years of drying in the collection. The species of this family, even in the larval state, are very sensitive to odors, and are guided by their olfactory organs to their food.

FIG. 454. — *Necrophilus subterraneus*.

The larvæ of Silphidae have six legs, four-jointed antennæ, strong bidentate mandibles, three-jointed maxillary and two-jointed labial palpi, and generally a two-jointed appendage each side of the anus. The ocelli vary in number, there being none in *Adelops* and *Anisotoma*, two pairs in *Agathidium*, and six pairs in *Silpha* and most other genera. The larvæ generally inhabit the same places and devour the same food as do the imagoes.

Among some of the smaller species, which have the posterior coxæ simple and the anterior coxal cavities closed behind, those of *Anisotoma* and *Agathidium* live in fungi.

Adelops, a word which signifies inconspicuous-eyed, is the name of a genus of beetles which have been erroneously said to be eyeless. The species have slender antennæ, which are longer than the head and thorax, and a prominently carinate mesosternum. *A. hirtus* was first described from a specimen taken under a stone in Mammoth Cave, Kentucky, and has since been found in other caves of the same region. It is oval in form, grayish brown, and about 0.1 of an inch long. Its larva and pupa have been described by Mr. H. G. Hubbard.

The genera *Silpha* and *Necrophorus* include the largest and best-known species of this family. In *Silpha* the form is flat, oval, or nearly so; the antennæ are eleven-jointed, and gradually increase in size from the middle toward the apex, or are slender and scarcely clubbed. *S. americana* (sometimes called *S. peltata*) is about 0.7 of an inch long. Its prothorax is yellow with a dull black median spot, its elytra are brownish black and rough. *S. atrata*, which is said to have been introduced into America from Europe, is about 0.4 of an inch long, black, densely punctured, and with elevated elytral ridges, between which the punctures are irregularly arranged. Its antennæ are nearly filiform. Another species, found both in Europe and North America, is *S. lapponica*, which is about the same size as *S. atrata*, but has a gray pubescent prothorax and dull-black elytra, the latter roughened by ridges with single rows of irregular protuberances between them. In New England *S. inaequalis* and *S. novboracensis* are common species. Both are a little larger than *S. atrata*, and have the prothorax and elytra longitudinally wavy; the former is entirely black, the

FIG. 455. — *Silpha americana*.

latter has the sides of the prothorax light red. As was noticed by Frisch, in 1740, in describing the larva of the European *S. obscura*, these larvæ are sometimes phytophagous, and in the last few years numerous notices have been published of injury to crops, especially to young sugar-beets, by larvæ and imagos of the last-mentioned species and of *S. opaca* and *S. reticulata*. Late experiments have shown that some of these species prefer vegetable to animal food. Sexual activity is great in *Silpha*; and Dr. C. F. Gissler has written of *S. ramosa*, a species from the western United States: "They copulate every few hours, the male constantly pursues and annoys the female, often snapping at the latter and biting into tips of elytra, for which reason these (in collections) are so often found lacerated. The female is often found burrowed into the soil to escape the caressings of the male, and also for oviposition, which takes place there." The oval eggs of this species, as Dr. Gissler has observed, are very large in comparison with the insects' size, measuring about 0.1 of an inch in length, while the beetle is only from 0.6 to 0.7 of an inch long. The larvæ of *Silpha* are dark colored and flat, having the characters already given for larvæ of this family.

FIG. 456. — *Silpha atrata*.

The species of *Necrophorus* have ten-jointed antennæ with a four-jointed round club, and are of an elongated form, with red-spotted elytra, which are truncated at their tips. On account of their habit of burying small dead vertebrate animals, in

FIG. 457. — *Necrophorus vespillo*, grave-diggers at work.

which they lay their eggs, these beetles are often called sextons or grave-diggers. This habit makes these beetles useful scavengers. The largest North American species of this genus is *N. americanus*. It is 1.25 to 1.50 inches long, the top of the head is red, the pronotum is of the same color margined laterally and behind with black, and there are two red spots on the outer side of each elytron, one just anterior to its middle and one near its tip. *N. tomentosus* is a common species in the northeastern United States, and is about 0.75 of an inch long. Its prothorax is clothed with dense yellow pubescences, and the red spots extend nearly across the elytra. Somewhat resembling the last-mentioned species is *N. vespillo* from Europe. *N. germanicus*, a nearly black European species a little over an inch long, captures and devours *Geotrupes stercorarius*.

The SCYDMENIDÆ differs from the Silphidæ in having coarsely granulated eyes.

Dr. Le Conte says of the beetles of this family: "These are small, shining, usually ovate, sometimes slender insects of a brown color, more or less clothed with erect hairs. They are found variously near water, under stones, in ants' nests, and under bark, and are frequently seen flying in the twilight."

A small portion of the Coleoptera with claviform antennae have the dorsal segments of the abdomen entirely corneous and the elytra very short, not covering the abdomen. Of this portion the PSELAPHIDÆ have the abdomen rigid and the ventral segments five or six in number. The antennae have from one to eleven joints, the labial palpi are very short, the maxillary palpi are usually long and four-jointed, eyes are sometimes absent, claws simple and frequently single, wings often wanting. The species of this family are all very small and many are myrmecophilous, living on friendly terms with ants. As cause for this friendly relationship, it is said that certain species of Pselaphidæ secrete, as do the Aphidæ, fluids which the ants eat. This kind of life has been so long participated in by these beetles that many species are blind, and are fed, carried about, and protected by the ants exactly as they care for their own larvæ; this is the case with *Claviger testaceus*, a European species which has connate elytra and is apterous. Certain species of this family live in caves, and one of them, *Macharites subterraneus*, is peculiar in having males with eyes and females without these organs. In *Artibeus*, of which several species are found in Australia, the antennae are one-jointed. In the North American genera, *Adranes* and *Fustiger*, the antennae have but two joints, and in the former genus, eyes are wanting.

The STAPHYLINIDÆ, which, like the Pselaphidæ, have short elytra, differ from the latter family in having the abdomen flexible and consisting of eight ventral segments. While including many minute forms, this family also includes some species that are an inch or more in length. The antennae are generally eleven-jointed, but are variable in form and insertion, the labial palpi are usually three-jointed, the maxillary palpi generally four-jointed. The short truncate elytra usually leave most of the abdomen exposed; and when these beetles are disturbed, many of them turn the tip of the abdomen over the body as if intending to sting. Some of them discharge odorous defensive fluids from the tip of the abdomen when they have assumed this threatening position. The wings, when present, can be closely packed away beneath the short elytra. In *Pachycorinus dimorphus* from New Zealand, Mr. A. Tanvel has noticed that the females are dimorphic, the form that has normal eyes has longer elytra and wings, while the partly-blind form has very short elytra and no wings—a curious correlation of locomotion and sight. Some species of Staphylinidæ have, in addition to the compound eyes, a pair of ocelli.

FIG. 458.—Larva of *Ocypus*.

The larvæ of Staphylinidæ resemble the imagoes more than is usual with Coleopterous larvæ, chiefly on account of the larval-like appearance of the imagoes themselves. The antennae are always four-jointed, although apparently five-jointed in some genera. The mouth-parts are well developed, the maxillary palpi are of three or four joints, the ocelli vary according to genera from one to six on each side, the body is elongate and is usually armed at the anal end with a pair of appendages which are mostly two-jointed. These agile larvæ are of a firm texture, of a brownish black or yellowish color, and they pupate, for the most part, underground or beneath rubbish on the ground. In many forms the metamorphosis lasts but one year.

The larvæ of this family usually live in similar places to those frequented by the imagos; and, while their habits and life history have been little studied in comparison with other families of equal size, there is great and interesting variety in their habits. Some of the species live under bark, others eat fungi, many live about decaying plants and the excrements of higher animals. Quite a number are found in the nests of ants, but the exact relations which they hold to the ants are not yet determined. Mr. E. A. Schwarz has found species of Staphylinidæ in Texas in the nests of white ants (*Termites*), which, as will be recollected, are not Hymenoptera, as are the true ants. *Quedius dilatatus* breeds in hornets' nests in Europe, and will also eat honey. *Microglotta nidicola* frequents the nests of bank-swallows in France, and Mr. P. S. Sprague discovered that *Aleochara anthomyia*, in the eastern United States, was parasitic in the cabbage-maggot (larva of *Anthomyia brassica*). Heeger found that *Gyrrophana mamea* oviposits on leaves of plants. The larvæ, when first hatched, eat the eggs of mites, and later devour the larval mites themselves, finally pupating in moist earth. In a termitophilous South American genus the abdomen is soft, very much enlarged, and thrown upwards and forwards so as to hide the thorax. The eggs of these curious insects develop into larvæ, while still in the abdomen of the female, a fact first discovered by the late Professor Schiödte of Copenhagen, who, on account of its viviparous habits, named the genus *Corotoca*.

The rather robust species of *Oryporus* are found in fungi. The head is large, the eyes small, the long mandibles are not dentate, and the abdomen is strongly margined. *O. vittatus* is about 0.25 of an inch long, and black above with a light-brown longitudinal stripe covering nearly the whole of each elytron, and the margin of the abdomen is brown. It is common in the northeastern United States on species of *Agaricus*. The species of *Pachrus* are combinations of red and deep metallic blue in coloration, and are found under chips and stones in moist places. In *P. riparius* the head, elytra, and tip of the abdomen are blue, the rest of the insect for the most part red. It is about 0.3 of an inch long, and inhabits both Europe and America. In similar moist localities, as those in which *Pachrus* is found, live numerous species of *Stenus*, a genus of small Staphylinidæ, which have very prominent eyes, a broad head, narrow prothorax, and wide subquadrate elytra.

The largest species of this family are members of the tribe Staphylinini. The genus *Staphylinus* contains species often of considerable size. *S. maculosus*, common in the eastern part of North America, is from 0.7 to 1 inch long, is dull brown, densely punctate, and the tip of the pubescent abdomen is lighter brown. Of about the same size, and found in the same localities, is *Leistotrophus cingulatus*. This species is brown, speckled with brownish-black spots, and the apical portion of its abdomen is clothed with golden pubescence. It differs generically from *Staphylinus* in having the fourth joint of the maxillary palpi shorter than the third. Differing from the last-mentioned genera, in having the thorax without punctures, are the genera *Creophilus* and *Thinopinus*. *C. villosus*, the only North American species, is widely distributed over the country. It is from 0.5 to 0.9 of an inch long, of a black ground color marked with gray pubescence, especially upon the margins of the abdomen and in a band across the elytra. *C. macillosus*, from Europe, is a very similar species to *C. villosus*. *Thinopinus pictus*, which lives below high-water mark on the shores of the Pacific Ocean from Alaska to southern California, is from 0.55 to 0.75 of an inch long, of a yellowish-brown color, spotted above with dark brown and black.

Numerous species of the genera *Bledius*, *Cryptobium*, *Lathrobium*, *Philonthus*, *Quedius*, *Aleochara*, and *Homalota* are found in the United States, but their specific and even their generic determination is often difficult. *Aleochara brachypterus*, which is figured, occurs both in Europe and in North America.

FIG. 459. — *Aleochara brachypterus*.

The family PLATYPSYLLIDÆ consists of a single species, *Platypsylla castoris*, an ovate, elongate, much-flattened parasite of the beaver (*Castor fiber*). The beetle is only 0.16 of an inch long, and has neither eyes nor wings; the elytra are short, leaving five abdominal segments exposed. This insect was first described by Ritsema in 1869 as a new genus and species of Aphaniptera, but its coleopterous nature was pointed out in 1872 by Dr. J. L. Le Conte. Professor J. O. Westwood considers it to represent a distinct order of insects, the Achreioptera.

FIG. 460. — *Platypsylla castoris*.

With the family HYDROPHILIDÆ begins a series of several families of Coleoptera which inhabit water, or, in a few cases, extremely moist places. Of these families only

FIG. 461. — *Hydrophilus piceus*, larva, male, female, and egg-nest.

the Hydrophilidæ have clavate antennæ. The antennæ have from six to nine joints, the outer joints forming a distinct club, the palpi are long, the middle and posterior legs are sometimes flattened and fitted for swimming. The imagos of this family are said to eat vegetable matter, either decomposed or living, and this is probably true of many species; but certain kinds of *Hydrophilus* prefer animal matter when they can obtain it. Robert writes that *H. piceus* feeds upon snails (*Limæus*), and I found that this species ate greedily fresh meat or fish in preference to vegetable matter in an aquarium. Westwood asserts, however, that *H. fennicus* eats turnip leaves in the

fields during the night. The insects of this family respire under water from a supply of air which they carry about attached to the pubescence of the under surface of their bodies; and this air, which appears like a sheet of silver beneath the beetle when in the water, is often renewed by the insect coming to the surface.

The life history and habits of some of the Hydrophilidæ are interesting in the extreme because of the nest which the females construct and in which they deposit their eggs. This cocoon-like nest is produced by the hardening of a gelatinous secretion from accessory glands of the sexual organs of the females, and in it are deposited from twenty to over one hundred eggs, according to the species. The cocoon is fastened by some of these beetles to submerged vegetation, by others it is left to float on the surface of the water, and the females of still other species carry their cocoon about beneath them, fastened between the posterior coxæ and steadied by the hind legs, until the young larvæ have hatched. The larvæ are recognized, according to Professor J. C. Schiödt, by their "claw-formed tarsi, which are sometimes wanting, the terminal pair of stigmata, the free projecting mouth-parts, the very short joint membrane of the maxillæ, the connate clypeus and absence of the labrum, the sharp, sickle-formed, imperforate mandibles, the absent or sharp ligula, the want of a neck on the extended head, and the very short, unarmed anal segment." The larvæ when first hatched often prey upon one another in the same cocoon; later they feed upon insects which fall into the water, and upon snails. In the case of the larvæ of *Hydrophilus piceus*, which eat common house-flies with avidity, the mode of feeding is curious. Seizing the fly in its jaws, the swiftly swimming larva seeks some place where it can eat it in quiet and security. Having found a suitable place, it rests upon a piece of grass or leaf and projects the head above the surface of the water, holding it perpendicularly. In this position it chews the fly into a pulp, using the antennæ as mouth-parts during the process, and sucking the juices of the fly down its throat, which, during the mastication, acts as a tunnel to catch the juices crushed from the fly. The head is apparently held above the surface of the water in order that the juices of the prey shall not be diluted by the water. After the juices have been sucked from the fly its chitinous parts are rejected, at least by young *Hydrophilus* larvæ, in the same way as like innutritious parts of its prey are rejected by scorpions after they have drawn the juices from it. Pupation takes place in the ground.

Among the small species of Hydrophilidæ are a number of very convex form, terrestrial habits, and having the middle and hind tarsi with the first joint elongated. Of these small forms species of *Spharidium* have a narrow mesosternum and elongated scutellum. *S. scarabæoides* is black, with yellow legs, a yellow spot on the tip of each elytron, and just in front of this yellow spot a larger blood-red one. It lives in cow-dung in Europe, and a single specimen, perhaps accidental in occurrence, has been reported from Canada. The larvæ of *Spharidium* and of *Cereyon*, related genera, live in moist earth and in dung, and prey upon dipterous larvæ.

FIG. 462. — *Spharidium scarabæoides*.

Hydrobius and *Phyllhydrus* include closely related aquatic species which have the middle and hind tarsi not compressed and with the first joint short, and in which the prothorax at the base is as wide as are the elytra. The last of the five exposed ventral segments is entire, and the antennæ are nine-jointed. In *Hydrobius* the last joint of the maxillary palpi is longer than the third joint. In *Phyllhydrus* the last joint is shorter than the third. *H. globosus* and *P. rotundatus* are similar appearing, smooth,

shining black species, found in the northeastern United States. The form is nearly hemispherical, the length from 0.3 to 0.4 of an inch.

The genus *Hydrophilus* contains the largest species of this family. They differ from *Hydrobius* and genera associated with it in having compressed tarsi, and in having the metasternum prolonged posteriorly into a long spine.

H. triangularis, a common North American species, is 1.5 inches long, and shining black in color. The egg-case of this species has been carefully described by Dr. C. V. Riley. It consists of three parts, a floater surmounted by a horn-shaped process, an egg-case proper, attached to the basal end of the floater, and an outer bag or covering. The larvae remain a day or two in the outer bag after they hatch; and Dr. Riley concludes "that the curious contrivance in *Hydrophilus* is intended not only to secure an ample supply of air to the eggs and to protect them, but also to protect the newly hatched young from their numerous enemies until their jaws have strengthened and they are better able to begin the struggle for existence." The eggs are white, cylindroid, and about 0.15 of an inch long and .04 of an inch in diameter. In Europe the corresponding large species of this genus is *H. picus*, both sexes of which are figured above, with nest and larva. The sexes of these insects are easily distinguished, because the male has the anterior tarsi much enlarged, to form an organ, common among water beetles, by which he clings firmly to the female during copulation. Notwithstanding the reputed phytophagous habits of the imago of *H. picus*, this beetle sometimes captures and eats *Triton punctatus*, when confined in an aquarium.

Nearly related to *Hydrophilus*, but having a short metasternal spine, is *Hydrocharis*. *H. obtusatus*, an oval black species, about 0.7 of an inch long, is common in the eastern United States. Several smaller species are united in the genus *Tropisternus*, of which *T. glaber* is an abundant species in New England.

The remaining families of beetles are often termed Adephaga, and are characterized by Drs. Le Conte and Horn as having the first three ventral segments connate; the first divided by the hind coxal cavities, so that the sides are separated from the very small medial part. The Adephaga are pre-eminently predaceous Coleoptera, although, as will be seen later, a few partake of vegetable food.

The GYRINIDE includes a small number of Coleoptera which swim rapidly about in groups upon the water, unless disturbed, when they dive beneath the surface. They are noticeable for their having a pair of eyes upon the upper surface of the head, with which to look out into the air, and a pair upon the under side for sight under water. Their flattened oval form and bluish-black color, together with their four eyes, serve to distinguish them from all other Coleoptera. When seized they emit an odorous milky fluid. In *Gyrinus* the scutellum is distinct, while in *Dineutus* it is wanting. The only other North American genus is *Gyrates*, of which a species is found in Illinois, Arizona, and Texas, and which differs from *Dineutus* in having the last ventral segment of the abdomen elongated and conical. *Dineutus*

FIG. 463. — *Hydrophilus triangularis*.

FIG. 464. — *Tropisternus glaber*.

FIG. 465. — *Dineutus vittatus*.

cittatus is the largest species from the United States, where it is common in the Atlantic region. It is about 0.55 of an inch long, and the elytra have rounded tips.

The larvæ of Gyrinidæ respire by means of ciliate gills and a closed tracheal system. These gills are situated one on each side of every abdominal segment, and an additional pair upon each side of the anus, — in all, ten pairs of gills. These ciliate branchiæ serve as swimming organs, enabling the larvæ to swim rapidly. Notwithstanding their active aquatic life these larvæ are subject to parasitism by three or four species of Hymenoptera.

The flattened water-beetles belonging to the family DYTISCIDÆ live in the water as do the Hydrophilidæ, rather than upon it like the Gyrinidæ, from all of which insects they are readily distinguished by their filiform eleven-jointed antennæ. The Dytiscidæ have but two eyes, their metasternum has no antecoxal piece, and is prolonged in a triangular process posteriorly, their abdomen has six segments. The legs of these beetles, especially the posterior pair, are oar-shaped and clothed with long hair, being consequently well fitted for natation; but these insects are not confined to swimming as a mode of locomotion, for they are provided with serviceable wings, and during the night fly from pond to pond. These beetles are apparently guided to water by sight, for they often fly against green-houses, the glass of which they mistake for the surface of water. Many Dytiscidæ emit between the

FIG. 466. — *Hydrophilus griseostriatus*.

head and prothorax, a milky secretion, and between the mesothorax and metathorax a yellowish fluid; the function of both these odorless fluids is not determined with certainty. At each side of the anal end of the intestine are two glands which furnish a strong odorons, acid fluid, said to contain butyric acid; these anal glands, which are not rare in aedephagous Coleoptera, are defensive in function. Many species of Dytiscidæ stridulate; that is, produce more or less musical sounds, both under water and in air. Species of *Acilius*, *Dytiscus*, and *Colymbetes* produce sound by rubbing the abdominal segments upon the elytra; the males of *Cybister*, by action of the posterior femora upon a corrugated spot behind the hind coxæ; and *Pelobius*, a genus placed by some authors in another family, by friction of the stout margin of the wings against the under side of the elytra. The anterior and often the middle tarsi of males, in certain genera of this family, have a part of their joints widened, and provided with pedunculate suckers beneath. These suckers enable the males to adhere firmly to the females during copulation. In the males of *Dytiscus* and of some allied genera the three basal joints of the anterior tarsi, which are the ones most strikingly modified, are so widely expanded as to form unitedly a saucer-shaped disc, which bears on its under surface two large and numerous small chitinous suckers mounted on stems. These somewhat toadstool-formed suckers are altered tarsal hairs. The females of some species of Dytiscidæ exhibit an interesting dimorphism in that some of the individuals have the elytra striate, while others of the same species have them smooth. Different species of *Dytiscus* have been known to copulate with each other, and Kraatz has published a notice of a bastard between two species of this genus. Dytiscidæ are rarely found in salt water, and their occurrence there is apparently accidental and temporary. Species

FIG. 467. — *Dytiscus verticillatus*.

occur, however, in hot springs, and Hooker writes of a Himalayan species that was found abundantly in springs which had a temperature of 112° F. Insects of this family respire, when under water, a supply of air which they carry beneath their elytra, and which they renew, from time to time, by coming to the surface, and resting with the head hanging and the tip of the abdomen just at the surface of the water. Some of them remain submerged an hour and a half, before renewing their supply of air. The larger species of Dytiscidae often attack small fishes.

FIG. 468. — LARVA OF *Dytiscus*.

The larvæ of the Dytiscidae, which are aquatic in habits, and have free mouth-parts, five-jointed thoracic legs, four-jointed antennæ, and six pairs of ocelli, are especially noticeable because their mandibles are hollow, and are consequently adapted both for seizing their prey and for sucking out its juices. The mouth cavity between the mandibles is not, as is often asserted, entirely closed. The larvæ respire by means of two stigmata at the posterior end of the abdomen.

Cybister has the suckers on the under side of the tarsal disc alike, and arranged in four rows. *C. fimbriolatus*, from the eastern United States, is greenish black, margined with yellow, and is about 1.25 inches long. In *Dytiscus* the suckers of the tarsal disc are of different sizes, and the posterior stigmata are larger than in *Cybister*; the species are all large. *D. fusciventris*, a species about 1.1 inches long, is common in New England, and *D. verticalis*, about 1.3 inches long, is not very rare in the same region. Both are black, with yellow lateral margins of the prothorax and elytra. In Europe *D. marginalis*, a species about the size of *D. fusciventris*, is the common one, and its larvæ attack young frogs, tritons, and fishes.

The species of *Acilius* are of medium size, and have the posterior tarsi ciliate, the claws of the same tarsi equal or nearly so. Many of the species have a yellowish band across the posterior half of the elytra, and transverse yellowish lines on the prothorax.

FIG. 469. — *Matus bicarinatus*.

FIG. 470. — *Rhantus notatus*.

FIG. 471. — *Hybius ater*.

FIG. 472. — *Coptotomus interrogatus*.

The tarsal discs of the males are round. *A. fraternus* is very common in New England. Its length is about 0.6 of an inch, and the black portions of its elytra have a yellowish tinge, due to the black consisting of very dense punctures upon a yellow surface. *A. sulcatus* is the common representative of this genus in Europe.

In *Rhantus* the discs of the anterior tarsi of the males are oblong, and the elytra smooth. *Rhantus notatus*, a species about 0.4 of an inch long, is found in Europe

CARABID BEETLES.

1. *Calosonia sycophanta*. 2. *Casnonia*. 3. *Tachnyporus rugosus*. 4. *Elephrus riparius*. 5. *Cychrus rostratus*.
6. *Catadromus tenebrioides*. 7. *Callistus quadripustulatus*. 8. *Panagaeus tomentosus*. 9. *Scarites goudotii*.
10. *Onypterigia fulgens*. 11. *Procrustes coriaceus*.

and North America. The species of *Agabus*, *Matus*, and *Hybius* are all somewhat similar in appearance to *Rhantus*, and most of the species are about the same size. *Coptotomus interrogatus* is very common in the eastern United States. It is about 0.35 of an inch long, the elytra are somewhat irregularly striped longitudinally with yellow, and the prothorax is banded transversely with the same color.

In *Hydroporus*, a genus which contains over seventy-five described North American species, the prosternum is deflexed between the front coxæ, the anterior and middle tarsi are apparently four-jointed, the

FIG. 473.—*Hydroporus rotundatus*.

scutellum is not visible, and the metasternum attains the mesosternum. The species are all of comparatively small size.

FIG. 474.—*Haliplus fasciatus*.

The family HALIPLIDÆ, often united with the Dytiscidæ, includes a small number of minute, sub-aquatic Coleoptera, which are oval and very convex, and which swim poorly. They are yellow, spotted with black. Their metasternum has an ante-coxal piece separated by a distinct suture, and their antennæ are ten-jointed.

The CARABIDÆ number probably over ten thousand described species, varying in size from very minute forms up to beetles from two to three inches in length. Drs. Le Conte and Horn give the following characters by which species of this family can be readily distinguished from other adephagous coleoptera: Metasternum with an ante-coxal piece, separated by a well-marked suture, reaching from one side to the other, and extending in a triangular process between the hind coxæ; eleven-jointed antennæ arising at the side of the head, between the base of the mandibles and the eyes; hind coxæ mobile and simple; and habits terrestrial. These beetles have slender legs, and run rapidly; the wings are often poorly developed. On account of their rapid running habits, the Germans term these Coleoptera "Laufkäfer." Sonorific organs are not common in insects of this family, but species of *Blethisa* and of *Elaphrus* stridulate. Luminous organs have been reported in the case of *Physodera noctiluca* from Java.

A large number of Carabidæ have anal glands, which have been mistaken by some writers for urinary organs, but which are defensive in function. The muscular bladder-like receptacles of these glands are two in number, one on each side of the terminal portion of the intestine, and each opens just above the rectal opening. Into these receptacles, which serve to store the defensive fluid until needed, open the ducts of the glands which prepare the secretion. In most cases the secretion is an odorous acid liquid, which can be spurted out quite a distance, and Pelonze has shown that, in certain species of *Carabus*, this secretion contained butyric acid, the same acid that imparts its indescribable odor to rancid butter. In *Brachinus* and a few other genera the secretion of the anal glands is either partly gaseous on emission, or becomes a permanent gas immediately afterwards, as can be readily proved by compelling one of the insects to discharge its secretion under water beneath an inverted test-tube filled with the same liquid. In this way I have collected, in a few moments, from *Aptinus displosor*, a Pyrenean species related to *Brachinus*, an amount of gas equal to several times the space occupied by the beetle itself. The discharge of the anal glands of *Brachinus*, often rapidly repeated when the beetle is held between the fingers, is accompanied by a smoke-like vapor and a popping sound, whence insects of that genus are popularly termed bombardier-beetles.

FIG. 475.—*Brachinus fumans*, bombardier beetle.

Beetles of this family live, for the most part, on or near the ground, remaining concealed beneath boards and stones during the day, and wandering out at night in search of their prey. A particularly favorable place to collect

FIG. 476. — *Anophthalmus tellkampfi*.

many species is beneath the *débris* left by the overflowing of rivers. Another situation not much less productive is under stones along the banks of larger streams and rivers; a few are found along the sea-coast, under stones; and a species of *Epus* live between the high and low water mark upon the shores of the ocean, where they are covered by the salt-water the greater part of the day. They respire air which surrounds and adheres to them while they are submerged. On account of their predaceous habits, few Carabidæ live in nests of ants or of other insects; but Bates states that *Solcnogenys foda*, from the upper Amazon, lives on the nests of termites. A number of species of this family inhabit caverns; among them those of the genus *Anophthalmus* are best known and are eyeless, or at least blind, both as larvæ and imagoes. *Ilaphanus*, an Australian genus, is, as its name indicates, eyeless, while *Richia lucifuga*, which is found along river banks in southern France, has the eyes aborted.

The larvæ of Carabidæ are elongated, often partly corneous. They have four-jointed antennæ, and somewhat long five-jointed legs. The mandibles are falciform and prominent, the maxillary palpi are four-jointed, the labial palpi two-jointed, and the ocelli are generally from four to six on each side. In the larvæ of *Scarites* and *Anophthalmus*, and of a few other genera, ocelli are absent. It is usually stated that carabid larvæ, like those of the Cicindelidæ, Dytiscidæ, and Gyrinidæ, and unlike those of most other families, have two claws on each foot; but this character is not without exception in the carabid larvæ, for the larvæ of *Epus*, a genus already mentioned, and of *Cyllenum*, are stated to have but one claw on each foot. Chapuis and Candèze write: "The color of these larvæ varies from a light brown to a deep black, and, exceptionally, to yellowish white. They are very active, and wander about upon the ground. The greater part of them live upon prey which they get possession of in various ways. Thus insects, caterpillars, and molluscs form their ordinary food. They do not tear this prey to pieces, but limit themselves to extracting its juices, a circumstance that explains the smallness of their buccal aperture. Some live on vegetable substances. This fact, proved for *Zabrus gibbus*, probably will be the same with the greater part of the larvæ of Harpalini and of *Amara*." This prediction as to the phytophagous habits of Carabidæ has since proved true, and quite a large number of these insects are known to feed upon pollen and other parts of plants, while the *Zabrus* mentioned above has proved at times destructive to young turnip plants and to other crops. In parts of California *Platynus maculicollis* has become so abundant as to be a nuisance, swarming in every corner, and entering food and clothing in masses. The popular name given this beetle is "overflow-bug." With the exception of *Zabrus gibbus* and *Platynus maculicollis*, the insects of this family may be regarded as generally beneficial, for the phytophagous species mostly devour the pollen and seed of weeds, while the great majority of Carabidæ attack the larvæ of noxious insects.

Among curious food habits of Carabidæ it may be mentioned that D'Aumont observed that *Brachinus crepitans*, in company with carrion beetles, helped devour a

dead snake. According to a statement lately made by J. Frivaldsky, a Hungarian entomologist, *Acinopus ammophylus*, a species from southern Russia, feeds upon pods and seeds of medie (*Medicago sativa*), which the beetles collect during the night and heap up about their burrows in the ground.

Of the extreme variety of forms which species of Carabidae present, none is more remarkable than that of *Mormolyce*. The commonest species is *M. phyllodes*, a beetle often reaching three inches in length, and found in the forests upon the mountains of Java, where its remarkable form, best shown by the figure, has attracted the attention of the natives, by whom it is called *bibliolah'an*. Its antennae and legs are black; the rest of the beetle is pitch-brown, a little lighter in shade upon the margins of the elytra. These beetles, as well as their larvae, are found about *Polyporus fomentarius*, a fungus upon the trunks of trees. The larvae, which exhibit no remarkable structural peculiarities, and resemble those of *Carabus*, live within the fungus, feeding, it is supposed, upon the larvae of other insects. Pupation takes place within the fungus, and the form of the elytra in the pupa indicates, to a certain extent, the remarkable form of the beetle that is to emerge from it. Larval life requires from eight to nine months; pupal life from eight to ten weeks. The imagos are found mostly from August to November.

FIG. 477. — *Mormolyce phyllodes*.

A large sub-family, the Harpalinae, includes such Carabidae as have the "middle coxal cavities entirely enclosed by the sterna, the epimeron not reaching the coxa; head without antennal grooves beneath, and supraorbital distinct setae; ambulatorial setae of abdomen usually well-developed."

FIG. 478. — *Harpalus caliginosus*.

The genus *Harpalus* includes a large number of flattened usually black beetles, of which it is often difficult to determine the species. Most of them have nearly square prothorax. Of the species of this genus *H. caliginosus* is very common in the eastern United States, often feeding upon the pollen and seeds of the common ragweed (*Ambrosia artemisiifolia*). It is about an inch in length. A number of slightly smaller species are equally common, and have similar habits to the one last mentioned. Not very different from *Harpalus* in structure and habits are the many species of *Austrodactylus*. Still smaller than insects of the last-mentioned genera is *Gynandropus hylacis*, found in the eastern United States. This beetle is about 0.3 of an inch long. It is black above, and has brownish legs and mouth-parts; the elytra are striate. This beetle often abounds under the loose bark of hickory trees. Among other small carabids, which are not far from *Harpalus* in systematic position, are the species of *Agonothecus*. *A. lincoln*, a very common little beetle about 0.35 of an inch long, which flies into the open windows in the evening, attracted by the lights within, is yellowish-brown, with black dots upon

FIG. 479. — *Gynandropus hylacis*.

the prothorax, and a stripe of the same color along the middle of each elytron. Much larger (about 0.6 of an inch), but of similar form, and pale-brown coloration, without distinct black markings, is *Geopinus incassatus*, a common New England species. In *Geopinus*, *Agonoderus*, and other genera of the group to which they belong, the left mandible is longer than the right one, and overlaps it distinctly in the first-named genus.

The genus *Chlenius* includes beetles of medium size, which usually are of a greenish or purplish bronze color above. Sometimes the margin of the elytra or a few spots upon them are yellow. They frequent moist places beneath stones, and attain their maximum size and beauty in Africa. Most of the species have an odor somewhat like that of Morocco leather. *C. sericeus*, a bright green species, with brown antennae and legs, is common along the banks of the larger rivers in the north-eastern United States. *C. tomentosus*, from the same region, is of a deep purplish bronze color.

FIG. 480. — *Chlenius sericeus*.

The genus *Brachinus*, already mentioned on account of its habits, consists of over 150 species distributed throughout temperate and tropical parts of the world. The beetles of this genus are mostly red, with blue or green elytra, and are found often in numbers together beneath stones. The species are very difficult to distinguish, but the genus is readily distinguished by its form, colors, and habits. The specific names *armiger*, *bellicosus*, *bombarda*, *crepitans*, *echalaus*, *explorens*, *fumans*, *fulvator*, and the like, have reference to the habits of the bombardier-beetles.

Numerous small species of Carabidae, which are much flattened, often ornamented with bright colors, and many of which frequent flowers, belong to the genus *Lebia*, in its older and less-restricted sense. *L. grandis*, one of the larger species of this genus, measuring about 0.4 of an inch in length, is yellowish-brown, with dark-blue elytra. This insect has proved useful by eating the eggs of the Colorado potato-beetle

FIG. 481. — *Lebia grandis*.

(*Doryphora decemlineata*). The genus *Coptodera*, of which *C. emarginata*, from Brazil, is figured, does not differ greatly structurally from *Lebia*. *Dromius*, another genus closely related to *Lebia*, has a heart-shaped prothorax. *D. piceus*, a common North American species, is shining black and about 0.3 of an inch long. *D. quadrinotatus*, found in Europe, feeds, as larva, under the bark of pines. upon the larvae of *Pissodes notatus*, a weevil.

FIG. 482. — *Coptodera emarginata*.

Of the genus *Galerita* there are five North American species. In the northeastern United States, *G. janus* is common under stones in early summer. Its length is about 0.75 of an inch; its antennae, prothorax, and legs are red, and the rest of the beetle is bluish-black. The head is much elongated, and the prothorax is not half as wide as are the elytra, which latter are truncate at the tip. In *Casnonia*, which includes small beetles, the structure is quite similar to that of *Galerita*, but the thorax is very much more elongate. *C. pennsylvanica* is not rare under stones. Its length is about 0.25 of an inch, and its color is brown and black, the head, prothorax, and spots upon the elytra being of the latter color.

FIG. 484. — *Casnonia pennsylvanica*.

FIG. 483. — *Galerita janus*.

About eighty-five North American species of described Carabidae, which are considerably flattened, and resemble, to a certain extent, those of *Lebia*, but are not usually as vividly colored, and are generally somewhat larger, are included in the genus *Platynus*. The entire coloration of *P. cupripennis*, a North American species about 0.3 of an inch long, is metallic green with reddish reflections. *P. octopunctatus*, which is common in New England, although not as common as *P. cupripennis*, is similar in size and coloration to the latter species, but has four deeply impressed punctures arranged longitudinally near the inner margin of each elytron. Many of the species of this genus are black. Differing systematically from *Platynus*, in having the claws more or less serrate, is *Calathus*. In the last two genera the elytra are obliquely sinuate;

FIG. 485. — *Calathus impunctatus*.

but in *Lachnophorus*, of which *L. rugosus* from Brazil is figured, the elytra are round at the tip.

FIG. 486. — *Dicalus purpuratus*.

Dicalus comprises about twenty species of Coleoptera, all of which are North American. These beetles have the pronotum flattened, with a few slight wrinkles and an upturned margin; the elytra are striate. *D. splendidus*, from the southern United States, is over an inch long, and black with coppery-bronze elytra. *D. purpuratus*, a purplish-black species about an inch long; *D. longatus* and *D. dilatatus*, both black, and 0.7 and 0.8 of an inch long respectively, are all found on the Atlantic slope as far north as Massachusetts.

Dr. G. H. Horn has described the larva of a species of *Dicalus*, possibly of *D. dilatatus*. The body of the larva is dark greenish blue and semi-opaque, its head being reddish yellow. The larva is narrowed toward both ends; and the anal segment is armed with two slender inward-curved processes, between which the anus extends as a corneous tube equal in length to an abdominal segment. Its antennae, although, as is usual in this family, four-jointed, are about one-third the length of the body. The legs increase in length from the first to the third pair. Pupation, which takes place beneath logs or in the ground, lasts but a week. Nearly related, systematically, to *Dicalus* is *Badister*. *B. bipustulatus*, from Europe, is about 0.2 of an inch long, brown, with black head and two curved black lines on each elytron. Its larva has been described by Schödté.

FIG. 487. — *Badister bipustulatus*.

FIG. 488. — *Pterostichus lucublandus*.

The genera *Pterostichus*, *Amara*, *Evarthrus*, and *Loricarius*, each contain numerous species; but they are separated with difficulty, and but little is known of their life history. Most of the species of these genera are black. A few have metallic colors, or vary from brown to red. Allied to these genera is *Zabrus*, of which *Z. gibbus* has already been mentioned on account of its destructiveness to crops. *Amara similata*, another European species, is said to eat both flowers and leaves of the shepherd's-purse (*Capsella bursa-pastoris*). To this same group of genera belong *Catadromus*, of which the Javanese *C. tenebrioides* is

figured on the plate. *Anopthalmus*, already mentioned as a genus of blind cave beetles, contains about fifty species, of which seven are North American, being found in the caves of the Ohio Valley, and the rest European. The first North American species described was *A. tellkampfi*, from Mammoth Cave, in Kentucky. It is about 0.3 of an inch long,

slender and with long legs. Its color is light brown. This species is eyeless, although Grenier states that *A. auberti*, from southern France, has minute non-pigmented eye-spots, and that these spots are black in *A. milleri*, from Hungary. The larva of an *Anophthalmus* from Mammoth Cave has been carefully described by Mr. H. G. Hubbard. The larva has no ocelli, and Mr. Hubbard writes of it that, "except in its very elongate form, I can find no striking differences between this and other Carabid larvæ allied to *Trichus*." *Trichus* and *Patrobis* are genera which are closely related, systematically, to *Anophthalmus*, but which have eyes.

FIG. 489. — *Trichus rubens*.

FIG. 490. — *Patrobis rufipes*.

A large number of small beetles, which scarcely ever exceed 0.25 of an inch in length, and many species of which are found running about in the sunlight upon the sand of river banks and of the shores of lakes, are included in the genus *Bembidium* in its wider sense. In proportion to their size these beetles are among the quickest running insects, and considerable dexterity is necessary to capture them. The species of *Tachys* are even smaller than those of the last-mentioned genus, which they resemble in habits.

FIG. 491. — *Bembidium levigatum*.

Morio georgii, which is black and about 0.5 of an inch long, is the single representative in the United States of the tribe of insects to which it belongs, of which a few species are found in most parts of the world. It is found in the southern States.

The sub-family Carabine, which includes the larger and more beautiful species of Carabidae, are characterized as follows: "Middle coxal cavities not entirely enclosed by the sterna, the epimeron of the mesosternum reaching the coxa." The genera are more easily recognized in this sub-family than they are in the preceding one, and their characters will be given, following, as usual, the authoritative work for North American Coleoptera, Drs. Le Conte and Horn's classification.

FIG. 492. — *Morio georgii*.

FIG. 493. — *Scarites subterraneus*.

In the tribe of which *Scarites* is the typical genus, the posterior coxæ do not attain the side margin of the body, the anterior coxal cavities are closed behind, the prosternum does not conceal the mesosternum, the antennæ arise either under a distinct frontal plate or a ridge which extends backward over the eyes, the body is pedunculate, and the posterior coxæ are contiguous. In *Scarites* itself the hind angles of the thorax are wanting, the elytra are without a humeral carina, the maxillæ are slightly hooked at the tip, and the basal joint of the antennæ is long. *S. subterraneus* is a very common species in New England, and is from 0.7 to 1 inch in length, with large mandibles. It is said to live in the burrows of *Capris*, a scarabæid, and probably devours coprophagous larvæ. *Monhotia gloriosa*, a species from southern Europe, which is similar to *Scarites*, attains a length of over two inches. *Pasimachus* differs from *Scarites* in having the hind angles of the thorax distinct, the elytra with a humeral carina of variable length, and the maxillæ very obtuse at the tip. The species, which are usually margined with blue, are all North American. *P. depressus* is of a dull black color, without striæ or punctures, and is found in the southern United States.

FIG. 494. — *Pasimachus depressus*.

Metrius contractus, from California, is the single species representing a tribe which differs from *Scarites* in having the body not pedunculate and the posterior coxæ separated. This beetle is found under stones in forests.

The genus *Elaphrus* differs from the genera of Carabinae already mentioned in having the antennæ free at the base. In this genus the form is robust, the mandibles have a setigerous puncture, and the elytra are marked with impressed spots. The species of this genus are found running about in the sunlight on the surface of the mud around the borders of ponds and pools. The color of many of the species is a purplish or greenish bronze. *E. riparius*, which is figured, is about 0.25 of an inch long, and is common in parts of Europe. In *Ble-*

FIG. 496. — *Elaphrus riparius*.

FIG. 495. — *Metrius contractus*, enlarged.

thisa the elytra have striae between the impressed spots. *B. multipunctata* is a European species that has been found in America. According to Laudoit, *E. riparius* and *B. multipunctata* stridulate by rubbing the upper side of the penultimate abdominal segment against the inside of the elytra, both the parts rubbed together being provided with surfaces suitable for sonification.

The typical genus of this family is *Carabus*, which is represented in North America by only about ten species, reaches its highest development in Europe, where a large number of species are found. In this genus the anterior coxal cavities are open behind, the posterior coxæ are contiguous, the labrum not bifurcate, the mandibles without a setigerous puncture externally, and the third joint of the antennæ cylindrical. Most of the species are of medium, some of large size,

FIG. 497. — *Blethisa multipunctata*.

FIG. 498. — *Carabus serratus*.

and many have beautiful coloration. Their food consists of earthworms, caterpillars, and other insects. The species of *Carabus*, and those of the allied genera *Calosoma* and *Cychrus*, have well-developed anal glands, and throw a strong acid fluid. *C. serratus* is the most abundant species in the northeastern United States. It is from 0.60 to 0.75 of an inch long, is black, with the upturned margins of the prothorax and elytra bluish, and its elytra are punctate. *C. sylvestris*, from the same region, is similar to *C. serratus*, but larger, being about an inch long. One of the prettiest of the common European species is *C. auratus*, which is nearly an inch in length, and has the entire upper surface greenish bronze with a reddish reflection.

In *C. glabeatus*, another European species, the elytra, which are often connate in this genus, are so firmly united that the suture between them is scarcely noticeable. *C. hispanus*, from Spain and southern France, is about 1.4 inches long; and the elytra are coarsely punctured, and reddish bronze margined with blue, while the head and the prothorax are metallic blue. *Procrustes* differs but little from *Carabus*. *P. coriaceus*, a black species, nearly 1.5 inches long, is found throughout southern Europe.

Calosoma differs generically from *Carabus* in having the third antennal joint compressed. The habits of the species of this genus are very similar to those of

Carabus. In the United States *Calosoma calidum* and *C. scrutator* have been observed to eat canker-worms (larvæ of *Anisopteryx*), and the larvæ of *C. externum* prey upon army-worms (larvæ of *Leucania unipuncta*); in Australia the larvæ of *C. curtisii* live beneath cow-dung, where they probably feed on noctuid larvæ; and the larvæ of several species of *Calosoma* devour snails. The commonest species of this genus in the eastern United States is *C. calidum*, which is about an inch long. Its elytra are covered with large bronze-colored punctures, the rest of the insect being black. Professor A. S. Packard states that he has seen this species attack the June-bug

FIG. 499. — *Calosoma calidum*.

(*Lachnosterna fusca*) and tear its sides open. The larva of *C. calidum* is black. The most brilliant species of this genus that inhabits the eastern United States is *C. scrutator*, which measures a little over an inch in length. The elytra are metallic green, margined with a narrow line of reddish bronze; the prothorax is deep shining blue with the channel formed by its up-turned edges paved with reddish bronze. This species is said to climb trees in search of larvæ. In Europe *C. sycophanta* resembles quite closely *C. scrutator*, but lacks the reddish-bronze margins of the prothorax and elytra.

FIG. 500. — *Calosoma scrutator*.

The species of *Cychrus*, which are distributed by some authors into several genera, differ from those of *Carabus* and *Calosoma* in having the posterior coxæ separated and the labrum bifurcate. The antennæ have four basal joints glabrous. The larvæ of *Cychrus* are said to be distinguished from those of *Carabus* by their brown color and by the four teeth with which the last abdominal segment is armed in place of the two horns so common in carabid larvæ. The generally elongated anterior parts of these beetles well fit them for their mode of life, enabling them to reach deeply into

FIG. 501. — *Cychrus elevatus*.

the shells of snails, on which they feed. The flattened, often broadly triangular apical joints of the palpi of these insects apparently co-operate with their elongated mandibles in extracting the soft tissues of snails from their shells. *C. stenostomus*, of which *C. lecontei* is a variety, is found in the eastern United States, and is of a bluish-black color. *C. levatus* has the posterior angles of the black thorax margined, and the margins elevated to meet the elevated margin of the anterior part of the coppery-bronze elytra. This beautiful species is rare in New England, but more common to the southward and westward. Its length varies from 0.6 to 1.1 inches. The only specimen that I have taken in New England was found in northern Connecticut, eating a species of freshly killed *Helix albolabris*. The largest species of *Cychrus* found in New England is *C. viduus*, which varies from 0.70 to 1.16 inches in length. *C. rostratus* is found in many parts of Europe.

The genus *Omophron* includes a small number of flattened, nearly round beetles, which live in moist places. The anterior coxal cavities are closed behind, the prosternum is prolonged and dilated so that it entirely conceals the mesosternum, and the

scutellum is completely concealed. The species are usually marked with dark brown and yellow.

The last family of beetles to be considered is the CICIHELIDÆ, which, not only on account of its structural peculiarities, but also because of the exclusively predaceous habits of its species, is generally considered the highest family of Coleoptera. The special character by which they are separated from the Carabidæ is the place of insertion of the antennæ. In the Cicindelidæ, these organs are inserted on the front above the base of the mandibles. The general

form and usual pattern of coloration of the insects of this family serve to make them easily recognized. In a few forms the elytra are connate and the wings absent, but most of these insects both run and fly rapidly. Many of the species live on the sandy banks of rivers and of the ocean, some tropical species live in trees, and a few abound in open places in the woods. Coquerel states that *Cicindela trilinearis*, from Madagascar, has the power of running upon water. Species of *Megacephala* are crepuscular, remaining in their holes during the day, and running about on the sand just before and

FIG. 503. — *Megacephala senegalensis*.

after sunset. Bates states that *Tetracha nocturna* and *T. pallipes* are nocturnal in habits. The former species is of the color of the sand upon which it runs, and is thus protected from insectivorous birds. *T. pallipes* is, on the contrary, brilliantly colored, and owes its protection from insect-eating animals to its very strong, disagreeable odor.

The larvæ of Cicindelidæ live in holes in the ground, the holes being, in some species, a foot and a half in depth. The larvæ have four-jointed antennæ, three-jointed maxillary palpi, and two-jointed labial palpi. Upon each side of the head are the ocelli, which are two in number in *Amblychila* and eight in species of *Tetracha*, *Omus*, and *Cicindela*. These larvæ are assisted in their motions up and down their burrows by a pair of protuberances which are armed with hooks. When waiting for prey these larvæ rest at the top of their burrows — their metallic-colored head and prothorax serving as operculum for the entrance to their burrow — with their sickle-shaped mandibles wide open. When the larva has made a capture of some insect that incautiously attempted to run over its head, it retires into its burrow to eat its prey at its leisure. It is said that the larvæ of *Cicindela campestris*, a European species, leave their holes at night to search for prey.

Of the group of Manticorini, those Cicindelidæ that have the posterior coxæ separated, the eyes small, and wings absent, only two genera are found in this country, both of which are confined to North America. In *Amblychila*

FIG. 502. — *Manticora marillosa*.

FIG. 504. — *Amblychila cylindriciformis*.

the elytra are widely inflexed, the prothorax scarcely margined, and the terminal joint of the maxillary palpi shorter than the third joint. *A. cylindricornis*, the only species, is found in Kansas, New Mexico, and Arizona. It is the largest species of this family found in the United States, and is brownish-black in color. Its habits are nocturnal. In *Omus* the elytra are narrowly inflexed, the prothorax distinctly margined, and the last two joints of the maxillary palpi subequal. The nine described species are all from the Pacific slope of North America, and are nocturnal.

FIG. 505. — *Omus dejeani*.

In *Tetracha*, the only representative of the Megacephalini found in the United States, the eyes are large and prominent, the posterior coxæ contiguous, and the third joint of the maxillary palpi longer than the fourth. *T. virginica* is dark metallic green above, with light brown legs and antennæ. Its length is about 0.75 of an inch. It is found in the southern Atlantic states concealed under logs and bark by day, for its habits are crepuscular. *T. carolina*, which has a yellow spot near the apex of each elytron, and is about 0.6 of an inch long, is widely distributed over America, from the middle United States to Chili and Peru.

The Cicindelini are represented by about sixty North American species of *Cicindela*. In these insects, the third joint of the maxillary palpi is shorter than the fourth. The five species of *Cicindela* figured are all common in the northeastern United States. Their size and figuration are well illustrated in the cuts. *C. sexguttata* is very bright metallic green, often with a bluish lustre, and the yellow spots upon its elytra are subject to some variation. This species, like the next, frequents sunny roads in the woods, where the grass is worn down quite short. *C. purpurea* is purplish-bronze color, with the lateral margin of the elytra metallic green, and the markings upon the elytra yellow. *C. generosa* is coppery bronze color, with the yellow elytral markings extending as an outer margin

FIG. 506. — *Tetracha carolina*.

FIG. 507. — Tiger beetles. a, *Cicindela generosa*; b, *C. tranquebarica*; c, *C. purpurea*; d, *C. hirticollis*; e, *C. sexguttata*.

around the elytra, and *C. tranquebarica* and *C. hirticollis* are of dark bronze color, sometimes almost black, with yellow markings on the elytra. *C. generosa*, *C. tranquebarica*, and *C. hirticollis* frequent sandy river banks. In *C. dorsalis*, which swarms along the south coast of Long Island, the elytra are nearly white, and the purplish prothorax is clothed with white scale-like hairs. This coloration is evidently protective; for these beetles are very difficult to see upon the white sand of the seashore, and still more difficult to capture, as they fly, without the slightest hesitation, directly out over the surf.