SHADE TREE INSECTS

. . . LESSON NUMBER TEN . . .

PART I.

BORERS

JOHN DAVEY
"FATHER OF TREE SURGERY"

NOTE TO STUDENTS: It is important that the Tree Surgeon should not only know when a tree needs his technical skill in removing decay and repairing injuries, but he should also be able to quickly detect the presence of any agency liable to injure or kill the tree.

In the last lesson you studied the fungous and similar diseases tending to injure or kill shade trees, but the insects, one of the commonest causes of disease as there defined, were considered of too great importance to be treated at that time.

The present lesson is the introduction to this very important subject, and will consider the borers, or those insects which burrow under the bark or into the harder parts of the trees. Their habit of working entirely within the tree makes them very hard to control, and they frequently cause serious injury before even their presence is suspected within the tree.

The control of the borers is such a difficult problem that few entomologists have given it the attention that it deserves; consequently, the literature on the subject is widely scattered, and much of it is very unreliable. For this reason a full lesson will be devoted to this important subject, and the other shade tree insects will be left for the next lesson. The fruit insects will be considered under the subject of fruit growing.

The science of economic entomology, to which you are introduced in this lesson, is so vast and so important that most of your information must come from your text books and from the references furnished you. All that can be done in the lessons is to consider a few of the more important and representative species, and those with which you are most liable to have to deal in your future work as Tree Surgeons. By having a thorough understanding of these, you will also be able to deal successfully with the other related species when you meet them.

INSECTS

1. The insects, or the six-legged animals comprising the Class *Insecta*, are the most highly developed of the invertebrate animals. They include the smallest of the walking animals, and a greater variety of forms than all the rest of the animal kingdom combined. Man can learn many valuable sociological lessons by a careful study of some of these forms.

2. It has been estimated on good authority that fully ten million species will be represented before the insect life of the earth is fully explored. New species are being described and named at the rate of about 10,000 a year, and the richest collecting grounds have hardly been touched. The total number named is rapidly approaching a million.

3. Fortunately but a very small part of these are injurious, and many are beneficial. The American insects of special economic importance would hardly reach a thousand, and a tenth of these are responsible for the billion dollar loss sustained by the United States each year. Even ten of them are responsible for a loss each year greater than the total expense for the maintenance of the United States Department of Agriculture and all the experiment stations.

4. This will give you an idea of the enormous loss that these pests are capable of inflicting, and will help you to see the great importance of knowing the more important insects that work on our shade trees.

5. To control these pests, you must know their habits, the part of the trees attacked, the time when they are the most easily killed, the proper remedy to use, and the effect of the remedy upon the tree and upon the pest. This knowledge can come only by thorough study, hard work, close observation, and practical experience.

6. It would be helpful at this time to consider the structure and habits of the different types of insects, but this can be easily secured from your text books and general references on the subject.

CLASSIFICATION

7. For convenience in studying them, the insects will be classified according to the nature of the injury which they inflict upon the trees. But to a certain extent this will also classify them ac-

cording to orders and families to which they belong, for the reason that similarity of habits means a similarity in structure, and similarity in structure is the basis for the natural classification used in grouping and naming insects.

8. Classed according to the nature of the injury they inflict, the injurious insects fall into the following four classes:

Borers, or those insects that work under the bark, either in the adult or larval stage, and the subject of this lesson.

Leaf Feeders, or the insects that feed upon the leaves, either in the adult or larval stage, and consume all or part of the tissue of the leaves. This includes the eating insects, the leaf miners, skeletonizers, case bearers, etc.

The Sucking Insects, or those that secure their food by puncturing the tissue and sucking the juices, whether from the bark, leaves or fruit.

The Gall Insects, or those that cause abnormal growths on the different parts of the tree as a result of the injury inflicted. This class contains representatives from nearly every order of insects. It contains a great variety of forms, of which comparatively little is known, especially regarding the methods of control. They may affect the leaves, twigs, bark, flowers, fruit or roots.

BORERS

9. From the nature of the injury they inflict, and their habit of working under the bark or within the wood, the borers are the most difficult, of the serious shade tree insects, to control. In some cases the larvæ live within the tree for three or more years. This makes it difficult if not impossible to study their habits, and also protects them to a great extent from their natural enemies.

10. For the most part, the borers are scavengers, living on dead or decaying wood, and are an efficient help to the saprophytic fungi in reducing waste material to its natural elements, ready to be worked over again by other living organisms. In this way some of the borers are a great benefit.

11. Unfortunately, however, some of the borers, in working in decaying trees, came too near to the living tissue, and so developed a taste for the fresher living wood. From these a few species

have developed which will attack and kill living trees, and in a few cases species which will attack and kill or seriously injure trees in apparently good health. In this they are very similar to the parasitic and saprophytic fungi. Many of them cannot cause injury until they get started through a wound, or until the vitality of the tree has been weakened by some other cause.

12. Among the borers you will find a smaller per cent. which can successfully attack a tree in perfect health than in any of the other classes of the injurious insects. In most cases the eggs are laid upon the bark, and when the minute larva crawls out of the shell it begins to burrow into the tree. The entrance is so small that it is hard to find, and the larva is quickly buried where it can carry on its destructive work unobserved. However, if the tree is in vigorous health, when the robber reaches and injures the cambium layer, this starts a flow of sap that drowns out the intruder. In some cases the healing is sufficiently rapid so that the burrow is closed faster than the larva can make it, and the pest is buried in a grave of its own digging.

13. Anything tending to check the growth of the trees makes it easier for the borers to become established, and, if sufficiently abundant, to cause serious injury. Under the right conditions, a few dying trees can produce borers in such vast numbers that they cannot find enough dead or dying trees for their food; consequently, they must attack healthy trees or perish.

14. Under city conditions, for this reason, you will meet with serious injury done to shade trees by species that would be harmless under forest conditions, owing to the adverse conditions under which these city trees must struggle for an existence. Keep this thought in mind, therefore, both when working with the trees and when studying the literature on insects. Many of these species with which you will have to deal have, up to this time, been studied only from the forester's standpoint.

15. Remember, that city trees are very largely deprived of the natural protection afforded the forest trees by the birds and other natural enemies of the insects. Remember, too, that city trees must frequently struggle against insufficient sunlight, food and water. Their roots are also frequently buried beneath asphalt pavements and cement sidewalks, which keep away the fresh water and the invigorating gases brought down with the rain. City trees are also subjected to the severe slashing of the contractors

and linemen in laying foundations or pavements, and in stringing telephone wires through the streets.

CONTROL

16. Although the borers do a great amount of injury to our trees each year, very little thorough work has been done to determine satisfactory methods for their control. The problem is so difficult, and the prospect of obtaining satisfactory results is so small, that few entomologists have been tempted to undertake the work. It is much easier to guess at the remedy, to advise a remedy used for a similar insect, or to shift the responsibility altogether and follow the recommendations of the earlier writers.

17. To judge correctly the value of the methods of control generally in use today, it is necessary to trace these methods back through the literature and see whether they are based upon careful observations or experiments, or simply given first as a guess and later quoted as a fact.

18. The following quotations of remedies suggested for the control of the elm borer will serve as an illustration of the development of some of the remedies still in use:

19. 1905, Felt. "The badly infested portion should be cut away and the grubs destroyed, and where a few are working in living bark it might be well to remove the upper layers till the grubs are nearly exposed, and then brush over the shaven surface with strong kerosene emulsion or whale-oil soap solution, finally covering the wound with a paste formed of a mixture of fresh cow-dung and lime."

20. 1893, Lintner. "Remove the outer bark from the entire infested portion of the tree in the spring by shaving it down to the inner bark until the first indications of the fresh burrows are disclosed. A kerosene emulsion of good strength brushed over the shaven surface would kill the insects, after which a coating of some thick substance, as lime and cow-dung, should be applied to prevent the splitting of the sap-wood from exposure to the sun, drying winds or extreme weather."

21. 1880. The use of kerosene emulsion as an insecticide was discovered about 1880 by the United States Department of Agriculture, consequently is a recent addition to the remedies.

22. 1848. Robert (France). "Strips about two inches wide were cut out of the bark from the large boughs down the trunk to

the ground, and it was found that where the young bark pressed forward to heal the wound and a vigorous flow of sap took place, many of the maggots near it were killed; the bark which had not been undermined was consolidated, and the health of the tree was improved."

23. Using this as a basis, he tried a more extensive experiment by "paring off the whole of the rough outer bark from 2,000 elms with a scraping-knife shaped like a spoke-shave. This operation caused a great flow of sap in the inner lining of the bark, and the grubs of the *Scolytus* beetle were found in almost all cases to perish shortly after."

24. 1842, London Botanic Society. A similar treatment was given to elms encircling their garden in the Regent's Park, London. "It consists in divesting the tree of its rough outer bark, being careful at the infested parts to go deep enough to destroy the young larvæ, and dressing with the usual mixture of lime and cow-dung."

25. The "usual mixture" is probably the following "Forsyth's Composition," or a modification of it. The directions for preparing this were given under oath at the Land Revenue office, in Scotland Yard, the 11th day of May, 1791. They are as follows:

26. 1791, Forsyth (England). "Take one bushel fresh cow-dung, one-half bushel lime rubbish from old buildings, one-half bushel wood ashes, one-sixteenth bushel pit or river sand. The last three are to be sifted fine before they are mixed. Then work them well together with a spade, and afterward with a wooden beater, until the stuff is very smooth, like fine plaster used for the ceilings of rooms."

27. Soapsuds or urine were used to make this "composition" of the consistency of wet plaster or paint. The composition was also valued as a filling for cavities in trees.

The following is still earlier, but along the same line:

28. 1629, Parkinson (England). "The canker is a shrewd disease when it happeneth to a tree; for it will eate the barke round, and so kill the very heart in a little space. It must be looked into in time before it hath runne too farre: most men doe wholly cut away as much as is fretted with the canker, and then dresse it, or wet it with vinegar or cowe's pisse, or cowe's dung and urine, etc., until it be destroyed and after healed againe with your salve before appointed."

Courtesy Connecticut Agr. Exp. Station.

Fig. 1

Leopard moth and its work. After W. E. Britton.

29. In the following discussion the remedies advised are based upon experience and experiments, or have been traced far enough back so that we know they are the best that can be given until more is known on the subject.

LEPIDOPTERA

30. Very few of the butterflies and moths comprising this order have the habit of burrowing into wood or the harder part of plants. The three species considered below represent the two families containing the more important of these borers.

31. The injury they do is done in the larva stage. These larvæ are provided with well developed thoracic legs, as well as five pairs of prolegs.

1. LEOPARD MOTH

Family COSSIDÆ. Species *Zeuzera pyrina* Fabr.

32. This European moth was introduced into this country before 1880. It was first found in Hoboken, New Jersey, in 1881, and has since spread up the Atlantic coast from New Jersey to Massachusetts, causing very serious damage to the shade trees in many of the cities. It has not been found far back from the coast, nor in the country where the native birds are plentiful.

33. This moth is widely distributed in Europe, where it has been known in the literature under the name of *Zeuzera æsculi* Linn.

34. *Food Plants.* In Europe it is reported as feeding upon six species of shade trees, but in this country it has been found feeding upon eighty-three different species of trees and shrubs. It is most injurious to the elms, maples, horse chestnut, Ohio buck-

eye, beeches, birches, dogwoods, hickories, oaks and walnuts, in the order named.

35. *Symptoms.* Dead, dying or wilting limbs, projecting above leafy branches, or broken and hanging among otherwise healthy trees, are the surest indications of the work of this borer.

36. *Habits.* The dirty white adults, appearing from May to September, have a wing expanse of from 2½ to 3 inches in the female, but the male is not so large. The fore wings are covered with numerous black spots. The under side of the body and the legs are black. The upper side of the abdomen is black or striped with black, and the thorax is spotted with six or seven black spots. The females are large and sluggish. They have a three-jointed ovipositor, with which the eggs are placed in cracks of the bark or under bark scales.

37. The males can be collected in great numbers around electric street lights, but the females are poor flyers and do not frequent the lights so abundantly.

38. The eggs, 400 to 800 in number, are laid in crevices in the bark of the trunk or limbs, singly or several in a place. On hatching, the larvæ crawl to the top of the tree and enter the smaller branches just above a bud or twig.

39. When the larva first begins burrowing upward through the limb, its presence can be detected by the white powdery dust expelled from the hole. Later this changes to cylindrical pellets, light golden or brown in color. New openings through the bark are made from time to time through which the frass is expelled, but these holes are sealed with a silken web when not in use. The pellets collect in clusters below these holes, where they hang suspended by the web, or form small piles on the pavement or ground below. In this way they betray the presence of the borers, especially when the larvæ are nearly grown. If the limb becomes too small for the rapidly growing larva, the latter leaves its burrow and enters at another place, usually in a larger limb.

40. The first winter is passed by the larvæ when about an inch long, within the burrow, deep in the wood. Up to this time they have done comparatively little damage to the tree. The greatest damage is done during the second summer and the spring following, before the larvæ change to the pupæ. The larvæ are now 1½ to 2½ inches long, and are ravenous feeders. They frequently girdle large limbs or excavate large cavities in the wood,

weakening the limbs so that they are easily broken by a storm or fall of their own weight.

41. *Control.* From what has been said, it is evident that the control of this pest is a difficult matter, especially upon large trees. A close inspection of the upper limbs cannot be made to locate or kill the larvæ within their burrow, or to remove the affected limbs and destroy them with the contained larvæ before the injury is too great.

42. All that can be recommended is to dig out the larvæ, or destroy them with a wire or by injecting carbon bisulphide into their burrows. Infested limbs that fall or are pruned off should be destroyed before the larvæ desert their burrows. Repellants may help to check egg laying, but the whole of the trunk and larger limbs will have to be protected from May until September to be successful. The moths can also be collected by trap lights or by hand and killed. Protecting the native birds that feed upon these insects is also a powerful means of fighting them.

43. It has been generally observed that healthy, vigorous trees, while they are not free from attack, are not as badly injured as the unhealthy ones. Moreover, they outgrow the effect of the injury much quicker.

2. CARPENTER WORM

Family COSSIDÆ. Species *Prionoxystus robinæ* Peck

44. This moth is a native of this country, but belongs to the same family as the leopard moth, and has similar habits. The larvæ are similar in appearance, but this one grows to be fully three inches long, and confines its work more to the trunk and the heart-wood.

45. The carpenter worm was first described by Peck as *Cossus robinæ*, but Newman changed the genus to *Xyleutes*, and later it was changed to *Prionoxystus*,—the name by which it is now known. It has also received the following specific names: *plagiotus* Walker, *crepera* Grote, *reticulatus* Lintner, and *zabolicus* Strecker.

46. *Food Plants.* It feeds upon black locust, black, red and white oak, ash, maple, cottonwood, poplar, willow, and chestnut.

47. *Symptoms.* Large, half-inch galleries in the trunk and larger limbs, running parallel with the grain and of about the same size throughout their length, are generally the work of this

Courtesy New York State Museum.

Fig. 2

Work of the carpenter worm in ash. After E. P. Felt.

species. Many burrows frequently start from the same wound in the trunk, the number increasing from year to year.

48. *Habits.* The large moths, of a pale gray color, mottled with black, appear during June and the early part of July. They fly only by night, and hide during the day upon the rough bark with the wings folded over the back. The color of the moth, in this position, and the color of the bark, blend in such a way as to make them hard to find.

49. The female lays 300 or more eggs, placing them in crevices in the bark or around wounds made by preceding generations of the larvæ. The young larvæ feed for a time upon the inner bark, but gradually work deeper into the heart-wood, several successive generations feeding within the same tree. Fitch states that he found the larvæ feeding only in the sound wood and never in decaying tissue.

50. The larvæ when full grown are fully three inches long, and are of a livid, reddish color, greenish beneath, and with a black, shining head. The body is somewhat flattened, with scattered, long, fine hairs. They live within the tree for three or four years. The pupa is also found within the burrow, and works itself half way out the exit hole before the skin splits down the back to liberate the moth. The cast skin remains in this position after the moth flies away.

51. *Control.* While this is considered to be one of the most destructive of our native borers, it is more easily controlled than

its European cousin. It confines its work more to the trunk and the larger limbs, and consequently its burrow can be more easily located, and the larvæ destroyed with a wire or with carbon bisulphide.

52. Repellents for preventing egg laying would be a more effective means of fighting this insect, inasmuch as only the trunk and larger limbs have to be protected instead of the whole tree, as with the leopard moth. The moths fly only during the month of June and part of July, so the protection would also be required for a much shorter time. Where the trees are badly enough injured to require it, the affected heart-wood should be removed and the cavity filled, as explained in a subsequent lesson.

3. MAPLE SESIAN

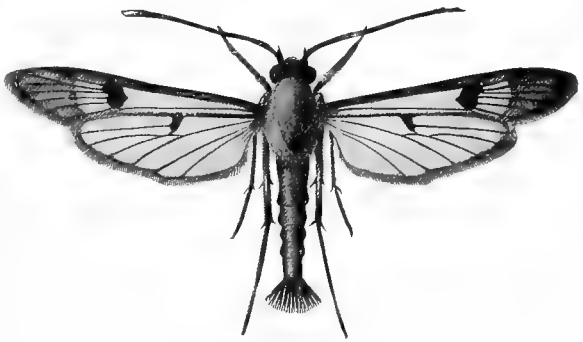
Family SESIIDÆ. Species *Sesia acerni* Clem.

53. This moth is much smaller than the preceding species, and represents another family of boring lepidopterous larvæ. It is a small, wasp-like moth, with transparent wings and black markings. The head and a tuft on the tip of the abdomen are a bright red.

54. The red-headed larvæ of these moths burrow in the newly forming callus around wounds, thus preventing healing. At times they cause quite serious injury to both hard and soft maples. They have the same habit as other boring Lepidoptera of leaving the cast pupa skin in the exit hole after the moth emerges.

COLEOPTERA

55. The greater part of the insects that bore into the woody tissues of plants belong to this order. Most of them belong to three families, and are included in the three following groups:



Courtesy Illinois State Entomologist.

Fig. 3

Maple Sesian. After S. A. Forbes.

The round-headed borers, or those belonging to the family CERAMBYCIDÆ.

The flat-headed borers, or those belonging to the family BUPRESTIDÆ.

The bark beetles, or those belonging to the family SCOLYTIDÆ.

ROUND-HEADED BORERS

56. CERAMBYCIDÆ. The beetles of this family are called the "long-horn beetles," from the long antennæ or feelers, which usually equal or exceed the length of the body. The body is usually more or less cylindrical, although some species are more or less flattened.

57. The larvæ are called "round-headed borers" because they usually bore into woody plant tissue, and are more or less cylindrical in form, with the segments well marked. The legs are rudimentary or wanting, the thorax enlarged but round, and the mouth parts strong, well developed, and more or less contracted within the enlarged thorax. For the most part these larvæ burrow into dead or dying wood, but a few of them will attack and frequently kill living trees.

4. MAPLE BORER

Family CERAMBYCIDÆ. Species *Plagionotus speciosus* Say

58. This is one of the most destructive of the round-headed borers, and readily attacks trees in apparently good health. It is a native American, and its work was described as early as 1828. It has been discussed in the literature under the following names: *Glycobius speciosus* Say, *clytus speciosus* Say, *Clytus hayii* and *Arhopolus speciosus* Say.

59. The sugar maple is the principal food plant attacked, but the other maples suffer at times.

60. *Symptoms.* The beetles are sun lovers, so the portion of the trunk or limbs exposed to the bright sunlight is the most liable to attack. In the fall, the location of the young larvæ in the bark can be detected by a rusty, irregular discoloration of the bark about the size of a cent, and by the frass, or castings, which have been expelled from the burrow. These castings are frequently in

the form of a spiral attached to the bark, and an inch or more in length.

61. Later, when the tree attempts to heal the burrow, the bark is pushed up in the form of a ridge following the burrow. The burrows usually run upward and around the trunk or limb, but may run in other directions in certain cases. Frequently they cut off an area of bark, causing it to die and peel off, especially if two or more borers are working in the same tree.

62. *Habits.* The large black, cylindrical beetles, with yellow head and legs and conspicuous yellow markings on the back, appear in July and August, and begin laying eggs in obscure gashes in the bark. On hatching, the larvæ burrow into the bark or just into the cambium, and there pass the first winter.

63. The following summer they penetrate the cambium and feed until the approach of the second winter, when they penetrate deeper into the wood. The second spring the burrowing is continued under the bark, but at a more rapid rate. A short time before pupating they again enter the hard wood, working inward and upward, forming a chamber in which to pupate. The total length of the burrow may vary from one to three feet. The burrow at the last is one-half inch wide and one-third inch deep.

Courtesy New York State Entomologist.

Fig 4.

Sugar maple borers, natural size. The lower one a male and the others females. Note the variations in the markings. After J. A. Lintner.

64. *Control.* From what has been said, you can see the dangerous nature of the work of this insect, and the difficulty of reaching it after it once penetrates well into the tree. To attempt to follow the burrow and kill a nearly full-grown larva would make a serious wound in the tree.

65. This can be avoided by the use of repellents during July and August to prevent egg laying, or by locating and killing the

larvæ during the fall and winter before they reach the cambium. Old burrows will heal more quickly if cleaned out and properly dressed.

5. ROUND-HEADED APPLE TREE BORER

Family CERAMBYCIDÆ. Species *Saperda candida* Fabr.

66. This is another of our native borers which is capable of doing a great amount of damage to many of our shade and ornamental trees, as well as to the fruit from which it receives its common name. In many sections it is so destructive to the apple

Courtesy Connecticut Agr. Exp. Station.

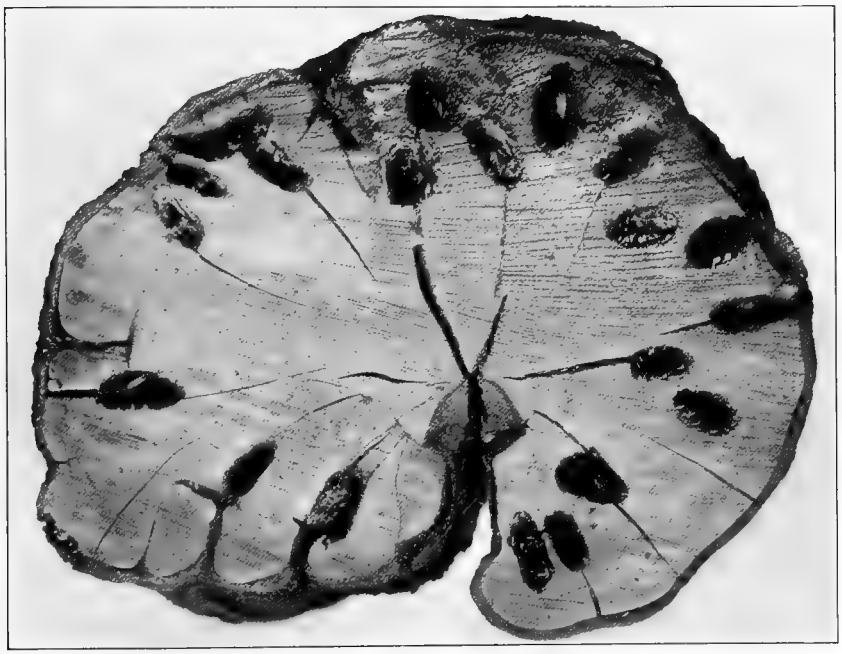
Fig. 5.

Rounded-headed apple tree borer, and its work. Natural size. After W. E. Britton.

trees that some class it next to the codling moth as being the most destructive of the insects affecting the apple. Its deeds are dark and consequently most of its work is done under cover of darkness, preventing any but the closest observers from becoming

acquainted with the conspicuous adult beetle when laying her eggs upon the bark. Figure 5 is a remarkable photograph of this beetle upon the trunk of a tree from which it has recently emerged through one of the holes in the bark. Figure 6 is a cross section of the same tree, showing the destruction wrought by a few of the larvæ.

67. It was first described by Fabricius in 1787 as *Saperda candida*,—the "white Saperda," and in 1824 by Say as *Saperda*



Courtesy Connecticut Agr. Exp. Station.

Fig. 6

Work of the rounded-headed apple tree borer in cross section. After W. E. Britton.

bivittata or the "two-striped Saperda." It has been extensively discussed under both of these names.

68. *Food Plants.* This species has been reported as feeding upon the following plants: mountain ash, hawthorn, quince, apple, pear, crab apple, chokeberry and June-berry.

69. *Symptoms.* Unless the trees are closely watched, the first indication of the presence of these borers is the gradual decline or the death of the tree, or the breaking of the trunk in a storm near the ground.

70. If the trees are carefully examined each May and September, the borers can be located in the trunk close to the ground. You can detect their presence by means of the small areas of discolored or dead bark, or by the sawdust expelled from the burrows.

71. *Habits.* The adult is a light brown, cylindrical beetle, with the antennæ as long as the body, and with two silvery white stripes running the full length of the back. It emerges through a round hole in the bark. In size it is about three-quarters of an inch long. It flies by night and is seldom seen in the daytime. The eggs are mostly laid in slits in the bark near the surface of the ground. Occasionally, however, the eggs are laid farther up the trunk or upon the larger limbs.

72. The larvæ on hatching burrow downward through the bark, expelling orange-colored castings from the opening. For a time they feed just under the bark. The first winter is passed in the sap-wood at or below the surface of the soil, in a dormant condition; but the larvæ begin feeding again in the spring. The second summer the sap-wood is mined at the base of the tree or below the ground, in many cases being entirely girdled by the borer.

73. The second winter is passed near the surface of the ground, and in the second spring a burrow is made upward through the heart-wood, curving outside, and finally ending just under the outer bark. After plugging the hole with sawdust at both sides, the larva pupates about an inch back from the bark and emerges as the beetle in May, June or July, thus feeding for nearly two years within the tree. Most of these beetles come out in June.

74. *Control.* Digging out the young larvæ in October of each year, when they are still in the inner bark, is probably the safest and surest method of control. The use of the repellent washes described in Paragraphs 41-44 of Lesson Eight is also strongly recommended to prevent egg laying, but the trees must be protected from May until July, through the whole egg laying period.

75. The trees can also be protected by wrapping the trunk with wire cloth, paper or other mechanical protectors, to prevent the beetles from reaching the base of the tree. Vigorous, rapidly grow-

ing trees tend to drown out the larvæ before they penetrate the bark, and are consequently less subject to attack.

6. ELM BORER

Family CERAMBYCIDÆ. Species *Saperda tridentata* Olivier

76. This is another native *Saperda*, and probably does not attack the trees until they are weakened through some other cause or agency. They become very abundant in certain localities from time to time, and kill many magnificent elms by undermining the bark and cutting off the food supply, thus causing the bark to separate from the wood in large flakes.

77. The elm borer has been known in the literature as *Compsidia tridentata*, *Compsidia tridentata* var. *dubiosa*, and as *Saperda trilineata*.

78. It is generally associated in its destructive work with three other borers, the reddish elm snout beetle, *Magdalis armicolis* Say; the black elm snout beetle, *Magdalis barbita* Say, and the American elm borer, *Neoclytus erythrocephalus* Fabr. The elm borer is probably the primary cause of the injury, as it is found in the living tissues, while the others are found in the dead or dying tissues.

79. These borers work just under the bark, making irregular burrows which, if abundant, eventually girdle the trunk or limbs. The work is done so secretly that frequently their presence is not suspected until the trees are beyond hope.

80. The life history of the elm borer has never been carefully worked out, but it is probably the same as the life history of the other *Saperdas*, requiring two or three years for the larva to mature. The larva is a typical round-headed borer, a little over an inch in length when full grown. The beetle is of a grayish color, with a reddish margin to the thorax and a red stripe near the outer edge of each wing cover, and three teeth of

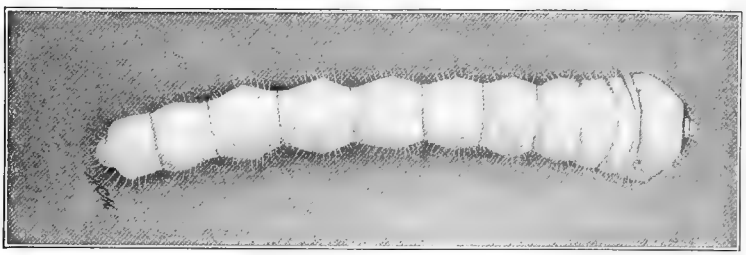
Courtesy Illinois State Entomologist.

Fig. 7
Elm borer enlarged. After S. A. Forbes.

the same color extending inward and backward from them. These teeth may or may not meet on the middle line.

81. *Control.* Owing to the nature of their work and the difficulty of detecting their presence before serious injury is done, the elm borer is a difficult pest to control.

82. Cut and burn all badly infected trees or parts of trees before May to prevent the beetles from emerging. Force the growth



Courtesy Illinois State Entomologist.

Fig. 8.

Elm borer larva. After S. A. Forbes.

of the remaining trees as much as possible. On valuable trees, remove all dead or badly infested bark to kill the borers under it, scrape off the outer bark from the rest of the trunk and larger limbs if infested, and spray it thoroughly with 15% kerosene emulsion. If the trees are thoroughly sprayed with repellents from June to the middle of August, this will tend to prevent egg laying. If the cambium is exposed it can be protected from drying out by the composition described above (paragraphs 18-28).

7. LOCUST BORER

Family CERAMBYCIDÆ. Species *Cyllene robinæ* Forst.

83. This-round headed borer is so destructive to black locust that it is difficult to grow these trees with any prospect of success in many localities. It has been described under the following names: *Leptura robinæ* Forster, *Leptura picta* Drury, *Clytus flexuosus* Fabr., *Clytus pictus* Drury, and *Clytus robinæ* Forst. It has also frequently been confused with the hickory borer.

84. The adult is a beautiful black and yellow beetle, quite similar to the maple borer. These are also lovers of the bright sun-

light, and can easily be found upon the blossoms of the golden rod or upon the sunny side of the trunk of the locust. They feed upon the pollen of the golden rod and upon the juices of other plants. They will feed freely upon sweetened baits.

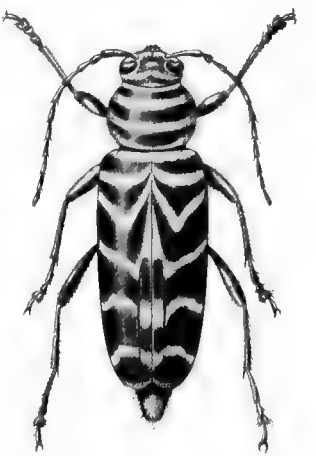
85. The eggs are laid upon the bark during the period when the golden rod is in bloom, the first adults appearing about the same time as the first golden rod blossoms. The larvæ on hatching burrow into the bark, and pass the winter in a small cell in the inner bark. The next spring they go deeper, burrowing through the cambium layer and later into the solid wood. The injury is so severe that the trees are girdled, or the heart-wood is so weakened that the tree is easily broken in a storm. The larva requires but one season to complete its growth.

86. *Control.* A number of remedies have been suggested. One suggestion calls for the destruction of all locust trees; another the hand picking of the beetles, and a third the destruction of the golden rod, upon which the beetles feed.

87. The more promising control measures include the use of repellents from the last part of August to the first part of October to prevent egg laying, the use of sweet poisoned baits to kill the beetles before they lay their eggs, and the spraying of the trunk and larger limbs in the fall with strong kerosene emulsion to kill the young larvæ, which pass the winter in cells just under the outer hard bark.

88. In all control measures, you should not overlook the importance of reducing the number of beetles by destroying all badly affected or worthless trees during the winter or early spring, before the larvæ complete their growth.

89. The trees can be prevented from sprouting by peeling the bark from the trunk during August. If the wood is valuable, the larvæ can be prevented from entering it by removing all the bark during the fall or winter. This will also kill the larvæ, as they are unable to develop in the bark alone.



Courtesy U. S. Department of Agriculture.

Fig. 9.
Locust borer (female).

90. Severe pruning and the forcing of the growth has caused affected trees to outgrow the injury from this pest when not too severe. Many of the larvæ die from fungous diseases and othe causes.

8. HICKORY BORER

Family CERAMBYCIDÆ. Species *Cyllene caryæ* Gahan

91. This species is very closely related to the locust borer, and for a long time the two were confused or considered as the same insect. The locust borer feeds entirely upon the black locust, but the hickory borer feeds upon hickory, walnut, mulberry, Osage orange and honey locust, but not on black locust.

92. It has been discussed in the literature under the following names: *Leptura picta* Drury, *Leptura robinæ* Forst., *Clytus flexuosus* Fabr., *Clytus pictus* Drury, *Clytus robinæ* Forst., *Cyllene robinæ* Forst., *Cyllene pictus* Drury, and *Cyllene caryæ* Gahan. The last name has been in use but a short time in the American literature.

93. The larvæ work under the bark and in the wood of dead or dying trees; consequently, it is not of great importance as a shade tree pest.

94. The control consists in keeping the trees in a healthy condition, or in the use of repellents during the egg laying period from April through May.

9. LINDEN BORER

Family CERAMBYCIDÆ. Species *Saperda vestita* Say

95. This species is very similar in its habits to the round-headed apple tree borer, working at the base of the tree and in the roots, and burrowing under the bark or deep into the wood. Very little is known about its life history or the length of the larva stage. Its food is probably restricted to the linden, although this species has also been reported upon elm, poplar and apple.

96. The beetle is a typical *Saperda*, black in color, but covered with a dense olive pubescence. There are usually three spots on each wing cover where the pubescence is wanting, and the spots show as black. In some specimens, part or all of these spots may be wanting. The adults appear the latter part of the summer, and feed for a time upon the tender bark and leaves, and may when abundant, cause some injury in this way.

97. The control, as far as known, is the same as for the apple tree borer,—*i. e.*, protecting the trunk and exposed roots from attack.

10. POPLAR BORER

Family CERAMBYCIDÆ. Species *Saperda calcarata* Say

98. This is the largest of our native *Saperdas*, measuring from one to one and one-fourth inches long. Together with the broad-necked Prionus, it makes it next to impossible, in many sections, to grow the Lombardy poplar. The larva is nearly two inches long, making a half-inch burrow under the bark and through the heart-wood. Packard reports taking eight to ten larvæ from a section of a five-inch trunk ten inches long.

99. It causes serious injury to Lombardy poplar, cottonwood, quaking aspen and willows. It has also been reported from apple. The adults can be found on the trees during August and September in the northern states.

100. The nature of its work and the lack of a full record of the habits and life history of the species make it difficult to know the best methods of control. Digging out the larvæ, the use of carbon bisulphide in the burrows and the use of repellents to prevent egg laying, are the only remedies to be suggested. The destruction of badly infested trees will also help to reduce the injury, by reducing the number of beetles.

11. BROAD-NECKED PRIONUS

Family CERAMBYCIDÆ. Species *Prionus laticollis* Drury

101. This is one of the largest of the borers belonging to this family. The beetles, one to one and one-half inches long, are broad, black, and have three irregular teeth on either side of the thorax. The larvæ are round-headed borers with rudimentary legs, and when full grown, are fully three inches long. They burrow in the trunk and roots of Lombardy poplar, balm of Gilead, black oak, pine, apple and grape vines. Most of their work is underground, making them difficult to control.

12. OAK TWIG PRUNER

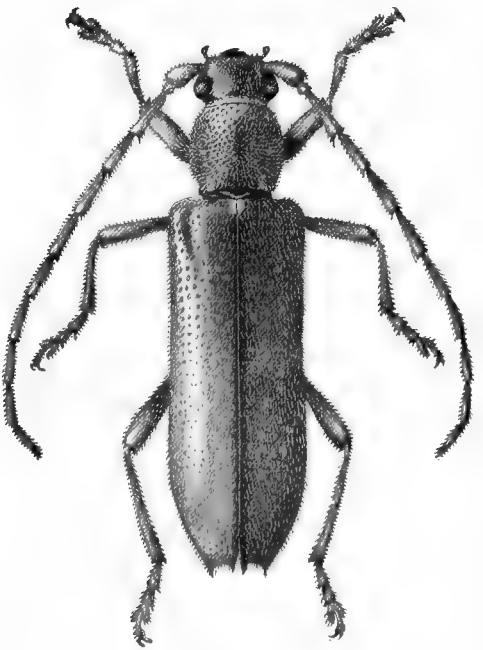
Family CERAMBYCIDÆ. Species *Elaphidion villosum* Fabr.

102. While this species is a typical round-headed borer, it has a peculiar habit that throws it into a class by itself, as indicated by

its name. The larvæ are provided with rudimentary legs. Its peculiar habits and the nature of its injury were first described by Peck in 1819, although Fabricius had described the adult at a still earlier date.

103. The species has been discussed under the following names: *Stenocarnus villosus* Fabr., *Stenocarnus putator* Peck, *Elaphidion parellelum* Newman, *Elaphidion putator* Peck, and *Elaphidion villosum* Fabr.

104. The dark brown, slender, cylindrical beetle, covered with a mottled grayish pubescence, appears in early summer and usually deposits the eggs in a tender branch. The larva first feeds by burrowing the tender branch toward the main limb. On reaching the latter, it tunnels through the wood or pith, and when about half grown, cuts the twig partially off at the lower end of the burrow. This it does by eating away the wood from the inside, but leaving the bark and enough wood to keep the twig from breaking until dry. The larva retreats up the limb, and plugs the hole below it with sawdust and wood fiber. The first strong wind breaks off the twig, carrying the voluntary prisoner to the ground with it. Here the larva lives, feeding upon the dead wood until the next summer, when it pupates and the mature beetle emerges.



Courtesy Illinois State Entomologist.

Fig. 10.

Oak twig pruner (greatly enlarged). After S. A. Forbes.

105. In some seasons this pest is so abundant that the fallen twigs can be picked from under the trees by the wagon load. If these are gathered and burned while the larvæ are still within, the number of beetles present the next season will be greatly reduced. This is the only method of control that can be suggested, with the addition

of removing any dead twigs that may be still hanging to the trees.

106. The food plants include oak, hickory, chestnut, beech, spruce, birch, firs, locust, redbud, sumach, orange, Osage orange, apple, plum, quince, peach, grape and bittersweet.

13. TWIG GIRDLER

Family CERAMBYCIDÆ. Species *Oneiders cingulatus* Say

107. The adult of this peculiar round-headed borer appears in July and August. It is similar in its habits to the twig pruner, in so far that it cuts the twigs from the tree upon which the larva is to feed. It differs from this species, however, in that the beetle cuts the twig from the tree instead of the larva. This is done by cutting a U-shaped groove around the twig, leaving nothing but a small portion of the heart-wood. When this dries it is easily broken by the wind. The eggs are laid in a crescent-shaped cut in the bark, above the point where the twig is girdled. These may hatch before or after the twig falls. The larva feeds within these twigs and emerges as the adult beetle the following summer.

108. The simplest and most effective control is to collect and destroy these twigs as fast as they fall.

109. They attack hickory, pecan, persimmon, elm, linden, oak, apple, pear, quince, peach, orange, and rose bushes.

14. HEART-WOOD BORER

Family SPONDYLIDÆ. Species *Parandra brunnæ* Fabr.

110. While the larva of this species closely resembles the round-headed borers and has similar habits, the adult beetles are very different. These are about three-quarters of an inch long and one-third as wide. In color they are a chestnut brown. They are much flattened, and in general appearance resemble the common pinching bug, but with smaller mandibles or pincers.

111. The larvæ live in the heart-wood of different trees, gaining entrance through a wound and then honeycombing the heart-wood, causing rapid decay. This has not been generally considered to be a pest of shade and fruit trees until recently, owing to the fact that its work has been confused with the work of the round-headed apple tree borer. It has been found to cause serious dam-

age to telephone poles, and consequently has received the name o the chestnut telephone pole borer. C. A. Hart also reports it a doing serious damage to apple, maple and other trees, includin conifers, burrowing into the sound wood and hastening decay.

112. *Control.* So little is known in regard to the habits o this species that control measures have not been worked out From what is known it will probably cause little trouble if wound are properly protected against decay and the cavities are properly cleaned out and filled.

FLAT-HEADED BORERS

113. BUPRESTIDÆ. A large proportion of the beetles be longing to this family are bronzed or have a metallic luster, and other are marked with gaudy red or yellow bands or spots. The beetle are elongate, usually stout, but sometimes cylindrical, and have a broad thorax and elytra tapering back from the shoulders. The prothorax is closely united with the mesothorax and is usually somewhat flattened. Most of them are so characteristic in ap pearance that they are easily recognized.

114. The larvæ are also very characteristic, with their slende abdomen, the segments well defined, and their large flattened thorax with the small head and strong mouth parts partly con tracted within it. When at rest, the abdomen is usually curved back upon itself in the form of a U. Most of these larvæ feed upon dead or dying trees, burrowing under the bark or through the wood making rather broad but shallow galleries or chambers. However some of them feed upon living tissue, and in some cases seem to attack trees in perfect health. The common names of "flat headed" or "hammer-headed" borers came from the slender ab domen and greatly enlarged and flattened thorax.

15. FLAT-HEADED APPLE TREE BORER

Family BUPRESTIDÆ. Species *Chrysobothris femorata* Fabr.

115. This bronze-colored beetle, about one-half inch long, can frequently be seen on the sunny side of the trunk of fruit and shade trees during the latter part of May to July. It is a native species widely distributed throughout the United States and Canada, and even extends its range into Mexico. When first described it was placed in the genus *Buprestis*, but later transferred to the genus

Chrysobothris. Eight or more varieties of this species have been described. Among these are *alabamæ* Gory, *fastidiosa* Gory, *lesueuri* Gory, *misella obscura* Lec., 4-*impressa* Gory, *semisculpta* Lec. and *soror*.

116. The beetles deposit their eggs during June and July, mostly upon the bark exposed to the sun, and at times it is a question whether the primary cause of the injury is due to the borers or to sun-scald or winter injury. However, there is no doubt but that healthy trees are less liable to attack than diseased trees.

117. The food plants include oak, soft maple, mountain ash, box elder, hickory, chestnut, sycamore, horse chestnut, beech, willow, cultivated redbud, apple, pear, peach, plum, cherry, and currant.

118. *Control*. In orchards the best preventatives are clean culture and care, tending to produce vigorous growth, together with proper pruning to prevent exposing the trunk or large limbs to sun-scald. The trees should also be carefully inspected in fall and spring to kill any borers that may be found in trunk or large limbs. The use of repellents has also given good results. The larva do not burrow deep into the wood, so can be more easily located and killed than the larvæ of the round-headed borer.

16. BRONZE BIRCH BORER

Family BUPRESTIDÆ. Species *Agrilus anxius* Gory

119. This flat-headed borer has killed many of the magnificent birches in some of our northern cities, but has not been found to be injurious to trees under forest conditions. This is probably due to the effect of the birds and other natural enemies. In the cities, when a tree becomes infested, it seldom lasts more than two to three years. The species was first described in 1841. It has appeared in the literature under the names of *Agrilus anxius* Gory, *Agrilus gravis* Lec., and *Agrilus torpidus* Lec.

120. The first indication of the destructive work of this borer is usually seen in the dying of some of the top branches. These are usually the first to become infested, and consequently the first to be injured. When the trees reach this stage, no remedy is known that will save them. The only thing to be suggested in such cases is the complete destruction of the affected trees, including all the branches down to one-quarter inch, before May 1st, to

prevent the beetles from emerging and spreading to healthy trees.

121. The small, bronze green or violet beetles are about one-half inch long, with parallel sides, but conspicuously tapering wing covers with a blunt tip and a notch where they meet. They emerge through peculiar bean-shaped holes in the bark during May and June. The eggs are laid during these months in cracks in the bark.

122. The larvæ on hatching penetrate the bark with zig-zag burrows, and work just under the bark, making tortuous burrows that frequently intersect, and soon girdle the tree if abundant. When the larvæ are full grown, the burrows are about one-eighth inch in diameter. Professor Slingerland has demonstrated that from June 1st to October 1st a larva is capable of making a burrow over five feet long.

123. When full grown the larva is about three-quarters of an inch long, with the characteristic of the flat-headed borer, but with a peculiar brown, horny, forcepslike appendage at the caudal end of the body, with two teeth upon the inner side of each of the two prongs. This pest seems to prefer the European white birch, but will also attack and kill some of our native species, including the black and yellow birch. It has been known to also attack the paper, or canoe birch.

Courtesy Illinois State Entomologist.

Fig. 11.

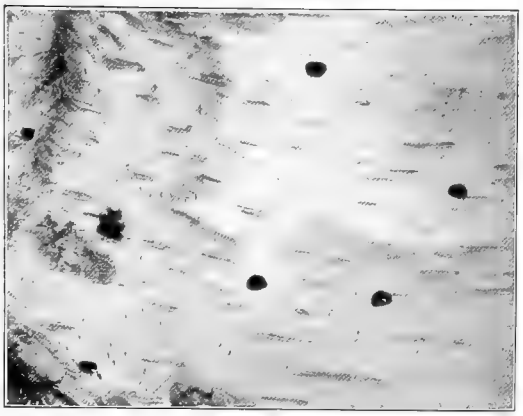
Bronze Birch Borer. After S. A. Forbes.

125. As stated above, when a tree begins to die at the top the only remedy is to cut and burn the tree before the beetles emerge and spread to other trees. If all badly infested trees are promptly destroyed, the number of beetles that emerge can probably be reduced to the point where their natural enemies will control them. The secrecy of their attack, and the habit of starting upon the upper limbs, puts this pest practically beyond the reach of the known insecticides.

17. TWO-LINED CHESTNUT BORER

Family BUPRESTIDÆ.
Species *Agrilus bilineatus* Weber

126. This borer is similar to the bronze birch borer, but is only three-eighths inch long and makes a smaller burrow. When full grown, the burrow is but one-quarter inch in diameter, and is confined largely to the bark and cambium layer. In some cases the larva feeds entirely within the bark and does not enter the wood.



Courtesy Cornell Agricultural Experiment Station.

Fig. 12.

Exit holes of the bronze birch borer in bark of white birch. After Slingerland.

The larva closely resembles the bronze birch borer, but is only three-quarters inch long when full grown. Its work is confined to the chestnut, oak, and beech. Some writers think that it will attack healthy trees, but in some cases the chestnuts will be badly injured or killed, while the oaks near them remain uninjured. The evidence strongly indicates that injured trees are the ones attacked.

127. The larvæ usually pupate in the bark, and the beetles emerge in May and early June. The latter are long and slender, about three-eighths inch long and one-third as broad, and of a dark brown to black color, with a greenish tinge. The sides of the thorax and wing covers are a light golden yellow, with a strip of the same color running the full length of each wing cover.

128. The size of the burrows and the habit of working in all parts of the tree, makes this a difficult pest to control. In most cases they will have to be left to the control of their natural enemies, after destroying or barking the badly infested trees, in this way destroying the larvæ before the beetles emerge in May and June. By removing the bark and burning it, the insects can be killed and the wood saved for other purposes. For valuable trees, the repellents can be used during May, June, and the first part of July to prevent egg laying. The trunk and large limbs can also

be sprayed with penetrating contact insecticides to kill the larvæ when small. The larvæ are too small to dig out or kill with a wire.

BARK BEETLES

129. SCOLYTIDÆ. The beetles belonging to this family are commonly known as the bark beetles, bark borers, or ambrosia beetles. They are very small, cylindrical, black or brown, and seldom much over one-fifth inch in length. The adult female of the bark beetles burrows through the bark and makes a gallery in the cambium layer, in which she lays her eggs. The eggs hatch, and the legless grubs mine through the cambium layer in such a peculiar and characteristic manner that it is easier to tell many of the species by the burrow than by the adult beetles. The ambrosia beetles burrow more deeply into the wood and cultivate ambrosia, or a fungous growth, within the galleries, upon which they feed and upon which to feed the young.

18. HICKORY BARK BORER

Family SCOLYTIDÆ. Species *Eccoptogaster quadrispinosus* Say

130. The hickories in many sections have been killed by the hundreds by this pest. It works so secretly that frequently the trees are dying before the presence of the pest is suspected. The outbreaks that occur from time to time probably follow injury to the trees by adverse weather conditions or injury from leaf eating or other insects. This species has been considered in the literature mostly under the name *Scolytus quadrispinosus* Say. Riley described the female as *Scolytus caryæ*, but this name was dropped on finding that the difference was due to the difference in sex. It has recently been changed to the genus *Eccoptogaster*.

131. *Habits.* The dark brown or black beetles, about one-fifth inch long, emerge during the last of June and July through holes in the bark about the size of number eight shot. They feed for a time upon the young nuts, at the base of the leaves, or burrow into the young twigs, causing them to wilt, die or fall. The wilting or falling of these leaves and twigs is usually the first signs of their presence, and should be the warning to watch for more serious injury later.

132. During August, the females begin to burrow into the bark, usually starting their galleries in a crack or under a bark

scale, making vertical brood chambers, just under the bark, about one and one-half inches long and one-eighth inch in diameter.

In small pits on either side of this brood chamber, twenty to fifty eggs are laid, which soon hatch into small legless grubs which begin burrowing through the cambium at right angles to the parent chamber. The end burrows gradually diverge from the others, spreading out fan-shaped, until the end ones finally run nearly parellel to the brood chambers. The grubs grow rapidly and continue to extend their individual galleries until the latter are two to three inches long and the grubs are about one-quarter inch long.

133. The winter is passed within the burrows as nearly full grown larvæ. In the spring the work is continued, and their growth completed the latter part of May, when the larvæ change to pupæ. The adult beetles emerge about a month later through small round holes in the bark. Thus it will be seen that each colony will thoroughly undermine a portion of the bark from four to six inches square.

134. The brood chambers are placed with such regularity over the trunk and larger limbs that it does not require a very large number of them to completely girdle a tree. In a section where serious damage is being done, several hundred of these colonies can be found in a single tree of moderate size.

135. *Control.* From what has been said it is evident that this pest is a difficult one to control. In an outbreak covering a large area, or upon a large estate, the principal method of control consists in making a thorough inspection of the entire infested area in the early fall, and marking all badly infested trees and trees that have died since June of the current year. During the winter and spring all these trees are destroyed, or the bark removed and burned before May to kill the larvæ before they can emerge and spread to the healthy trees. If this is carefully done throughout the area, it will so reduce the number of borers that the natural means of control will prevent further serious injury. With small estates the greatest difficulty with this method is to secure the necessary coöperation among the different owners, so they will all carry out their part of the program.

136. For small estates or valuable trees the following campaign is the one promising the best results:

137. First—Remove and destroy all badly infested trees or parts of trees as before.

138. Second—Force the growth in the remaining trees by every means available.

139. Third—Use repellants on the trunk and larger limbs from the last of June to the middle of August, to prevent the females from entering the bark.

140. Fourth—Keep close watch during July and August for the injury of the beetles, as indicated by the falling, wilting or dying of the leaves or tender shoots.

141. Fifth—If these signs of the presence of the beetles are found, be on the watch for the first signs of the work of the females in entering the bark preparatory to egg laying.

142. Sixth—If but a few trees are involved, locate the entrance to the brood chambers, usually in cracks or under bark scales, by the fine sawdust found in the crack or upon the bark. With a small oil can squirt a small amount of gasoline into each of these brood chambers. Mr. Bird, of New York, reports treating in this way a 40-foot tree infested with 200 to 300 brood galleries in three hours' time and using but a quart of gasoline.

143. Seventh—Spray the trunk and larger limbs thoroughly with 25% kerosene emulsion, using an excess of whale-oil soap. To this add "Black Leaf 40" at the rate of one part of the "Black Leaf 40" to 400 parts of the diluted emulsion. Care must be taken not to get much of this upon the foliage, on account of the danger of injuring it or causing it to fall. This application is made when the females are making the brood chambers, and before the larvæ penetrate tco far from this chamber.

144. The following solution is reported as very promising by Dr. Felt for use in the same way: 1 gallon soft soap, 1 gallon hot water, 1 pint crude carbolic acid. Mix thoroughly and allow to stand over night, when it is ready for use after being diluted with eight gallons of cold soft water.

19. ELM BARK BEETLE

Family SCOLYTIDÆ. Species *Eccoptogaster multistriata* Marsh

145. This is an imported species, very similar to the hickory bark borer, and promises to cause as serious injury to the elms as the latter species does to the hickories. It has been reported from eastern Massachusetts.

146. The control is the same as for the other species, with the first consideration being given to keeping the trees in a healthy condition.

20. MOTTLED WILLOW BORER

Family CURCULIONIDÆ. Species *Cryptorhynchus lapathi* Linn.

147. This is an introduced species, belonging to a family containing a number of notoriously injurious species, but only a few borers. This species was first reported in this country in 1887, near New York, but has since spread throughout the Northeastern States and westward across the Mississippi. It is very destructive to nursery stock, working on willows, balm of Gilead, cottonwood, and several of the poplars.

148. It can be controlled to some extent by spraying with strong arsenate of lead, to kill the beetles when feeding upon the bark.

HYMENOPTERA

149. This order contains comparatively few wood borers of importance. Among the eating insects it is more important.

21. PIGEON TREMEX

Family SIRICIDÆ. Species *Tremex columbia* Linn

150. This is one of the larger of the Hymenoptera, and is preyed upon by one of the largest of the parasitic species of the same order. In the early literature it was known under the name *Sirex columbia* Linn.

151. The adult is a saw fly with four clear wings, with a spread of about two and one-quarter inches. The black and yellow cylindrical body is provided at the end with a horn or ovipositor about three-eighths inch long. The female can frequently be seen in the latter part of the summer upon dead or injured maple, elm, oak, sycamore or other trees with its ovipositor, or "saw," thrust into the wood. The infested trees are frequently full of round holes about the size of a lead pencil. In laying the eggs the female frequently gets the ovipositor so tightly wedged into the wood that she cannot get it out. Dead specimens can frequently be found in this position.

152. On the same trees can frequently be seen a large, long-legged, dangerous looking four-winged fly, with a long ovipositor

about three inches long. This is the lunate long-sting, *Thalessa lunator* Fabr., or the largest of our native ichneumon flies. The larva is parasitic upon the larvæ of the borer under consideration, and prevents them from becoming sufficiently injurious to require special treatment.

153. This borer is usually found in dead wood, and its work is stopped when this is properly removed and the cavity filled.

22. BLACK CARPENTER ANT

Family FORMICIDÆ. Species *Camponotus herculaneus* Linn.

154. The large black ants frequently found in hollow or decaying trees generally belong to this species. It is usually found in decaying trees, but after it once gains an entrance to the heart-wood of a number of kinds of trees, it can do extensive damage by burrowing through the heart-wood, in which it makes its nest.

155. It is hard to check their work, except by digging out the affected wood and destroying the nest, or by fumigating the cavity with hydrocyanic acid gas or carbon bisulphide. If you are sure that the cavity is such that the fire can be controlled and prevented from spreading farther than desired, the same results can be secured by burning out the cavity. This, however, is a dangerous practice.

LESSONS 10-11
SHADE TREE INSECTS
PARTS 1-2
HOST LIST

In the following host list the trees are given in alphabetical order according to their common names.

The insects affecting each tree are indicated by their respective members as given in Lessons 10 and 11.

Apple—1, 5, 9, 10, 11, 12, 13, 14, 15, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 36, 44, 48, 58, 61, 63, 64, 67.
Apricot—33, 68.
Ash—2, 25, 26, 27, 28, 32, 67, 68.
Arbor vitae—33.
Beech—1, 12, 17, 25, 28, 31, 32, 35, 44, 68.
Birch—1, 12, 16, 25, 27, 28, 31, 34, 44, 47, 63, 68.
Basswood—See linden.
Box elder—15, 25, 27, 29, 32, 36, 58.
Balm of Gilead—11, 20, 25, 31.
Catalpa—25, 63.
Cherries—15, 25, 26, 27, 28, 30, 32, 48, 63, 68.
Cottonwood—2, 10, 24, 61, 63, 64.
Chestnut—2, 12, 15, 17, 29, 31, 63, 67, 68.
Crab-apple—5, 25, 26, 44, 48.
Dogwood—1, 63, 68.
Elm—1, 6, 9, 13, 19, 21, 23, 25, 28, 29, 30, 31, 32, 33, 34, 41, 43, 45, 50, 55, 57, 63, 65, 68.
American—23, 25, 28, 44, 50, 53, 54, 58.
English—23, 25.
Scotch—23, 25.
Fir—25, 27.
Ginkgo—25.
Gum—1, 25, 28.
Hackberry—1, 30, 58.
Hawthorn—5, 35, 44, 64.
Hemlock—25, 33.
Hickory—1, 8, 12, 13, 15, 18, 27, 28, 29, 31, 32, 36, 52, 68.
Shag-bark—25.

Lesson 10

BIBLIOGRAPHY

Borers.

The references in the following bibliography are selected as the best ones and those most easily secured. It is not complete but will help you to know the different insects. A complete bibliography would be confusing and require too much space as the references for some of the species would be greater than the total references given below.

The two most comprehensive works on this important subject are Packard's Fifth Rept., U. S. Entomological Commission, and Memoir 8, New York State Museum of Natural History, in two volumes, by E. P. Felt. These are both excellent works and you should have them. They are getting out of date in some cases in regard to means of control but they are the best we have at the present time, treating of the same number of shade tree insects. Packard's Report is out of print and is hard to get. It is, however, the most comprehensive work treating of American forest and shade tree insects and contains liberal quotations from many of the early writings which are also out of print.

Send for as many of these references as possible and use them when studying Lesson 10. Some of them also contain good descriptions of other species to be considered in subsequent lessons.

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LESSON 10

NOTES

The lessons upon the shade tree insects, like the lessons upon the tree diseases, must necessarily be more technical, and consequently more difficult, than the other lessons of the course.

In the preparation of these lessons, it has been our aim to make them simple and brief yet contain as much practical information as possible that will help you in your work and in studying the references given in the bibliography.

The lessons are not intended simply for study while you are taking the course and answering the examination questions, but they are intended also for future reference while working as a Tree Surgeon.

Entomology was first studied as a past time or as a pure science. It had to do largely with the study of the dead insects, classifying and naming them or arranging them into collections for exhibition purposes. This is now generally spoken of as systematic entomology.

Economic entomology, as now understood, is a new science and does not date much beyond 1850. It deals with the insects in their relation to man together with the means used for controlling them. Such a great advance has been made in this subject within the past few years that it now ranks ahead of the older, more technical side of the subject.

However, the two subjects are so closely related that they can no more be separated than the bookkeeping system can be separated from the manufacturing end of a large corporation.

The insects must be named and classified and the scientific name recorded, together with the descrpition of the species, or we cannot tell whether the insect which we are studying is the same as the one described in the literature.

The two subjects are so closely related that many of the technical terms used in both sciences must be learned before the literature can be understood.

Study the rest of your Elementary Entomology and where possible collect and study the insects as outlined in the back of this book. Pay special attention to the external anatomy and to the structure of the mouth parts. It will be impossible for you to decide upon the correct remedy, in many cases, without knowing how the insect takes its food.

In studying these lessons, refer frequently to Lesson 8 until you understand the use of the remedies, there described, in controlling the different insects. Also review your earlier lessons, in your Elementary Entomology, until you know the characteristics of the different orders.

The bibliography furnished with the lessons will help you in getting additional literature upon the different species.