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9. Insects of the Forest.

THE insects of the forest comprise a large proportion of the entomological riches of the world. Those countries which have the most extensive forests have the greatest number and variety of insects. The tropics, particularly Brazil and the East Indies, sustain the richest assemblage of insect forms in the world. Their number and beauty diminish as we go north or south. Luxuriance of forests with great heat and moisture produces the widest diversity of forms and richness of hues. A large proportion of the insects sent home by collectors from tropical countries are the butterflies and large showy moths, with boring beetles, the Scarabeids preying on rotten trees, timber beetles of all descriptions, and the parasitic or predaceous forms which keep them in check. In the tropics when a tree dies it must be removed to make room and supply food for the growth of others. A wound made by some accident, such as the fall of an adjoining tree, the browsing of deer or bears, the gnawing teeth of mice or rats, leaves a scar, a weak place, which is immediately utilized by some boring insect as a place to deposit its eggs. Borers and timber beetles of many different kinds, with varied modes of attack run their galleries under the bark, or bore into the sap wood or straight into the heart of the tree. Their presence invites a horde of smaller invaders. Their parasites seek them and fall upon them until the tree and perhaps its neighbors are thoroughly worm eaten, when a tornado rushes through the forest and leaves its track behind, marked by a holocaust of fallen trees. Now these must, by the natural forestry practised on a gigantic scale in nature, be removed. Squads of Hercules beetles, Passali, and other devourers of decayed

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wood, luxuriate in the mouldering trunks. In an incredibly short space of time, aided by ants and Termites, the prostrate trunks are converted by the alchemy of nature into a mound of soil crowned by ferns and climbing plants, out of which will spring a new growth to take the place of the former generation. Many tropical trees are flowering plants, and immense throngs of gaudy *Cetonias*, Goliath beetles, and others of smaller stature frequent the blossoms for pollen, and fertilize the flowers of the trees. Nature, lavish of her ornaments in the tropics, hangs her stateliest trees with climbing vines, creepers and strange, bizarre orchids which attract multitudes of hawk moths and butterflies, whose gay colors light up the sombre glades of the primitive forests. Thus the forests are populated with hundreds of thousands of insect forms.

So luxuriant and rapid is the growth of forests in the tropics that they apparently are in the aggregate little affected by the ravages of insects. The latter on the whole rather serve to prune and check the growth of portions of the tree, to weed out the weaker, imperfect individuals and aid in the development of the stronger, and when a tree shows signs of decay to at once raze it to the ground and convert it into the soil from which it sprang.

Not so in the temperate regions of the earth, where man in subduing the forest exceeds his commission and well nigh exterminates it, leaving but scattered patches of the original forest primeval. In travelling through the pine forests of northern Maine, where the lumberers have made great gaps in the ranks of sturdy trees which formerly crowded the banks of the Kennebec, Penobscot, Alleguash and St. John, one may walk through the woods for miles and be struck with the poverty of insect life. Let him in a warm July or August day come out into a clearing where the lumberer's camp or lonely farm house is shaded by scattered trees, and he will be astonished at the number and variety of insect

forms. Brilliant green and golden Buprestids may be seen sunning themselves on the trunks of the trees, and the olive green *Monohammus* beetles so destructive to pines flying among the trees or emerging from their holes in the trunks. The *Urocerus*, a saw-fly like the *Tremex*, one of the characteristic insects of pine forests sails around in its circling flight, and pine weevils and timber beetles open their wings in the heat of the sun. The weeds, nearly all of European origin, crowd out the aboriginal inhabitants, and with their rank growth hedge about the cabin. With them have arrived the usual proportion of imported insects, but most characteristic of the northern forests are the *Arthemis* butterfly, the banded *Buprestis*, the pine weevils, the russet geometrid moth and others.

If the destruction of forests goes on as rapidly as at present all these forest insects will soon have lost their occupation. We shall then have to plant new forests, as they have and are doing in portions of northern Italy, in Austria, Germany and Great Britain. When this is done and the young trees are growing in extensive plantations, the danger arising from the ravages of destructive insects will be very great. As in Europe, we shall have to make chairs of forestry in our agricultural colleges, and appoint commissioners of forests. Then, if not at the present day, a thorough and practical knowledge of forest insects will be one of the guarantees to success in the cultivation of trees. At present Germany leads the civilized world in the intelligent care of her replanted forests. How carefully the trees are nurtured, how intelligently their diseases are studied, and with what pains the habits and forms of the destructive insects are described and drawn, is well known. The elaborate and beautifully illustrated works of the late Dr. Ratzeburg have made his name famous, and they form a perpetual witness to the intelligence and forethought of the people who encourage by their patronage the publication of such expensive and

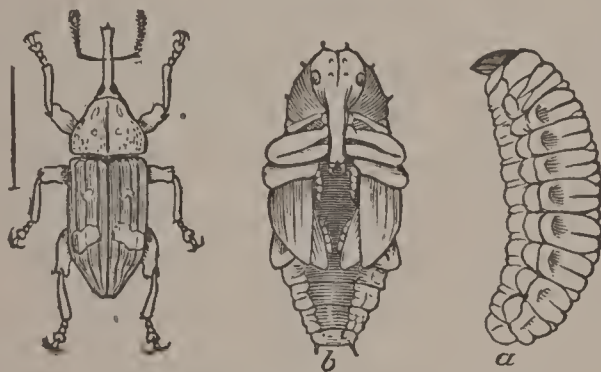
richly illustrated works. Such a work as that of Ratzeburg entitled "Animals Injuring Forests," has a double value. Not only is it of high practical importance, but the minute information therein contained regarding the habits of the destructive insects and their many parasites, the relation of the trees themselves to the animal world, the peculiar diseases resulting from their attacks, the deformities and changes wrought not only in single trees, but extended through large tracts of forest, all bear on theoretical points in biology, such as the supposed struggle for existence in organized beings, the origin of sports, strains, races, varieties and species, which combine to lend the highest interest to such stores of facts as are to be found in the works of this learned German.

Let us now walk through the pine woods, and notice the work of some of the more remarkable insects. I could take the reader by a favorite walk in the pine woods of Maine, and show him among a splendid growth of tall, straight, white pines, one enormous tree whose girth twenty feet from the ground is between fifteen and twenty feet. Above that the trunk divides into four branches, curved outwards at their base, forming a double crotch. In another walk I could show him several large trees, all within a few rods of each other, variously gnarled and distorted, either with single curved trunks, or double or triple-headed monsters, specimens of vegetable monstrosities which would delight a Geoffrey St. Hilaire or Daresté.

What is the origin of this deformation? It is a common little weevil which has the habit of laying its eggs late in the spring in the terminal shoots of white pine bushes. Several grubs hatch out and burrow in various directions under the bark. As they grow apace they sink into the wood, as far as the pith, and by the end of the second summer, according to Professor Peck, as quoted by Harris, they have each made a little cell in the wood, cleverly lined with pine

chips, in which the grub changes into a chrysalis. It is easy to find a stem of the pine containing a dozen or more of these cells, situated at quite regular intervals under the bark, now loosened or peeling off. If we examine it in the autumn we shall find the grubs, their pupæ, or chrysalides, together with the beetles. The accompanying excellent figures (174) of the pine weevil, its young and chrysalis or pupa, the two latter magnified three times, will give an excellent idea of the different stages of growth of this weevil. The footless grub is white, with a honey-yellow head. The white pupa has a mummified look, with its eyes partially concealed by its wings, and its legs folded on its breast. In this attitude it lies in its cell or sarcophagus awaiting the

FIG. 174.

Pine Weevil; *a*, grub; *b*, pupa.

dawn of a new life in the outer world. It either presses out from under the bark and seeks some other hiding place, or lies in its cell until some warm day in April, when with a troop of its fellows it flies about in the sunshine, busied with the care of providing for the continuance of its race.

Now this work of tunnelling and mining causes the death of the terminal shoot of the young tree. The bush sends out lateral shoots, more or less crooked. One can see plenty of them in the course of any walk in the edges of the woods. Thus deprived of their leading shoot such dwarfed and gnarled bushes grow up and vastly injure the appearance of the forest, and its value as lumber.

Dr. Fitch says that "young thrifty-growing pines are its favorite resort, and among these it selects those that are most vigorous, and whose topmost shoot has made the greatest advance the preceding year. But I have seen it so numerous that not only the topmost shoots of every tree in the grove, but many of the lateral ones also were invaded and destroyed by it. * * * The tree that is attacked continues its growth upward during the fore part of the season as usual, sending out from the summit of the shoot that is infested a leading shoot with a number of lateral branches around its base. But the growth of these new succulent twigs is arrested and they begin to wilt and wither about the middle of July, the worms having by this time become so large, and mined and wounded the stalk below to such an extent that its juices are exhausted, and it fails to transmit any nourishment to these tender green shoots at the summit, which consequently dry up and perish."

Here again the forester is aided by his best friends, the birds, which pick out the grubs and eat them. There are also several parasitic insects which further reduce their ranks.

Another pine weevil, equally abundant and often as destructive, is the *Hylobius*. It is a larger beetle, and darker, less reddish than the white pine weevil (*Pissodes strobi*). It is particularly destructive to the pitch pine, so much so in the southern states that Wilson, the ornithologist, thus speaks of its depredations near Charleston, South Carolina, as quoted by Harris. "Would it be believed that the larvæ of an insect, or fly, no larger than a grain of rice, should silently, and in one season, destroy some thousand acres of pine-trees, many of them from two to three feet in diameter, and a hundred and fifty feet high? Yet whoever passes along the high road from Georgetown to Charleston, in South Carolina, about twenty miles from the former place, can have striking and melancholy proofs of the fact. In

some places the whole woods, as far as you can see around you, are dead, stripped of the bark, their wintry-looking arms and bare trunks bleaching in the sun, and tumbling in ruins before every blast, presenting a frightful picture of desolation. Until some effectual preventive or more complete remedy can be devised against these insects, and their larvæ, I would humbly suggest the propriety of protecting, and receiving with proper feelings of gratitude, the services of this and the whole tribe of woodpeckers, letting the odium of guilt fall to its proper owners."

Not remotely allied to the weevils, which are distinguished by their more than Roman noses, are the little snub-nosed cylindrical timber beetles. Their hard bodies, short legs and strong jaws admirably adapt them for boring in the bark and solid wood of trees. They are sometimes called wood-engravers. They may well be styled animated gimlets, as they bore straight, even and true holes, as if driven by the hand of a carpenter.

There are several species which have different modes of assault. The first is the *Tomicus xylographus* (Fig. 175), the true wood engraver. It is quite small, chestnut-colored, about a line in length, its wing-covers are bevelled off at the tip, the edges of the declivity being armed with four or five teeth on each side. The female mines the outer surface of the sap wood and inner layer of the bark, lengthwise to the tree. Curiously enough there are more males than females and they help their partners, each working in turn. This is one of the few cases among insects in which the two sexes unite in the work of providing for the welfare of their future offspring. The female is said by Dr. Fitch, from whose admirable observations I am compiling this account, to make little notches at intervals along the burrow. In each of these notches from one to four eggs are placed. As the beetles,

FIG. 175.

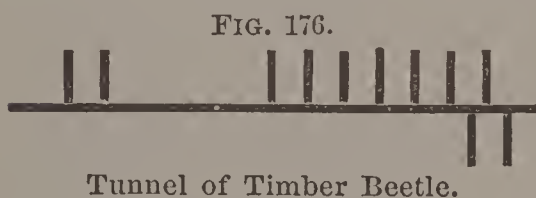
Wood
Engraver.

clothed with the short, stiff hairs which cover their bodies, pass backwards and forwards in their burrow, they brush the dust and chips into the notches, thus covering the eggs up.

When they hatch the young grubs gnaw their way straight out for two or three inches from the primary tunnel, which may be from four to eight inches in length. It has been noticed that the burrows are always separate, never touching or crossing each other. When about to pupate, *i. e.*, change to a pupa, the grub sinks deep into the wood at the outer end of the burrow. This species attacks the pine when in perfect health.

Another wood engraver, nearly two lines in length, is the *Tomicus calligraphus*. It makes short, large, irregular burrows, and is common in the yellow pines of the Carolinas, as well as the pitch pine of the northern states.

The burrow of the *Tomicus pini* is like a bird's claw, or the fingers of a hand. As the beetle is a line and a half in length its burrows are rather larger than usual.



The smallest form known is the *Tomicus pusillus*, slightly more than half a line in length.

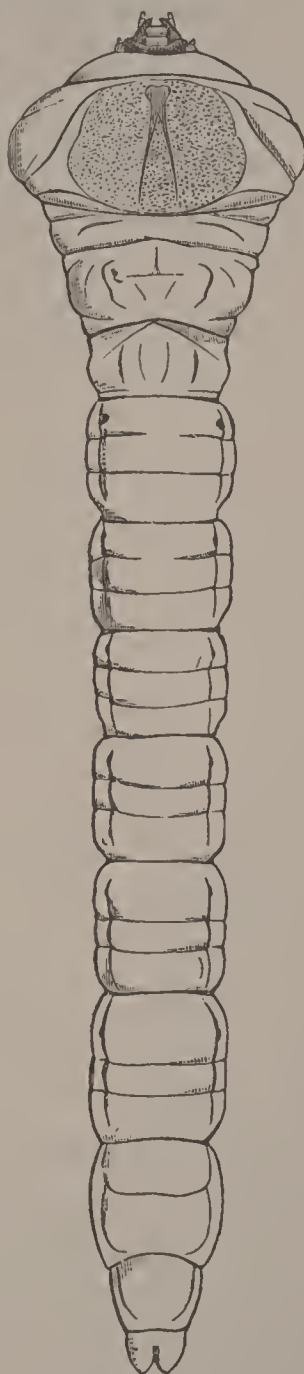
It mines extremely fine, slender, wavy passages in every direction, mostly in the wood. The eggs are laid so that the young grubs mine outwards, travelling away from each other.

In the bark beetles there are several males to one female at work in a mine. We now come to the true timber beetles, which sink their tunnels deep into the wood. Here the females are most numerous, and are probably not aided in their work by the males.

The *Tomicus materarius* is a line and a half long, and reddish-yellow in color. It makes a straight burrow, with regular secondary tunnels running out at right angles to the main one, somewhat as in Fig. 176. Its presence may be known by the clean white piles of borings it throws out of its hole.

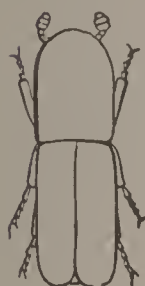
A very slender form is the wine cask borer (Fig. 177), which acts as a state constable, sily emptying the wine out of casks, or previously rendering them unfit for use by metamorphosing them into sieves through the transforming power of its jaws. To show how abundant these insects may become, a piece of elm three feet long, bored by the *Scolytus destructor* of Europe, was estimated to have contained 280,000 larvæ, while the *Tomicus monographus*, which does much mischief by drilling holes in malt-liquor casks in India, has been thought to bore as

FIG. 179.



A giant borer, natural size.

FIG. 177.



Wine cask borer, enlarged.

FIG. 178.



Chrysobothris larva.

many as 134,000 holes in the staves forming a single cask. These little beetles, when soft, fleshy grubs, are attacked by multitudes of the young of carnivorous beetles, such as *Staphylinus* and *Hister* and their allies.

Often in walking through the woods one's attention is attracted by large flakes of bark peeling off the trunks of pines. They are loosened by the gnawing teeth of grubs, such as are figured here (Fig. 178, a *Chrysobothris* larva, and 179,

the larva of *Euchroma columbica*, from Central America). It will be noticed that the body is broad and flattened just behind the hard, horny head, while behind the enlargement the body becomes narrow and cylindrical. It thus bores broad, shallow grooves between the bark and the solid wood, consuming the sap wood, the vital part of the tree.

Our largest and most abundant borer of this group is the *Chalcophora Virginiensis*. It is an inch or more in length, the body rough and hard and dark steel brown, with a brassy or coppery hue. It may be observed flying about on hot days in May and June, or sunning itself on the trunks of pine trees.

The grub forms a long, shallow groove, more or less serpentine in its course. As the young borer grows its track increases in width, which is stuffed with chips finely packed behind it. Finally when fully grown and ready to transform it bores a large oval hole deep in the wood, where the insect reposes during its pupal sleep. The insect lives one year as a larva.

Another species (*C. liberta*) is rather smaller, but very similar to the Virginian *Chalcophora*, and when at rest resembles the young fruit cones. The beetle itself eats the young buds of the pine. Pine saplings are much injured by the larval *Chrysobothris*, which girdles the trunks and branches.

When passing, in our strolls among the pines, some veteran tree whose days of usefulness have departed, and which already show signs of decay, our ears are often saluted with a harsh creaking noise issuing from the tree. The strain is intermittent and sometimes several voices join in a chorus of harsh, crepitant sounds. It is difficult at first to fix upon the exact site of the choristers, but on pulling off a piece of the bark, out tumble two or three large shining white worms, which tell the story. They are the young of the common

pine borer (*Monohammus notatus*), whose creaking noise we often notice in passing by piles of white pine wood, and sometimes hear issuing from some chair or table or chest of drawers, in which it has remained while they are passing through the saw mill and carpenter's shop on their way to the chamber or kitchen. Its mysterious creaking noise naturally occasions a good deal of speculation as to its source. One sometimes finds the beetle in sawn and planed lumber lying in its cell, or it may issue from the leg of a table or bureau drawer, with its long legs and horns like a ghost from another world, when its advent causes nearly as much of a flutter in the heart of the housekeeper as would the appearance of a veritable spirit.

I have found these larvæ in July in abundance, when they were a little over an inch long, and had apparently completed their first year. I was unable to find any beetles or chrysalides, and am disposed to think that they produced the noise by rubbing their hard, smooth, horny heads or jaws against the sides of their burrow. Dr. Fitch, however, states that the beetle itself makes the noise, and it is evident that both larva and beetle produce a similar sound. I will quote his statement entire. "On a still summer's night the peculiar grating or crunching noise which the larvæ make in gnawing the wood may be distinctly heard at a distance of eight or ten rods. That the insect does not open a passage out of the wood whereby to make its exit until it attains its perfect state, I infer from the fact that several of these beetles gnawed their way out of one of the pillars of the portico of a newly built house in my neighborhood, some years since, the noise being heard several days before they emerged, and whilst they were still at some distance in the interior of the wood."

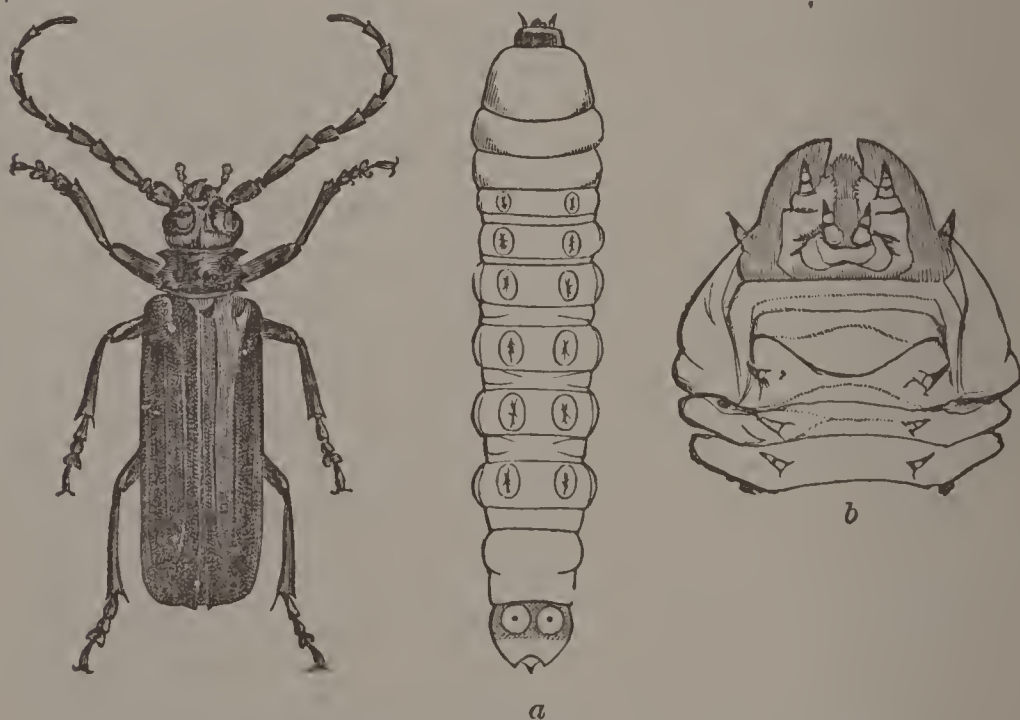
The grub is nearly cylindrical, white and soft, with numerous fine reddish hairs. The second segment of the body is flattened and larger than the others; the succeeding rings

are very short, with a transverse oval, rough space in the middle of the upper and under side of the body.

Its burrow is large, and winds around under the bark, finally sinking into the wood, where the grub undergoes its transformations into a beetle, which has remarkably long feelers, and is of a granite gray color. By its habit of tunnelling logs it is an annoying insect to lumberers, who remove the bark from the logs in order to free the wood from its attacks.

Similar to this beetle, with antennæ twice as long as its body, is a beautiful olive green species, with a white spot on

FIG. 180.



Orthosoma, grub, with head and thoracic rings enlarged.

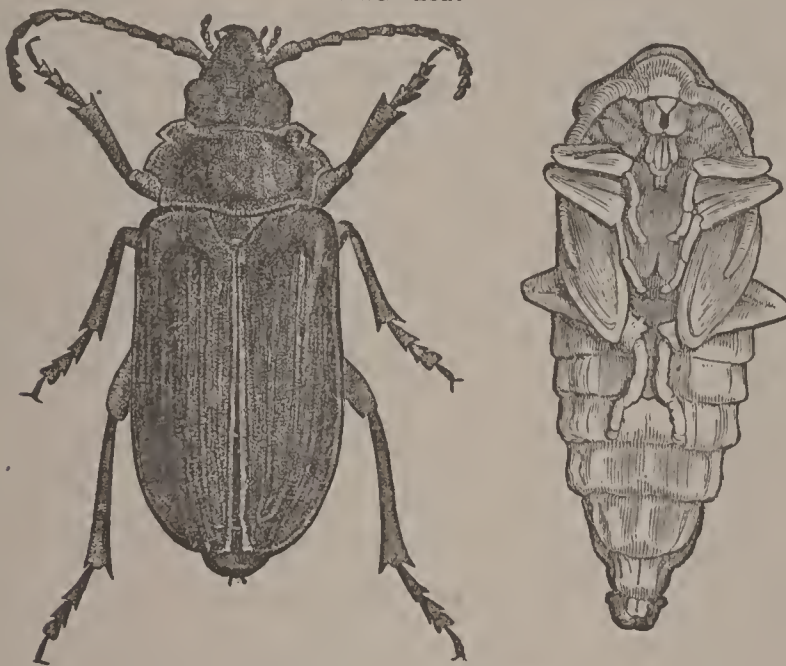
the scutel at the base of the wing-covers. It may be seen flying about white pine bushes in June, when it lays its eggs. It is particularly abundant in the woods around Lake Superior.

Somewhat related to these cylindrical-bodied beetles is the chestnut-colored *Orthosoma cylindricum* (Fig. 180; *a*, larva; *b*, head and thoracic rings), whose grub may often

be found in rotten pine stumps. The beetle itself occasionally enters our houses at night. Pine stumps are excellent breeding places for this and the borer of the large black *Prionus* beetle (Fig. 181, beetle and pupa), which occasionally leaves its native pine and cuts down our young plums, pear trees and grape vines.

As an example how forest insects may by their widespread ravages change the entire appearance of a landscape, I may cite the case of the injury committed one season in a growth of young pine saplings, or rather bushes, about six

FIG. 181.



Prionus and pupa.

feet high. For several square miles their tops had turned yellow, as if they were dying at the roots. But near the tops were exudations of pitch, forming large masses. On cutting these off, a little caterpillar was found in a hole beneath the pitch, and this was without much doubt the secret of the mischief. It seemed at the time impossible for one or two little caterpillars to do such injury to a large and flourishing bush. I have not since seen such an unusual fatality in young pitch pines, nor this caterpillar, and am now inclined to think that the mischief was produced by the

little caterpillar, the more since similar damage is caused to pine bushes in Europe by a little Tortrix, with similar habits.

A not uncommon sight in isolated pine trees is a nest of saw-fly caterpillars, whose sawdust-like castings form a large mass collected among the leaves. These "false caterpillars," as they are called, are social and live huddled up together on the end of a pine branch. Small trees are often ruined by them.

It always seems as if artificially planted forests suffer the most from the attacks of injurious insects. One of these saw flies, before unknown to science, has been found ravaging a plantation of young pitch pines on Cape Cod. By means of the saw-like ovipositor these curious flies are able to cut slits in the leaves and stems of plants. The present species (*Lophyrus pini-rigidi*) thus slits, and inserts an egg in each side of the needle of the pine. The males are easily distinguished from all other saw-flies by the beautifully pectinated antennæ and shining black bodies.

We could go on describing the insects injurious to our pine trees, but the enumeration would be tedious to the reader. About a hundred different species are known to prey on our native pines, and a number of them attack the imported ornamental pines and firs of our lawns. They attack the roots, the trunk, the leaves and the seed in the cones. M. Perris, a French naturalist, has written an extensive work on the insects of the maritime pine of France, describing with care a hundred species found on that tree alone; and not only the destructive kinds, but all the numerous parasitic and carnivorous forms which take up their abode beneath the bark of the tree and wage a ceaseless warfare against the primitive occupants. If any one would like to look behind the scenes and witness the struggle for existence going on under the bark of a pine tree, let him go to the woods for himself and study the various insects, in-

cluding many spiders, mites and thousand-legs which congregate in these retreats.

Now turning our steps towards the hard wood growths we shall find that the oak harbors a great number of insect inhabitants. We could enumerate from thirty to forty different kinds injurious to the oak in the northern states. The walnut is infested by a still larger number, fully seventy species. The elm struggles against the attacks of about twenty-five different kinds, while the locust and maple have a less number of species specially injurious.

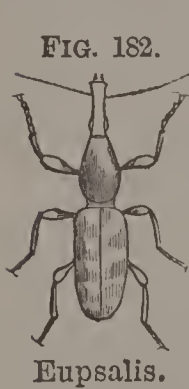
The oak suffers from the attacks of numerous gall-flies, which, not content with deforming the branches and leaves with unsightly tumors, sting even the roots, producing excrescences like ground nuts on the smaller rootlets. These little root gall-flies are wingless and look like little black ants. They are, strange to say, found only early in winter on the snow. They are rare and more curious than destructive.

If one will examine a pile of freshly cut red oak wood he will find the sticks of cord wood pretty thoroughly riddled with large holes and tunnels, nearly half an inch in diameter. This is the work of a large fleshy caterpillar, the young of the *Cossus*. It is the most destructive of all the insects feeding upon the oak, as after the worm is hatched,—and there are a good many of them, since the female lays about three hundred eggs,—they bore directly into the heart of the tree, leaving a passage for the rain and moisture, which aid in the work of destruction. The caterpillar is thought to be three years in attaining its full size, its life being an unusually long one, as few caterpillars are known to live longer than one season. It also infests the locust tree.

If a favorite shade tree has been attacked, the best way to prevent farther mischief is to soap the trunk in June and July, and thus prevent the moth from depositing its eggs, or after the holes appear to plug them up in order to keep the water out.

Another borer is the Brenthian weevil (*Eupsalis minuta*, Fig. 182). By means of its long snout, armed with short, stout jaws at the end, it bores a hole through the bark, inserts an egg, and the grub hatching out bores into the solid wood, finally making a burrow about a tenth of an inch in diameter.

Mr. Riley has described and figured, in his "Sixth Report on the Noxious Insects of Missouri," the transformations of this interesting beetle. He draws attention to the combative nature of the males in the following words. "The males of the Brenthians are known to fight desperately for the female, and, as it has been remarked by Mr. A. R. Wallace,* it is interesting, 'as bearing on the question of sexual selection,

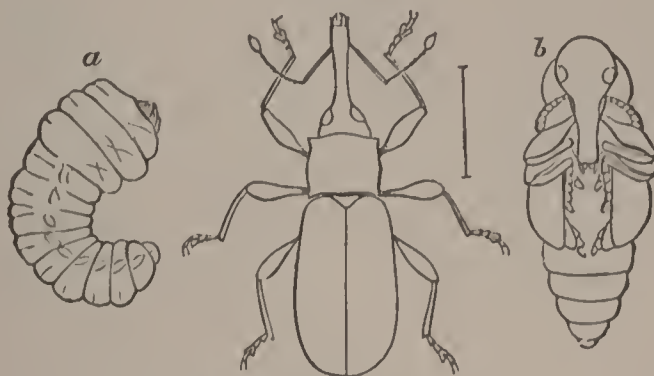


that in this case, as in the stag beetles, when the males fight together, they should not only be better armed, but also much larger than the females.' The eggs are deposited during the months of May and June, and perhaps later, the female boring a cylindrical hole with her slender snout, and therewith pushing her egg to the bottom of the hole, as is the habit of all snout beetles. Mr. Howard thus describes his own observations on these insects. 'It requires about a day to make a puncture and deposit the egg. During the time the puncture is being made, the male stands guard, occasionally assisting the female in extracting her beak; this he does by stationing himself at a right angle with her body, and by pressing his heavy prosternum against the tip of her abdomen; her stout forelegs serving as a fulcrum, and long body as a lever. When the beak is extracted, the female uses her antennæ for freeing the pinchers or jaws of bits of wood or dust, the antennæ being furnished with stiff hairs, and forming an excellent brush. Should a strange male approach, a heavy contest at once ensues, and continues until one or the other

*The Malay Archipelago, p. 482.

is thrown from the tree. The successful party then takes his station as guard. These contests sometimes last for hours, and are always repeated if the proper male is defeated, though not often if he is successful. I think it is by mere 'happen so' that the stranger passes by or runs across the busy couple, and if successful in routing his rival he takes the same care of the female as did the vanquished individual. The habits of these insects are much like those of the Curculio family. When disturbed they fold themselves up as well as they can and drop to the ground, where they

FIG. 183.



Oak weevil and young.

feign death. They will soon 'come to,' and hide beneath pieces of bark, stones or other rubbish, Curculio-like."

Another weevil, which may be found in all its stages of larva, pupa and adult, early in May under the bark of decaying oaks, is the *Magdalinus olyra* (Fig. 183; *a*, larva; *b*, pupa, enlarged three times).

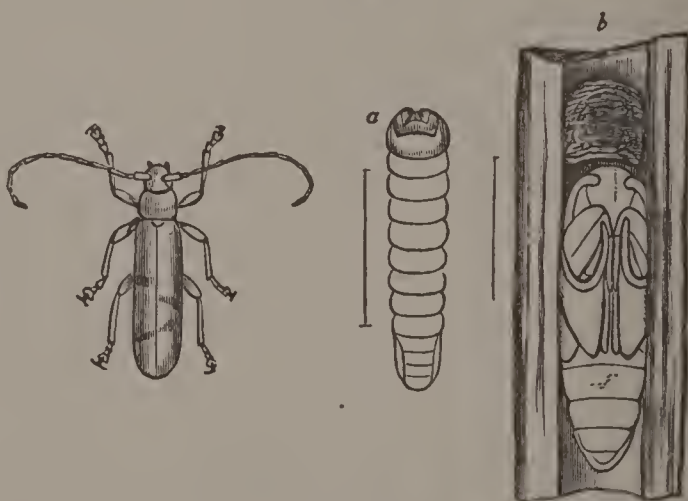
The most interesting and intelligent of all the borers is the oak Pruner (*Stenocorus putator*, Fig. 184; *a*, larva; *b*, pupa lying in its hole). The beetle appears in June and deposits its eggs near the axilla of a leaf stalk or small twig, or in the bark of larger branches. The grub hatches, and sinks into the centre of the twig. Now comes the strange part of its history, in which this grub evinces a most unusual trait in these boring insects. When half grown it nearly cuts the branch off. It then withdraws

into the hole in the portion of the branch beyond the cut, and plugs up the opening behind it before the limb is broken off by some strong wind and falls to the ground.

But as I am already indebted to Dr. Fitch for most of the facts regarding this intelligent insect, I will let him tell them in his own words.

“The worm being about half grown is now ready to cut the limb asunder. But this is a most nice and critical operation, requiring much skill and calculation, for the limb

FIG. 184.



Oak Pruner.

must not break and fall whilst he is in the act of gnawing it apart, or he will be crushed by being at the point where it bends and tears asunder, or will fall from the cavity there when it breaks open and separates. To avoid such casualties, therefore, he must, after severing it, have time to withdraw himself back into his hole in the limb and plug the opening behind him, before the limb breaks and falls. And this little creature accordingly appears to be so much of a philosopher as to understand the force of the winds and their action upon the limbs of the tree, so that he can bring them into his service. He accordingly severs the limb so far that it will remain in its position until a strong gust of wind strikes it, whereupon it will break off and fall.

“But the most astonishing part of this feat remains to be

noticed. The limb which he cuts off is sometimes only a foot in length and is, consequently, quite light; sometimes ten feet long, loaded with leaves, and very heavy. A man by carefully inspecting the length of the limb, the size of its branches, and the amount of foliage growing upon them, could judge how far it should be severed to insure its being afterwards broken by the winds. But this worm is imprisoned in a dark cell only an inch or two long, in the interior of the limb. How is it possible for this creature, therefore, to know the length and weight of the limb, and how far it should be cut asunder? A man, moreover, on cutting a number of limbs of different lengths so far that they will be broken by the winds, will find that he has often miscalculated, and that several of the limbs do not break off as he designed they should. This little worm, however, never makes a mistake of this kind. If the limb be short, it severs all the woody fibres, leaving it hanging only by the outer bark. If it be longer, a few of the woody fibres on its upper side are left uncut in addition to the bark. If it be very long and heavy, not more than three-fourths of the wood will be severed."

"Having cut the limb asunder so far that he supposes it will break with the next wind which arises, the worm withdraws himself into his burrow, and that he may not be stunned and drop therefrom should the limb strike the earth with violence when it falls, he closes the opening behind him by inserting therein a wad formed of elastic fibres of wood. He now feeds at his leisure upon the pith of the main limb, hereby extending his burrow up this limb six or twelve inches or more, until he attains his full growth, quietly awaiting the fall of the limb, and his descent therein to the ground. It is quite probable that he does not always sever the limb sufficiently in the first instance for it to break and fall. Having cut it so much as he deems prudent, he withdraws and commences feeding upon the pith of the limb

above the place where it is partially severed, until a high wind occurs. If the limb is not hereby broken, as soon as the weather becomes calm he very probably returns and gnaws off an additional portion of the wood, repeating this act again and again, it may be, until a wind comes which accomplishes the desired result. And this serves to explain to us why it is that the worm severs the limb at such an early period of his life. For the formidable undertaking of cutting asunder such an extent of hard woody substance, we should expect he would await till he was almost grown and had attained his full strength and vigor. But by entering upon this task when he is but half grown he has ample opportunity to watch the result, and to return and perfect the work if he discovers that his first essay fails to accomplish the end he has in view.

“Thus the first part of the life of this worm is passed in a small twig branching off from the main limb. This is so slender and delicate that on being mined as it is by the worm and all its green outer end consumed, it dies and becomes so decayed and brittle that it is usually broken off when the limb falls, whereby it has escaped the notice of writers, hitherto. The remainder of his larval life is passed in the main limb, first cutting off this limb sufficiently for it to break with the force of the winds, and then excavating a burrow upwards in the centre of the limb, both before and after it has fallen to the ground, feeding hereon until he has grown to his full size.”

Fitch adds that “not only the limbs, but small young trees, at least of the white oak, are sometimes felled by these insects; in which cases the worm instead of cutting the wood off transversely, severs it in a slanting or oblique direction, as though it were aware the winds would prostrate a perpendicular shoot more readily by its being cut in this manner.”

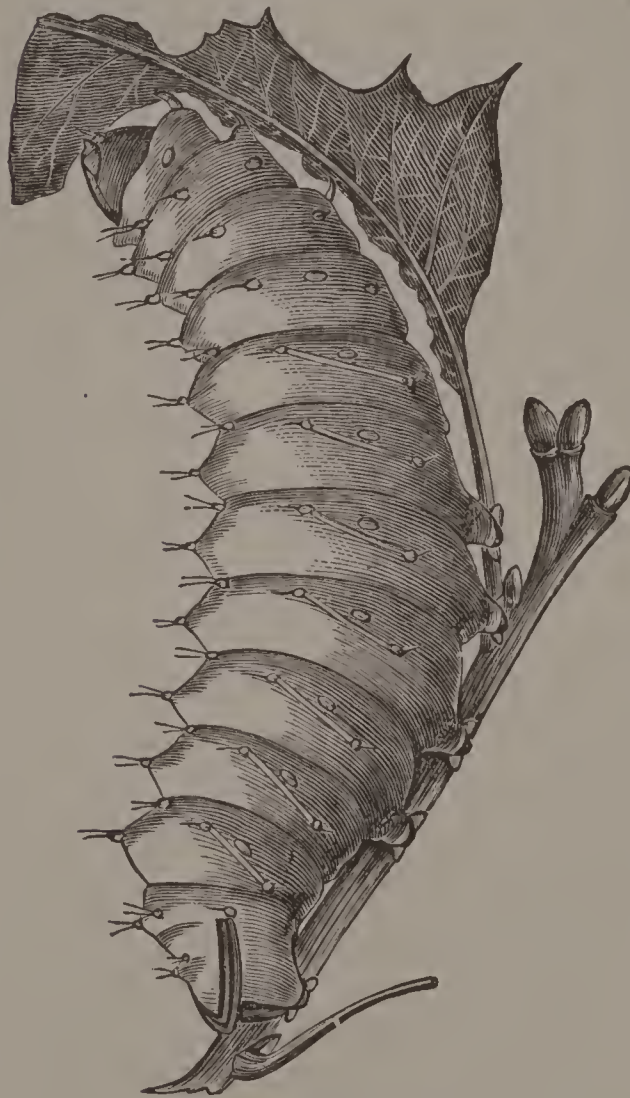
The larvæ become fully grown in the autumn, and some

change to pupæ in the autumn, while others wait till the following spring. The beetle appears in June.

Now in the remarkable habits of these insects, we find a variation in their mode of working corresponding to some difference in the size and nature of the branch in which they live. This is something quite different from the blind, unvarying instinct usually ascribed by the unthinking to the lower animals. The oak pruner selects a fitting place in which to lay its eggs, and because it does so for generation after generation, no one can deny that there was not a time when this habit was in process of formation, and gradually established after a course of experiments continued through, perhaps, many generations. Again, the borer itself is not entirely the creature of circumstances; there is some room left for the exercise of what we may call judgment. The incision it makes in the branch varies in depth with the size of the branch, and it must exercise a certain, be it a minimum, amount of reason to adjust its life with the physical forces about it, in order that the life of the species may be maintained. Doubtless it makes many mistakes, many branches falling too soon or not falling at all; many deaths occurring from these mistakes. Unfavorable seasons, calm weather, a too dry or too moist atmosphere, its parasites, all conspire to reduce its numbers and render its struggle for bare existence exceedingly precarious. But this is the history of every species of animal. The life of each species is a record of mistakes, and disease and often death in consequence of those mistakes. And turning to the human species, the philosophic historian of his race is forced to confess that it is often by their misfortunes that races as well as individuals of marked individualism have moulded their characters. We submit, then, that these unusual instinctive acts of the oak pruner have been in all probability gradually acquired, after many trials, mistakes and failures, until the peculiar habits distinguishing this species from its allies

have become moulded into a comparatively inflexible mode of life, when the creature is governed by what commonly goes under the name of "instinct," a term too frequently used to cover our ignorance and stifle free inquiry into the

FIG. 185.



American Silk Worm.

origin of the different psychological traits of different races of animals.

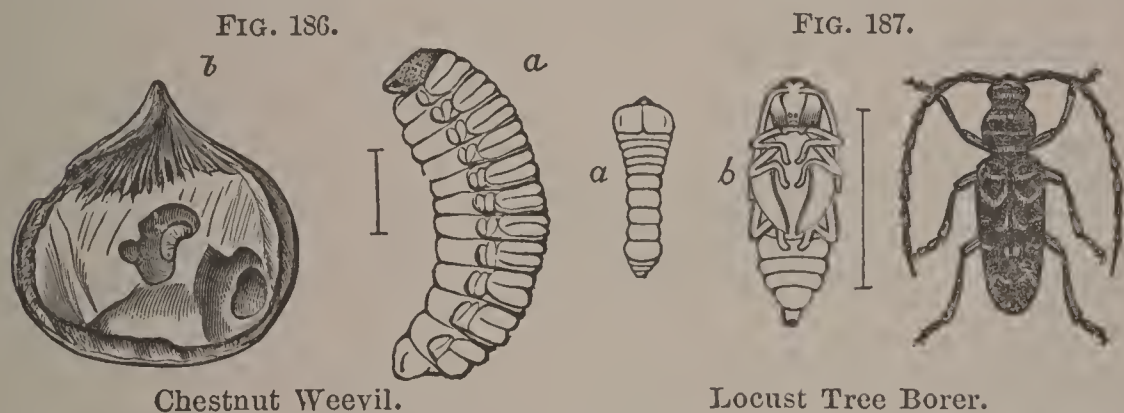
The leaves of the oak are often ravaged by the young of the senatorial moth, a gayly caparisoned caterpillar, with two horns arising directly behind the head. It is nearly two inches in length, black, with four yellow stripes along the back, and two on each side. It lives in clusters on the trees, sometimes well nigh stripping them of leaves in September and October, the large, handsome moth appearing in July.

Many pretty and curious moths pass their preparatory stages of existence on the oak, and it is the food plant of the American silk worm (Fig. 185). The acorn is infested by the grub of a long-snouted weevil, like that which infests the chestnut (Fig. 186). Riley finds that in the Western States this grub so infests the acorns or mast as to diminish seriously the crop which is largely fed to swine.

To show the economy of nature and her care not to waste

material, we may refer to the case of the tiny acorn moth, which Mr. Riley tells us takes up its abode in the deserted, worm-eaten acorn, feeding upon the crumbs left by the young weevil. The caterpillar "secures itself against intruders by closing with a strong covering of silk the hole which its predecessor had made in its egress."

The locust tree has, among a dozen or more insects known to prey upon it, been nearly exterminated by the well-known "borer." The beetle (Fig. 187, *Clytus robinia*; *a*, larva; *b*, pupa) is known by its bright yellow trappings, and the yellow W on the base of its wing-covers. It is very abundant on the flowers of the golden rod in September. The beetle lays its eggs on the bark and the young borer



makes its way under the bark upwards into the wood, ejecting the chips and castings through an orifice in the bark. Eternal vigilance should be the watchword in dealing with the locust borer. Its presence may always be known by the little pile of dust at its door, and a wire thrust up its burrow will destroy the worm. It would be an excellent plan to have a growth of golden rods near the locust grove. These will toll the beetles in great numbers, when they can be plucked off and destroyed. In the middle states the locust, which there thrives better than in the north, is often defoliated by a leaf-mining beetle, a kind of *Hispa*.

But the pride of our lawns and roadsides is the elm. This tree we regard with a special reverence. Not so the

insects, for they war upon it with a savage disregard of the proprieties of life. The plant lice infest it by millions, puncturing the leaves with their tiny beaks, curling them up and transforming the originally beautiful foliage into an unpleasing mass of crumpled leaves, alive with moving parasites. Then comes the squads of canker worms, which speedily convert the umbrageous tops into a naked mass of limbs, the ghosts of their former selves. While this work is going on, and the tree, deprived of its lungs the leaves, is, as it were, at its last gasp, industrious borers of different patterns are laying out their streets tunnelled beneath the bark, like sappers and miners, preparing for the destruction of the entire fabric.

The canker worm infests the elm, and sometimes injures it as much as the apple. We have already studied its habits

FIG. 188.



The Snowy Angle-wing.

and will turn to another geometrid caterpillar, which so far as regards its destructive habits replaces in New York and Philadelphia the canker worm of Boston. It is wide-spread, however, over the country. I have found it in the wilds of northern Maine, but it is only known to me to abound in exces-

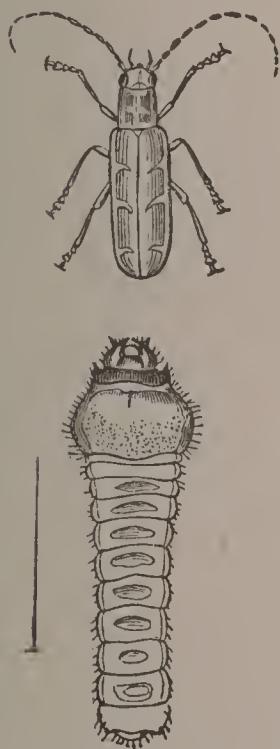
sive numbers in the cities just mentioned.

The caterpillar, though confounded with the canker worm, is quite different in its physiognomy, having a large red head, while the body is wood colored, but red again at the end. The moth (Fig. 188), which may be called the snowy angle-wing, in allusion to the snow-white angular wings, flies about in the woods in July and August, when it lays its eggs. In the city of New York the caterpillars hatch as soon as the leaves unfold in the spring, and for a week or

two they live unobserved among the topmost shoots, and are not usually detected until half grown. Towards the end of June they descend to the ground and transform to chrysalides, and in about a week after the moth appears.

The most formidable borer of the elm tree is the three-toothed Compsidea (Fig. 189, beetle and larva). It consumes the inner bark and sometimes girdles the tree so as to suddenly kill it. The female lays her eggs in June on the trunk of the tree. The worms attain maturity in the

FIG. 189.



Elm Tree Borer.

FIG. 190.



Short lined Elm Borer.

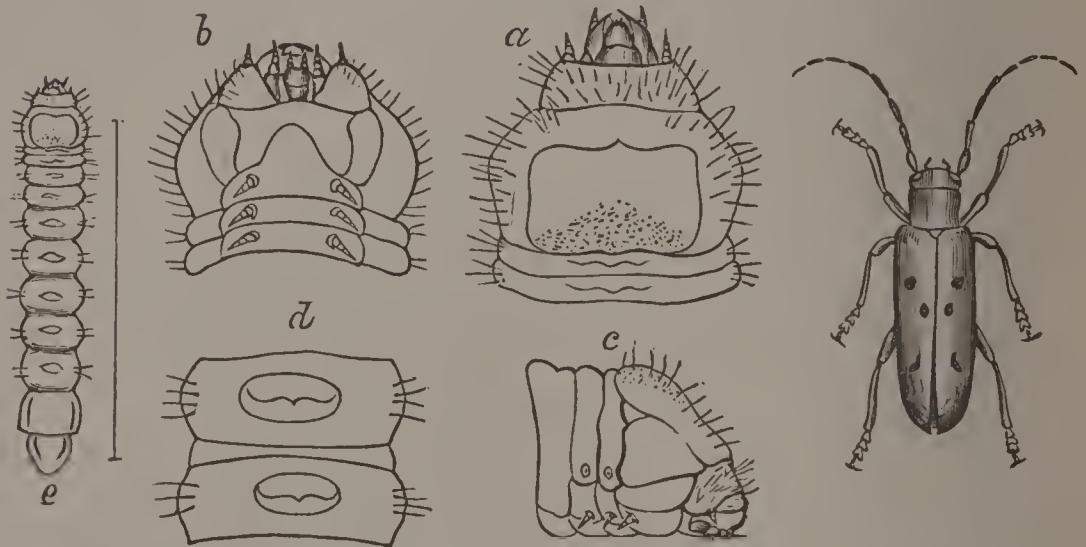
autumn of the third year succeeding, when they may be found under the bark. Another elm tree borer, but not as yet known to be at all common, is the short lined *Physocnemum* (Fig. 190).

Closely allied to the elm tree borer is the linden tree borer (Fig. 191, *Saperda vestita*, with its larva; *a*, *b*, *c*, different views of the head; *d*, body segments, enlarged). It perforates the linden tree, while the poplar is infested by

another species (Fig. 192, *Saperda calcarata*; *b*, upper and *c*, under side of the head, enlarged), one of our finest long-horned beetles.

Among other beetles found on the leaves of the elm are the European Calmar leaf beetle (*Galeruca calvariensis*). It is about the size of the common striped squash beetle, but grayish yellow, with three black spots on the thorax and a broad black stripe on the outer edge of the wing covers, with a small oblong spot near their base. Then there is the common Prussian blue flea beetle (*Haltica chalybea*, Fig.

FIG. 191.



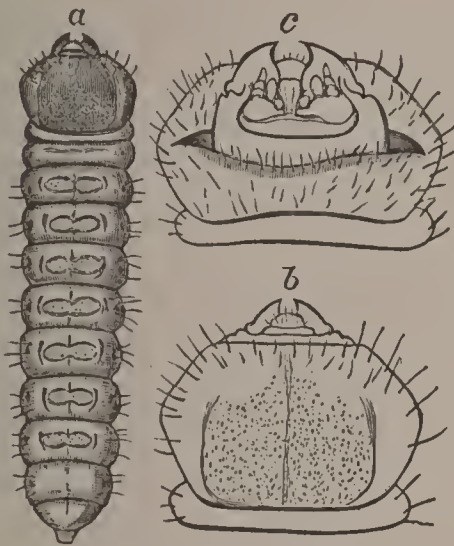
Linden Tree Borer and Beetle.

193), often occurring in great numbers on the leaves, and the Cotalpa beetle (see Fig. 21), which sometimes steals a few leaves.

The maples are unusually free from noxious insects. Young saplings are sometimes cut down in their prime by certain Buprestid borers, and the trunks are often riddled with the large holes made by the Tremex or horn-tail. This fine saw-fly may be found in maples, as well as elms and other trees, in all stages of growth in the autumn, the large, soft, white, fully grown larvæ, whose bodies terminate in a horny hook, occurring with the pupæ and the flies them-

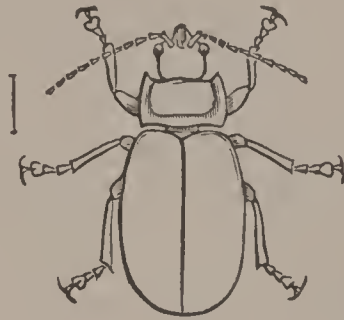
selves, which are found from July until October. It is probable that some of the flies may hibernate in their holes, as they were found in the tree as late as October. By means of her enormous saw or ovipositor, which she drives to the depth of half an inch through the bark into the wood, the female effects a safe lodgment for her eggs. They are apt to be social, and one may often see large numbers of them around a favorite tree, riddled with their holes, in some place previously wounded and deprived of the bark. Maples are

FIG. 192.



Poplar Tree Borer.

FIG. 193.



Flea Beetle.

sometimes killed by a beautiful *Ægerian* moth, which bores into the living trees.

Several of our most common and beautiful moths, as caterpillars, prey on the maples, from the minute *Tineids* up to the large rubicund *Dryocampa* and the *Io* moth (Figs. 64, 65). The leaves are sometimes mined by minute moths allied to our clothes moths. These little caterpillars are often flattened and in other ways curiously adapted for their life between the thin walls of their abode. The number of these mining moths is exceedingly great, and if any one could be found to devote his leisure to rearing them, and observing with care (note book in hand) their habits, he would confer a benefit to science. Nowhere more than

in these small neglected forms do we want a large number of observers. It would be an admirable subject of study for ladies, as the leaves containing them can be easily gathered, and if laid on wet sand in airy boxes or jars, the moths can be bred with much less trouble than the larger species.*

The walnut and hickory entertain a larger host of insect pests than any other deciduous tree; some seventy species are already known to draw their supply of food from these noble trees. Our black walnut wood comes from the western states, particularly Indiana, where the tree grows in the greatest perfection. It is estimated that within so short a period as ten years from the present date, the supply of black walnut lumber will be materially diminished. It is even now time to be planting groves of these precious trees in the western states. When they are in course of cultivation we can, in the imagination, if a scientist may be allowed to use that potent weapon, see the entomological evils which will cluster about those groves: a hundred different sorts of insects, represented by thousands of individuals, laboring away at root, branch, leaf, bud and fruit, unwittingly destroying the sapling, while securing their own means of livelihood.

Not to bore the reader with dry accounts of the beetles which occur in the walnut, we would allude to the tigrine Goës, which does the most serious damage to the trunks, as it bores large holes in the solid wood, lengthwise to the tree. The grub is rather large, cream-colored, with the head and the segment next to it yellowish. The beetle is a longicorn—we are now pretty familiar with the appearance of these longicorns with their remarkably long antennæ—and is brown, covered with a dense tawny pubescence, with a broad dark band beyond the middle of the wing covers, and

*Full directions for rearing caterpillars may be found in "Directions for collecting and preserving Insects," prepared for the use of the Smithsonian Institution by the writer.

another at their base. It is an inch in length, and is a common inhabitant of the hickory and walnut.

The locust tree borer also infests the hickory, and it is a curious fact that while the individuals which live in the locust tree appear as beetles in September, those which come from the hickory, though not differing specifically, appear in June, three months earlier.

The hickory girdler (*Oncideres cingulatus*,* Fig. 194) partially repeats in its singular habits those of the oak pruner. I will not attempt to condense Professor Haldeman's account of this insect, simply begging to differ from the writer's belief that the habit, unusual as it is, could never have been acquired. Until we know more of the habits of these *Oncideres*, and there are a number of other species of this and closely allied beetles in Central and South America, we are hardly in a position to deny but that there may be other species with quite similar habits, which in their turn may be related to still other forms which may exhibit traits intermediate between the girdler and the average longicorn beetle. It is only by comparing the intellectual acts of a long series of closely allied species that we shall be able to ascertain what is exceptional, and possibly be able to get a glimpse at the origin of such exceptional habits. It is for this reason that the study of the habits of our common, noxious insects will have a double value, an economic one and a philosophical one. They are so numerous that we can never be at a loss for material on which to make our observations and experiments.

“In our walks through the forests our attention was fre-

*By a mistake, owing to the slipping of the bark after drying from each side of the notch, the incision is wrongly represented; the cut should be represented as somewhat square in outline.

FIG. 194.



The Girdler.

quently drawn to the branches and main shoots of young hickory trees (*Carya alba*), which were girdled with a deep notch, in such a manner as to induce an observer to believe that the object in view was to kill the branch beyond the notch, and extraordinary as it may appear, this is actually the fact, and the operator is an insect whose instinct was implanted by the Almighty power who created it, and under such circumstances that it could never have been acquired as a habit. The effect of girdling is unknown to the insect, whose life is too short to foresee the necessities of its progeny during the succeeding season."

"This insect may be seen in Pennsylvania during the two last weeks in August and the first week in September, feeding upon the bark of the tender branches of the young hickories. Both sexes are rather rare, particularly the male, which is rather smaller than the female, but with longer antennæ. The female makes perforations in the branches of the tree upon which she lives (which are from half an inch to less than a quarter of an inch thick), in which she deposits her eggs; she then proceeds to gnaw a groove of about a tenth of an inch wide and deep around the branch, and below the place where the eggs are deposited, so that the exterior portion dies, and the larva feeds upon the dead wood and food which is essential to many insects, although but few have the means of providing it for themselves or their progeny by an instinct so remarkable."

"Where this insect is abundant, it must cause much damage to young forests of hop-holes by the destruction of the principal shoot."

A wood engraver plies its trade of scoring the trees beneath the bark. This is the *Scolytus caryæ*, whose habits have been well described by Mr. Riley. In Illinois, during a period of about ten years, it destroyed "many hundreds of fine young trees." Mr. Bryant writes that "it has sadly thinned my beautiful grove, and bids fair to destroy all the

hickory trees in it." Mr. Riley adds, "the beetles issue the latter part of June and fore part of July. Both sexes bore into the tree, the male for food and the female mostly for the purpose of laying her eggs. In thus entering the tree, they bore slantingly and upward, and do not confine themselves to the trunk, but penetrate the small branches and even the twigs. The entrance to the twig is usually made at the axil of a bud or leaf, and the channel often causes the leaf to wither and drop, or the twig to die or break off.

"The female in depositing confines herself to the trunk or larger limbs, placing her eggs each side of a vertical chamber, as described by Mr. Bryant. Here she frequently dies, and her remains may be found long after her progeny have commenced working. The larvæ bore their cylindrical channels, at first, transversely and diverging, but afterward lengthwise along the bark, always crowding the widening burrows with their powdery excrement, which is of the same color as the bark. The full-grown larva is soft, yellowish, and without trace of legs. The head is slightly darker, with brown jaws, and the stigmata so pale that they are with difficulty discerned. It remains torpid in the winter, and transforms to the pupa state about the end of the following May. The pupa is smooth and unarmed, and shows no sexual differences. The perfect beetle issues through a hole made direct from the sap-wood, and a badly infested tree looks as though it had been peppered with No. 8 shot. The sexes differ widely from each other, the male having spines on the truncated portion of the abdomen, not possessed by the female. The eggs are deposited during the months of August and September, and the transformations are effected within one year, as no larvæ will be found remaining in the tree the latter part of July."

The chestnut tree is sometimes infested by the Shining *Arrhopalus* (Fig. 195). Except the fact that it has been taken from the chestnut tree, I know nothing further con-

cerning its habits, nor of the appearance of its grub. The beetle itself is blackish brown, with slight, dark blue reflections. The top of the head and the sides of the prothorax

FIG. 195.



The Shining Arrhopalus.

and under side of the body are covered with short, fine gray hairs, and there are silvery w-like markings on the wing-covers.

We have thus seen what a force in the world these beetles are. Their work is done slowly but effectively, and their gnawing teeth, though slow in action, are as resistless as the "mordant tooth of time." Beetles have in fact well earned the right to have engraved on the escutcheon of their order the old saying: *Scarabæus aquilam quærit*.

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