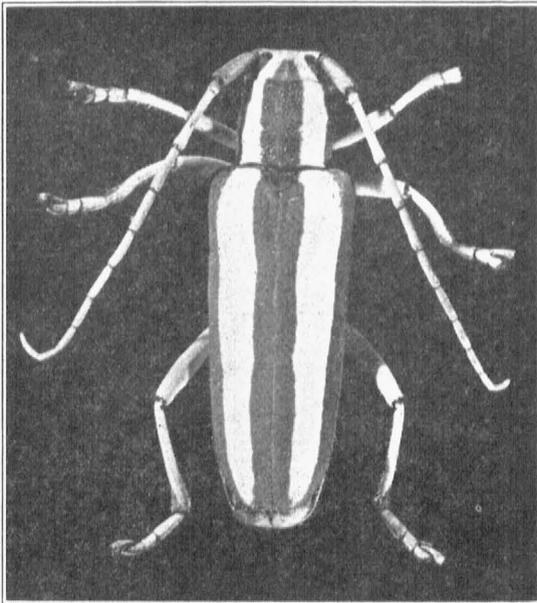


UNIVERSITY OF MISSOURI      COLLEGE OF AGRICULTURE  
AGRICULTURAL EXPERIMENT STATION

F. B. Mumford, *Director*

# Controlling Borers of Fruit, Forest, and Shade Trees

L. HASEMAN



Round-headed apple tree borer, adult.

COLUMBIA, MISSOURI

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# Controlling Borers of Fruit, Forest, and Shade Trees

L. HASEMAN

The unprecedented heat and drouths of 1934, 1935 and 1936, coupled with a reduced rainfall for several years previous, have provided ideal conditions for the development of tree borers. As a consequence, borers of fruit, forest, and shade trees are now doing serious damage in Missouri. The extensive plantings in connection with reforestation, soil erosion control, and highway beautification are being seriously damaged. For the last several years the writer has been studying the various tree borers and practical methods of preventing and controlling them. This report has been prepared to assist fruit growers, foresters, and others in charge of tree planting with the present serious outbreak.

Broadly speaking, there are several types of borers which affect trees and shrubs. These include a few wasp-like borers; the caterpillar borers—such as the peach tree borer; the bark beetles or shot-hole borers; the twig borers or pruners and girdlers; the flat-headed or metallic beetle borers; and the so-called round-headed borers which work mostly in the trunks of trees. Borers usually prefer to attack trees which are not in full vigor, as a rule, the newly transplanted trees or those which are not making vigorous growth first become attacked. To protect trees from borers, therefore, keep them growing vigorously, and in transplanting young or older trees be sure to provide conditions favorable for forcing strong vigorous growth. The best insurance against borers is a vigorous growth, and it is better to prevent them from attacking trees than to wait until they are in and then try to get rid of them.

The adults of some species of borers select the sunny side of limbs and tree trunks on which to bask and lay eggs, so by properly pruning fruit and shade trees or by shading or wrapping exposed portions of the trunks with burlap or other protection, damage from such borers may be largely prevented. Again, the adults of some borers may select the base of trees which have weeds and grass growing up around them for laying their eggs. Cultivation to force vigorous growth will eliminate weeds and grass from around the base of trees. Also, a coating of one part of lime sulfur solution to ten parts of whitewash, or other safe repellent, applied often enough to keep trunks well covered during the summer months may help to repel the adults and thus reduce borer injury. Good cultural practices in planting and caring for trees will usually do more to prevent borer attack than anything else. Borers

are more or less troublesome every year but during and following especially favorable breeding seasons they are sure to require special attention.

### BORERS WHICH ATTACK FRUIT TREES

The most important of the various regular fruit tree borers are the flat-headed apple tree borer (*Chrysobothris femorata* Oliv.), the round-headed apple tree borer (*Saperda candida* Fab.), the peach borer (*Conopia exitiosa* Say), the lesser peach borer (*Conopia pictipes* G. and R.), and the shot-hole borer (*Scolytus rugulosus* Ratz.). The twig pruner and twig girdler which often attack the smaller branches of fruit trees near timber will be discussed with the forest and shade tree borers.

**The Flat-headed Apple Tree Borer** (*Chrysobothris femorata* Oliv.)—This is perhaps our most common borer as it attacks all kinds of fruit trees, as well as shade and forest trees and shrubs. It is especially bad in hot, dry seasons when tree vigor is apt to be below normal. The adult is about half an inch long, flat, and brownish with a metallic copper or greenish luster. It loves to bask in the hot sunshine and most often lays its eggs on the exposed sunny south or west sides of trunks and limbs. Newly transplanted fruit trees which show poor growth in the summer and shade trees with long, exposed trunks offer ideal conditions for this pest.

The borer is a slender, white worm, with a broad, flat enlargement of the thoracic segments at its head end, which gives it its common name. It works just under the bark until it is full-fed, when it bores deeper into the wood to pass the winter. Its tunnel may extend for half a foot up and down the trunk of a small tree or it may run around the tree, thus girdling it. Its tunnel will be found filled with the dry powder or frass, and the overlying bark dies and usually becomes discolored.

The beetles begin to lay eggs in June and may continue until September and borers of varying sizes may be found all summer. The winter is passed in the larval or borer stage deeper in the wood of infested limbs or tree trunks. During the following spring the larvae pupate and the beetles begin to emerge in May. It therefore has a one-year life cycle. The borer makes an elliptical tunnel to accommodate the enlarged thorax and the adult beetle is also shaped to fit the tunnel from which later it must escape.

**CONTROL.**—Strong, vigorous trees, free of sun scald or similar injury, are seldom attacked by this borer. Therefore, keep trees in full vigor by cultivating and fertilizing where necessary. Special care must be taken with trees the first summer after they are transplanted. A barrel stave driven in the ground so as to shade the southwest side



Fig. 2.—Flat-headed apple tree borer, hibernating larva in trunk of young apple tree.

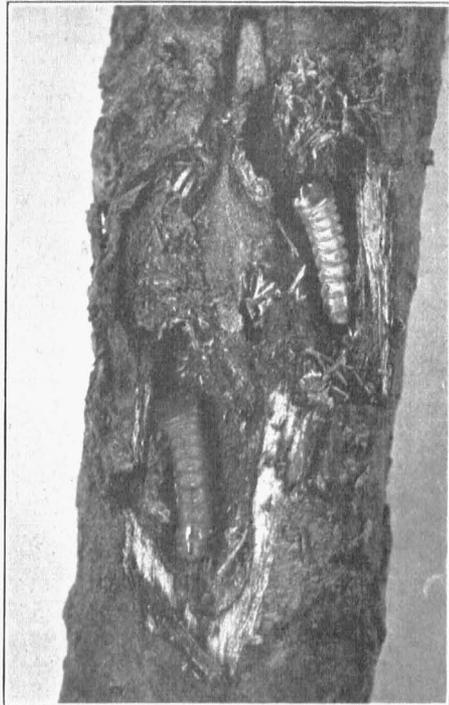


Fig. 3.—Round-headed apple tree borer, half-grown larvae in base of young apple tree. (See page 6)

of the trunks of young fruit trees, where they are not shaded by the foliage above, will help prevent this borer from attacking them. Some workers have reported good results in trapping the beetles by driving stakes in the ground in sunny spots over the orchard and painting them with Tanglefoot. Transplanted elms or other trees with long, exposed trunks may be wrapped with burlap, tough paper, or other similar protector to help keep out borers. Also, the painting or spraying of the exposed trunks of fruit or shade trees with lime sulfur whitewash once a month or oftener will help prevent borer attack. Ordinary whitewash with the addition of one part concentrated lime sulfur solution to ten parts of the whitewash is quite effective, if applied often enough to keep the trees covered with a repelling coat. However, where borers are already in a tree this wash is not effective in killing them. Careful removal of the borers with a knife and prompt painting of the wound is the surest way of getting rid of them once they appear

under the bark, but it is difficult to locate the small borers. However, most of the effort at control of this and other borers should be directed at prevention.

**Round-headed Apple Tree Borer** (*Saperda candida* Fab.).—This borer does not seem to distinguish between weak and healthy trees, but it is usually worse in seasons when tree vigor is below par. Besides apple, it also attacks quince, pear, red haws, and a few other trees. The borers usually work at, just below, and a short distance above the ground, though at times they may appear in tree crotches.

One or two borers may kill a young tree outright, and often trees five to ten years old suddenly break off at the ground due to earlier severe borer injury. In neglected orchards it is one of the most destructive apple tree pests. While it is worse on trees under ten years of age, it will continue to attack old bearing trees.

The body of the adult beetle varies in length from one-half inch to almost an inch, and the prominent antennae are about the same length. The upper surface is brownish with two white stripes extending from the face to the tip of the wing covers. The under surface is white and the legs and antennae are greyish in color. The larva or borer is light in color and when full-grown usually about  $1\frac{1}{4}$  inches in length, with the thoracic region slightly enlarged.

In Missouri it normally has a two-year life cycle in contrast with the one-year life cycle of the flat-headed apple tree borer. The female inserts her eggs in the bark near the ground level. Here, on hatching, the tiny worm feeds for a time in the bark before going deeper. At first the small borer has a brownish-red appearance due to the food in its digestive tract. Brownish sap strains appear on the bark where the small borer is feeding. In due time it works deeper, and usually by the first of September most of the borers are found between the bark and wood or beginning to tunnel in the sap wood. During this time most of the borers eject from their tunnels conspicuous rusty-brown frass and wood cuttings. By the time freezing weather sets in, most first-year borers are about half an inch long and have usually produced a tunnel three to four inches long. It usually passes its first winter in the sap wood at or a little below the level of the ground. The following spring, summer, and fall it grows rapidly, bores deeper in the wood, and in the fall prepares a winter chamber a few inches above the ground level and a quarter of an inch to perhaps half an inch beneath the bark. This chamber usually has its upper end plugged with fine cuttings and frass and its lower end with coarse wood cuttings. The upper end of the chamber curves out until it comes almost in contact with the overlying bark. The borer spends

its second winter in this chamber and pupates there the following spring. Later, it passes to the adult stage and in due time the beetle cuts away the bark cap and escapes. In the spring a small, circular patch of the bark over the upper end of the tunnel becomes dry and sunken, so that one can readily locate the outlet of the tunnel. Beetles may appear during May and June and oviposition may continue until late July. Most of the eggs have hatched by early August.

**CONTROL.**—This borer is worse in neglected or abandoned orchards. Proper pruning and cultivation to keep weeds, grass, and other litter away from the trunks of the trees will help reduce borer injury. The frequent application of whitewash containing lime sulfur to the tree trunks will also help repel the beetles. Any binding or greasy material painted on tree trunks for borers is apt to cause injury and is not recommended. The spraying of the young, as well as bearing trees, at regular intervals during May, June, and July may help to poison some beetles, since they are known to feed on foliage and tender twigs.\*

Wood veneer, and fine mesh screen wire wrappers on tree trunks, as guards against borers have not proven entirely practical, but limited tests with cellophane wrappers show some promise. Since the beetles do not seem to scatter far, special attention should be paid to trees in those parts of orchards where previous infestation has occurred, especially alongside woods.

In spite of all that the orchardist can do to prevent the beetles from ovipositing in the trees, however, some borers will get in and will have to be removed or destroyed later. Each year during August and early September the grower, who in the past has had trouble with this borer, should check on each tree for the presence of the young borers. In practically all cases the newly hatched borer will cause some escaping of sap at the point where it begins to feed in the bark and, as a rule, this rusty-brown sap stain can be seen plainly on the surface of the bark. It is usually more conspicuous than the presence later of the rusty-brown pigtail frass and borer cuttings. At that time a shallow slice in the surface bark with a sharp knife will expose or kill the young borer without causing any injury to the tree.

In central Missouri, even up until the middle of September most of the borers can still be removed without any serious injury to the cambium layer. However, later work will require deeper cutting and probing with a wire to kill the borers. Also, delay in removing the borers gives them additional time to girdle and more seriously damage the trees. Still, if early worming is not possible, the work should be done later even though more cutting and injury is necessary. At this

\* Geo. C. Becker, Tech. Bul. No. 146, Ark. Agr. Expt. Sta., 1918.

same time it is often possible to locate and destroy an occasional second-year borer, which may have escaped the previous year's worming. If the borers are removed in August it does not require much time and but slight damage need be done. It is best to worm the trees each year, especially in those parts of the orchard where borers are most numerous.

To date, we do not have a chemical wash or tree paint that we feel safe in recommending for killing the borers once they are in the trees. Beta naphthol, paradichlorobenzene, or calcium cyanide mixed with oil and daubed on the spots where the young borers are at work, or introduced in their tunnels, will kill them, but these materials are injurious to the cambium layer of apple bark and, if painted on tree trunks, may kill the trees outright. Their general use against this borer is hazardous and we do not recommend them, especially since the young borers can be quickly removed with a sharp knife without much injury to the tree.

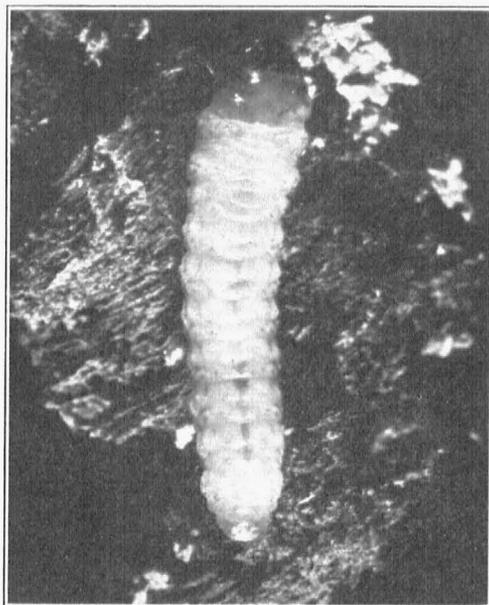


Fig. 4.—Peach borer, half-grown larva.

**The Peach Borer** (*Conopia exitiosa* Say).—The adult peach borer is one of the clear-winged moths which mimic wasps. The female has bluish front wings, clear hind wings, and a bright orange band across the abdomen, while the smaller male has clear wings and yellowish bands across the abdomen. The caterpillar, which does the damage,

is about an inch long when full-fed, milky white in color, and has a hard, brown head. Infested trees show the characteristic masses of gum at the ground line where most of the borers work. Not infrequently a tree will have a dozen or two borers of varying size working beneath the gum and bark. This girdling effect of the borers, which weakens and kills badly infested trees, makes this one of the most important insect pests of the peach tree in Missouri. Years ago the borer, together with the arrival of the San Jose scale, had much to do with the abandoning of the important peach growing industry in the south central part of the State.

The pest passes the winter in the partly-grown borer or caterpillar stage beneath the bark and gum at or just below the ground line. In the spring the borer resumes feeding, later producing a cocoon of silk covered with dirt and gum in which it pupates. Moths begin to emerge by the first of July and continue to emerge and oviposit until late September. As a result, the larvae found in a tree vary greatly in size and age.

**CONTROL.**—In the early days this pest was controlled largely by digging out the borers with a knife. This is a slow method and quite injurious to the trees if every borer is located and removed. In recent years investigation has shown that treating infested peach trees with paradichlorobenzene (PDB) is the most practical and effective remedy for this pest. However, the grower must apply the correct dosage in the proper way and at the right time, if he is to get satisfactory control and not injure especially young peach trees.

For several years PDB crystals have been applied in a ring around the base of the tree and then covered with soil to retain the gas. From one-half to three-fourths of an ounce is satisfactory for average four to five-year-old trees, and an ounce or more is the proper dosage for older and larger trees. The treating of trees under five years of age with the crystals is hazardous unless conditions are right and the grower takes proper precautions to prevent the accumulation of gas from injuring the tender bark of the young trees. Dosages of one-fourth ounce for trees planted in the orchard one or two years, and one-half ounce for trees planted three and four years, with normal Missouri late-September soil temperatures should give satisfactory kills of borers in 10 to 14 days. If the remaining crystals and the mound are then hoed away from the trees the treatment should not injure the young trees. However, the grower must remember that there is a risk in using this material on the young peach trees and where borers are not serious young trees can be wormed by hand with less hazard.

To apply PDB crystals, first hoe away all litter and rocks and smooth the soil for a foot around the base of the tree. Next apply the



Fig. 5.—Peach tree being treated with ring of Paradichlorobenzene for borers.

proper dosage of crystals in the form of a ring about the tree so that none of the crystals are less than one and one-half to two inches from the tree. Then cover the crystals with a few shovelfuls of mellow soil and firm and mound it about the base of the tree. In case of young trees remember to hoe away the mound and remaining crystals in 10 to 14 days, but with older trees the mound may be removed any time before the following summer.

For best results the treatment should be made in the fall after most eggs have been laid and hatched and before the soil becomes too wet and cold. For the north half of the state, September 20 to October 5, and for the south half, September 25 to October 10 in normal falls are the proper times to treat peach trees with PDB for borers.

More recently Snapp\* and others have developed a new method of treating peach trees with PDB, which they have found safer for young peach trees and also more satisfactory on trees of all ages. The PDB crystals are combined with crude cotton seed oil emulsion or with mineral oil emulsion and then applied as a spray to the base of the trees and the ground. Two pounds of the PDB are dissolved in one gallon of crude cotton seed oil and the mixture emulsified with a good grade of potash fish oil soap. The stock emulsion is then diluted with water so that the proper dosage of PDB for each tree is contained in

\* Oliver I. Snapp, Jr., *Econ. Ent.*, Vol. 25, p. 786, 1932, also Oliver I. Snapp and J. R. Thompson, Jr., *Econ. Ent.*, Vol. 27, p. 771, 1934.

one-half pint or in one pint of the emulsion as applied to the trees. For instance, this stock emulsion would contain 32 ounces of PDB or enough to treat 64 trees if each receives one-half pint of diluted emulsion, containing one-half ounce of PDB, and you would, therefore, add enough water to the stock emulsion to make 4 gallons or 64 one-half pints.

Under Georgia conditions, the following dosages per tree proved effective in killing borers without injuring the trees: Nursery trees, one-half pint of emulsion containing one-sixteenth ounce of PDB; orchard trees 1 and 2 years old, one-half pint containing one-eighth ounce; three-year-old trees, one-fourth ounce of PDB; four and five-year-old trees, one-half ounce; and six-year-old trees and older, three-fourths ounce PDB in one pint of emulsion. Vegetation, rocks, and other litter should be hoed away from around the tree before the material is applied. After applying it, mellow dirt should be used to make a low mound as in applying the ring of crystals.

In 1934,\* we used crude cotton seed oil emulsion impregnated with PDB on a small orchard of peach trees which varied in age from three or four years to nine or ten years. The dosage was varied slightly depending upon the size of the tree trunk, the older ones receiving about one-half pint containing one-half ounce of PDB. The results compared favorably with those secured in the same orchard with a ring of the crystals and apparently no injury to the trees occurred. Less extensive experiments with the PDB crystals dissolved in one of the commercial dormant mineral oil emulsions indicate that, while more hazardous apparently due to more rapid release of the gas, the kill of borers is satisfactory. The application of the PDB in an oil emulsion has some advantages but it involved additional details which must be carefully followed and the busy grower may prefer the ring of crystals treatment.

**Lesser Peach Borer** (*Conopia pictipes* G. and R.).—This borer is a close relative of the peach borer, being also a caterpillar. Fortunately, it is usually not a serious pest in this State. It works mostly higher up on the tree in the crotches where it causes the characteristic masses of gum. It is a whitish worm with a brown head and, when full-fed, it pupates in the tunnel and moth emergence takes place during May and June. There is one full brood and a partial or complete second brood farther south. The female moth lays her eggs in cracks

\* Herbert L. Koch, formerly of this department, assisted with this experiment.

or wounds especially in crotches, and the partly grown larvae pass the winter beneath the bark.

**CONTROL.**—Where the pest is not serious, good orchard management to keep the trees strong and vigorous and free of injury will usually control this pest. Careful hand worming will also help. Snapp and Thompson\* report effective control by thoroughly painting the *infested areas only* with a solution containing 1 pound PDB dissolved in 2 quarts of crude cotton seed oil.

**Shot-hole Borer (*Scolytus rugulosus* Ratz.).**—There are a number of small so-called bark beetles or shot-hole borers attacking fruit, shade and ornamental trees and shrubs, but since their habits, injury, and means of control are similar we will consider only the common species.

Weakened trees or limbs are often found with many small round holes in the bark and, in case of stone fruits, often gum appears in and around these holes. This is the external sign of shot-hole borers. The small blackish female beetle bores through the bark and then runs a tunnel between the bark and wood usually lengthwise of the limb or trunk. In the sides of the tunnel or egg chamber she places several eggs. In due time the eggs hatch and the grubs begin tunneling along under the bark. These larval tunnels start off at right angles to the egg chamber but later turn parallel to it. The tunnels are cut partly in the wood and partly in the bark and later on, if the bark is removed, there appears in the wood a centipede-shaped engraving. The larva, or small pinkish-white grub, on maturing, changes to a pupa and later to the beetle stage, which eats a round hole through the bark and emerges as a small strong-flying beetle. There are normally two or more generations of the pest a year in Missouri, and they can rapidly girdle and complete the killing of weak trees.

**CONTROL.**—Keep all fruit trees growing vigorously and promptly prune out and burn dead or badly infested trees or weak and dead limbs. Vigorous trees are not attacked. Piles of prunings left in or near the orchard may serve as a breeding place for the pest. Where a limited area of infestation shows up on the trunk of an otherwise healthy tree we have found that painting this area a time or two with a strong solution of lime sulfur, about a 1 to 10 dilution, will stop the spread of the pest. However, cutting out and burning infested timber is the surest way to dispose of a limited infestation.

\* Snapp, Oliver I., and Thompson, J. R., Control of the Lesser Peach Borer with Paradichlorobenzene Solutions, U. S. D. A. Cir. 172, 1931.

## FOREST AND SHADE TREE BORERS

The shortage of rainfall and the lowering of the normal water table for the last several years, together with the severe drouths of 1934, 1935 and 1936, have resulted in the death of much timber and the serious weakening of much more. These same conditions have also favored the increase of tree borers. At the present time, therefore, the borers are a real menace to forest and shade trees in Missouri. A number of the most important ones will be discussed and general control measures for these may be used in handling the various other less important species. The recent extensive plantings of black locust and various other native forest trees in connection with soil erosion control, reforestation, and highway beautification will require careful handling to prevent serious borer damage.

Since most of the tree borers prefer to attack the weak or dying trees, every effort should be made to keep all trees healthy and vigorous. In transplanting trees be sure that there is a goodly supply of roots, and prune the tops to match the root system. Regular nursery-grown trees will usually have better root systems and will withstand the shock of transplanting better than trees dug in the woods. Also, see to it that trees are properly planted and in soil favorable for good tree growth. In moving large trees, a ball of dirt should preferably be taken along. In case of a dry summer, water, cultivate, and fertilize to keep up the vigor and help discourage borer attack. Make sure that leaky gas mains in cities do not weaken trees and encourage borer attack. Forest fires always pave the way for later borer attack. Where transplanted trees along highways, streets, and in lawns die or are killed by borers, grub them out and burn them so as to dispose of the borers which may be in them. In case of native timber, the dead and dying trees should be removed for lumber or wood to prevent them from continuing to serve as breeders of various borers. Dead limbs and branches on otherwise healthy trees should also be promptly removed and used as fuel or burned. Good care in the handling of trees, including pruning, painting pruning scars, cultivation, watering when needed, or mulching will help to keep the trees vigorous and that is the best insurance against tree borers.

Tree borers do most of their destructive work inside the tree or its branches where it is difficult to get at them with ordinary controls, so it is important that every effort be made to prevent the parent of the borers from placing her eggs on or in the trees. Trees from nurseries or those dug in the woods, when transplanted singly, will tend to have much of their bare trunks exposed to the hot sun, which is sure to

attract the adults of borers. In such cases, by wrapping the exposed trunk with burlap or paper made for the purpose or by painting or shading the trunks in some way, danger of attack by borers can be lessened. Careless transplanting of trees, placing them under unnatural conditions, and the thoughtless cutting and slashing in forests and wood lots or the burning off of woods all encourage borers and borer losses.

Of the various species attacking native forest and shade trees probably the flat-headed borers, the locust borer (*Cyllene robiniae* Forst.), the elm borer (*Saperda tridentata* Oliv.), the painted hickory borer (*Cyllene caryae* Gahan), the cottonwood borer (*Plectroder scalator* Fab.), the carpenter worm (*Prionoxystus robiniae* Peck), the hickory twig girdler (*Oncideres cingulata* Say), and the oak twig pruner (*Hypermallus villosum* Fab.) should be considered as among the most important species in Missouri at this time. Many other species will be found but their injury and methods of control will be similar to those of the species considered.

**Flat-headed Borers.**—There are several important species of the so-called flat-headed borers which attack various shade and forest trees. The grub or borer has the thoracic region behind the head enlarged and flattened which gives them their common name. The adults are spoken of as the metallic wood borers, and the common flat-headed apple tree borer, discussed under fruit tree borers, is a typical species and one of our most important borers in shade trees. Transplanted shade trees, especially in exposed places such as along the highways, have been seriously damaged in recent years by this species. In fact, thousands of trees have been completely girdled and killed outright by it.

This type of borer works just under the bark and tends to girdle the tree. It is always worse on trees which have been injured or which have received a setback in transplanting, and it is the exposed sunny south and west portion of the tree that the pest usually attacks. The common flat-headed borer has a one-year life cycle. The adult lays the eggs in the bark during the summer and the grub matures by late fall, passing the winter deeper in the wood and transforms through the resting stage to the adult the following summer.

**CONTROL.**—To control this type of borer, first keep all trees growing as vigorously as possible, paint pruning scars and injured spots, and promptly remove and burn dead or hopelessly weak infested trees. Where trees are transplanted to open sunny places, as along highways, wrap the exposed trunks with a double thickness of burlap or some grade of paper or other materials which are not too binding. A type

of paper made by sealing two layers together with an asphalt binder, such as used to wrap nursery stock and other materials to prevent drying out, has given favorable results. Even a few thicknesses of newspaper or brown wrapping paper will give fair protection. A wrapper helps not only to protect the exposed trunks from sun scald in the winter but also to prevent the parent beetle from placing its eggs in the bark during the summer.

Repellent washes applied to the tree trunks to prevent oviposition have not always proven satisfactory but, if applied often enough to maintain a repelling odor, they will help. Lime sulfur solution added to whitewash so as to give a strong odor is a safe wash to use on young tree trunks and if applied frequently it will help to reduce borer attack. A sulfonated oil, such as some recommend as a rabbit repellent, used during the severe drouth of 1936 by our State Highway Department, shows promise as a repellent for this type of borer. It did not injure elm and ash, but did injure soft maple on the sunny side. It is made by bringing linseed oil to a temperature of about 470°F. and after removing from the fire slowly work into the hot oil 3 ounces of sulfur for each quart of oil. It is then applied with a brush. While various washes may help, they generally do not prove as effective as a satisfactory wrapper.

**Locust Borer** (*Cyrtene robiniae* Forst.). With the extensive planting of black locust for soil erosion control, this borer is sure to become a more important pest in Missouri in the next few years. In the past it has always been a serious pest in extensive locust plantings where conditions favored its development. The adult is a beautiful long-horned beetle about three-fourths inch in length; black, with bright yellow stripes or broken lines across its back. It is commonly found feeding on goldenrod blossoms and other fall flowers.

Eggs are laid in the fall on portions of the tree covered with scaly bark. The eggs soon hatch and the young borers tunnel into the soft inner bark to feed. They remain there until the following spring when they again begin to feed, causing wet spots with brown boring dust on the trunks and limbs. Later they tunnel directly into the heartwood. They cause enlargements at the point of attack and may deform, weaken, or even kill the tree or limb outright. The black locust is its natural host tree and its injury is largely confined to portions of the tree having rough scaly outer bark. By mid-summer the larvae are full-fed. They then transform to pupae inside the tunnels and by early September the beetles begin to emerge and feed on flowers or run about on the tree trunks laying eggs.

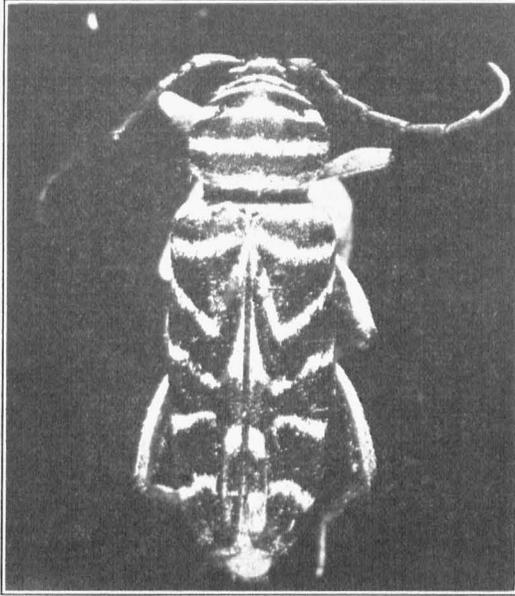


Fig. 6.—Locust borer, adult.

**CONTROL.**—This pest has always been a difficult one to control. A few trees, especially before they become too large, can be kept free of borers by going over them each fall and removing the borers from the inner bark or by injecting into the new tunnels a few drops of carbon bisulphide or the paradichlorobenzene-cotton seed oil mixture recommended for controlling peach tree borer. These chemicals should be used only in the individual tunnels as they may injure the bark if painted on or used too heavily. Craighead\* found that by thoroughly spraying the trunks of infected trees with one-fourth pound sodium arsenite or arsenate, and one quart of miscible oil in five gallons of water, just as growth starts in the spring, he was able to kill the young borers. One gallon of kerosene emulsion stock solution and one-fourth pound sodium arsenite in four gallons of water gave similar results. Where borers are not serious, an application so as to reach each borer tunnel every second year should keep trees reasonably free of borers. The oil emulsion causes the soluble arsenic to penetrate the borer tunnel to the inner bark where later the borer eats it and is poisoned.

Where locusts are used in soil erosion work borer damage can be reduced to a minimum if they are closely planted or used in mixed

\* Craighead, I. C., U. S. D. A. Bulletin No. 789.

plantings to provide dense shade. The adult is a sun-loving beetle and avoids shady places. Such plantings should not be pruned out and undergrowth should not be removed or burned. Natural plantings if thick, and dense growth of sprouts from older trees provide conditions unfavorable for the borer.

**Elm Borer.**—The different species of elms are among the most popular and satisfactory trees for shade and ornamental plantings. The old native elms of the east are famous for their beauty. Under normal conditions the elms are relatively free from insect attack but in dry seasons, or when for any reason an elm tree becomes weakened, the elm borer is almost certain to attack it. Then if steps are not taken promptly to control the borer the tree is almost certain to be killed by it.

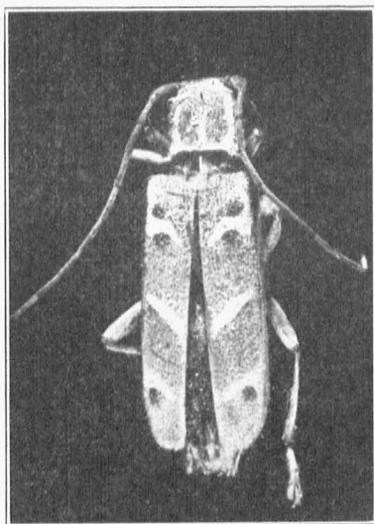


Fig. 7.—Elm borer, adult.

The adult elm borer is a beautiful grey beetle marked with red stripes and dark spots on the thorax and wing covers. It is about one-half inch in length, slender, and with its long antennae reaching almost to the tip of the wing covers. The beetles begin to emerge from the trees by early May and they may continue to appear throughout the summer.

Eggs are laid on the bark or in crevices where later the small white footless grubs hatch and bore into the bark. The escaping sap and brown frass may be observed as a brown moist spot on the bark. They may feed for a time on the outer corky layer of bark but later they



Fig. 8.—Elm tree showing severe borer attack.

reach the inner bark or cambium layer. Here they feed in part on cambium and part on the wood, making winding tunnels filled with their frass. At first the borers may have a reddish color due to the food in the digestive tract, but later as they approach full growth they are creamy white with a brown head. When full-grown the larva is about one inch long. The winter is passed largely in the almost mature larval stage. In the spring the larva prepares a pupal chamber and later emerges as the beetle. Under Missouri conditions it has normally a one-year life cycle.

**CONTROL.**—Strong, healthy elm trees are seldom or never attacked by this borer, but trees weakened due to excessive drouth, leaky gas mains, loss of roots in excavation work, disease, or for other reasons may attract the beetles and soon show borer attack. Since it is always better to prevent the attack of borers, if possible, every effort should be made to keep elm trees, especially the old native trees, healthy and in vigorous growth. Watering and fertilizing when necessary may save a valuable tree from attack. Borer trouble is usually more common

on elms in cities, due to the fact that the elm trees are usually less vigorous there than in the open country, but injury from this borer may occur in native elms in the woods, open fields, or on country lawns.

From year to year, especially in drouth seasons, one should keep a close watch for elm borer injury. If found before the borers have done too much damage one can usually kill or remove the borers and save the tree. Figure 8 shows a native elm in the writer's lawn which, due to the 1934 drouth, became seriously weakened and the elm borer attacked it. Something over 250 borers were removed from the bark of the tree during September and the tree has since completely recovered from the attack, as indicated by the healing of the scars made in removing the borers. All the borers were in the tree trunk and none over seven or eight feet from the ground. After digging out the borers, each wound was painted to prevent diseases or other pests from developing in the wounds. The rainy spring of 1935 favored recovery from the damage.

In place of digging out the borers, it is possible to treat the individual borer tunnels or the spots on the bark where the sap and frass indicate a borer is working, as in the case of the locust borer. This requires much less work, but when you use a stiff-bladed knife or a narrow wood chisel and remove and destroy the individual larva you know that it is dead.

Where the borers are not found in time to save the infected tree it should be removed and used for wood before the adults emerge from it the following summer.

**Painted Hickory Borer** (*Cyllene caryae* Gahan).—This borer is a pest of recently cut or dead hickory timber seemingly wherever it may be growing. Hickory is an important Missouri tree, not so much perhaps for its nuts as for its very valuable wood, and this is one of the most important insect enemies of hickory timber. The adult is a beautiful long-horned beetle closely resembling the locust borer. In fact, the resemblance is so close that for years they were mistaken for the same species though the adults of the locust borer appear in the fall while this one appears only in the spring. Besides hickory, it may also attack walnut, butternut, osage orange, and a number of other trees.

It has but one generation a year. The active, sun-loving adults appear in early summer about the time hawthorns are in bloom on the pollen of which they feed freely. Mating occurs soon after the adults emerge and oviposition begins soon after mating. Eggs are placed in crevices in the rough bark, and on hatching a week to ten days later the larvae bore through the bark and begin to tunnel between the cambium layer and the sapwood. In case of standing trees these tunnels

usually first extend downward, but in case of cut logs they may run with the grain in either direction. As the borer increases in size it enlarges the tunnel so that when full-fed the gallery may be about three fourths of an inch in width and a third of that in depth. The galleries usually have one or several loops to them and they are made partly in the bark and partly in the sapwood, and always tightly plugged with sawdust. The larva requires about three months to mature when it prepares a large pupal chamber in which it later changes to the pupal stage. The pupal cell may extend into the wood as much as two inches and then a like distance at right angles with the grain of the wood. Pupation occurs in the late fall, the winter is passed in this stage, and about the time red haws bloom in the spring the beetle emerges.

**CONTROL.**—While the borer does not attack live, vigorous trees it may cause much damage to recently cut logs if precautions are not taken to prevent it. Hickory trees which may die for any reason should be cut promptly and all hickory timber should be used within a few months after it is felled or else the logs should be barked or submerged in water to prevent borer injury. If these precautions are taken, later damage to valuable marketable timber will be prevented. In the woods the pest can be kept under control by promptly disposing of the hickory brush and other slash not used for fire wood or for marketing.

**Cottonwood Borer** (*Plectroder scalator* Fab.).—The adult of the cottonwood borer is a large, black and white mottled beetle with antennae longer than its body. It has been taken in great numbers in

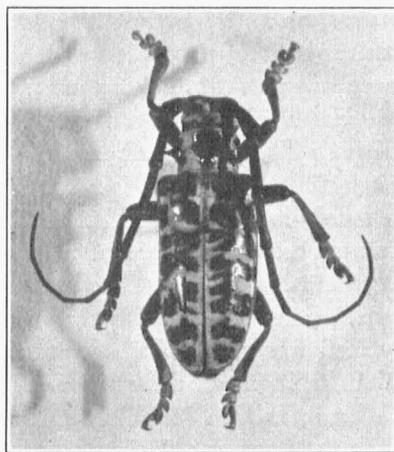


Fig. 9.—Poplar borer, adult.

Japanese beetle traps in St. Louis during the last two summers. The borer is of a yellowish color, and when fullgrown, over an inch long and resembles other large round-headed borers. It hatches from an egg laid during the summer at the base of poplar, cottonwood and willow trees. The grub feeds for two years before emerging as the beetle. It works first between the bark and sapwood but later runs its tunnel deeper in the tree, weakening or even killing the tree. Sawdust and shredded wood cuttings thrown out of the tunnels collect around the base of infested trees.

**CONTROL.**—Protective washes applied to the base of the tree from the first of July until the first of August will help to prevent the beetle laying eggs where the borers on hatching later get into the tree. Fine-mesh screen guards, a foot or more tall, placed about the base of trees will also help keep beetles away. If borers get in they can be removed from valuable trees by hand before they have gone very deep, or a few drops of carbon bisulphide or similar chemical can be injected into the borer tunnels and the tunnels closed with moist dirt. Where trees are killed outright, or so weakened that they cannot be restored to normal vigor, they should be removed and the timber used for fire wood. This borer is usually worse in towns and cities, attacking trees of all ages.

**Carpenter Worm** (*Prionoxystus robiniae* Peck).—This is a large caterpillar borer which, while less important than some of the more destructive beetle borers, may cause considerable damage some seasons. It is known to attack black locust, oak, ash, maple, cottonwood, and

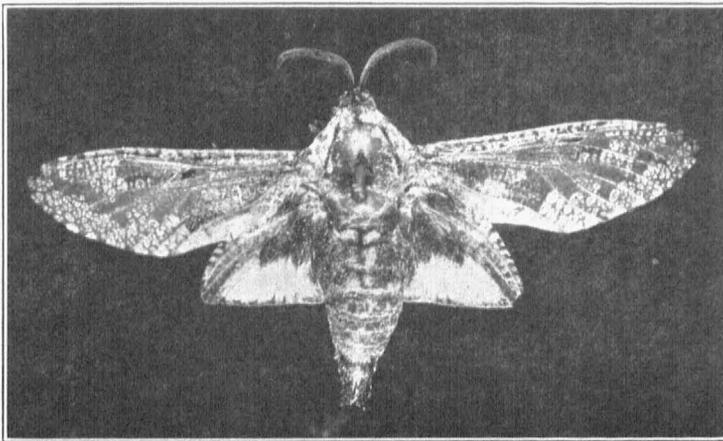


Fig. 10.—Carpenter worm, male moth.

other trees. The female moth expands about three inches and is dark gray mottled with lighter gray. The male is smaller and its hind wings

have a yellow or orange area along the outer margin. The larva requires three years to mature when it is nearly three inches in length, white with a pinkish tint, and a brown head. It is one of the largest borers found in timber, often making a tunnel over half an inch in diameter. While it does not often kill trees it may so deform and weaken them that they must be removed.

CONTROL.—The eggs are usually laid around wounds or scars on limbs or trunks of trees, so by painting pruning scars and being careful to avoid injuring trees there is less danger of their becoming attacked by this borer. Prompt removal of infested portions of trees or injection of carbon bisulphide into their tunnels will help to eliminate this pest, where it is attacking valuable shade or ornamental trees.

**Twig Girdler** (*Oncideres cingulata* Say).—The adult beetle is about three-fourths of an inch long, stout, and brownish with a lighter band across the middle of the wing covers. It appears from August

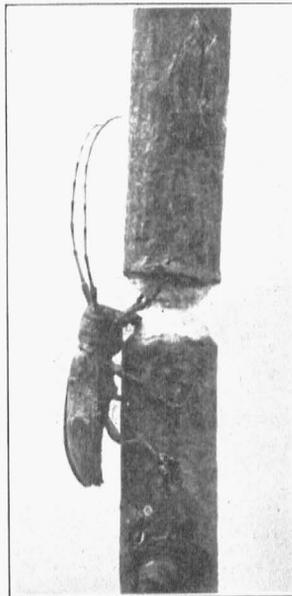


Fig. 11.—Hickory twig girdler, adult.

until early October and inserts an egg beneath the bark of small limbs just below each side branch and undeveloped bud. Then it crawls down the branch and with its powerful jaws cuts a smooth girdle around it deep enough so that later the wind or its own weight usually causes it to break and drop to the ground. The eggs hatch and each

tiny borer begins to feed on the wood at the point where it hatches. As they grow they extend their tunnels and pass the winter in the fallen twigs as partly grown larvae. The following spring, feeding is continued and the larvae usually consume most of the wood, leaving the bark largely intact. Pupation occurs in the cavity made by each larva and later the adults emerge and prepare to lay their supply of eggs and girdle twigs.

It has been called the hickory twig girdler, but in Missouri it is usually much more severe on persimmon, elm, and pecan than on hickory. However, it may attack several other forest and shade trees and it also does some damage to apple and other fruit trees. The writer has often seen persimmon groves so severely attacked that mature trees were pruned back to a round top, consisting largely of short one-year growth. Also, during the period of heavy oviposition, elm trees in lawns may have a large armful of cut-off twigs beneath them each morning.

CONTROL.—Since the pest survives the winter in the partly grown grub or borer stage, in fallen branches, it can be effectively controlled by gathering and burning these as they fall.

**Oak Twig-pruner** (*Hypermallus villosus* Fabr.).—During the fall one often finds great numbers of small branches of apple, oak, and

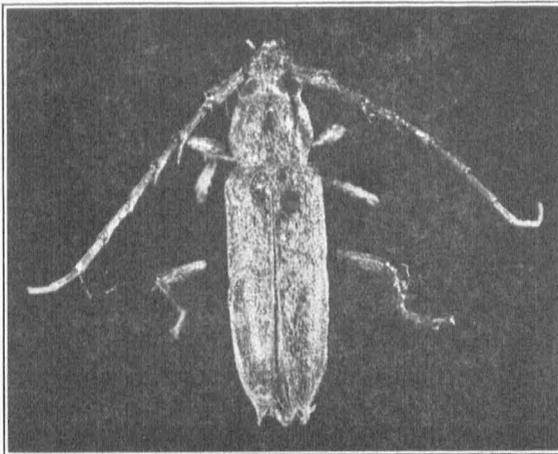


Fig. 12.—Oak twig pruner, adult.

other trees, cut off smoothly as if by a knife and with a central tunnel in the end of the fallen branch plugged with wood cuttings. This is the work of the oak twig-pruner. The adult is a grayish-yellow colored slender beetle about one-half inch in length, with long antennae. It

usually lays its eggs in a small dead twig during the summer and the grub or borer first tunnels out this and then works into the branch. Eventually, when full-fed, the borer severs the branch by making a smooth cut. The pest usually spends the winter in the slender, yellowish-white borer stage, pupating and emerging from the fallen branches as the beetle the following spring and summer.



Fig. 13.—Apple twig showing work of oak twig pruner.

It attacks a considerable number of forest trees, as well as most of the different fruit trees, being most noticeable on apple near woods. The amount of damage done is usually not great, especially on thrifty trees, but the severed branches always attract attention.

**CONTROL.**—In the case of forest trees, control measures are usually not necessary or practical. Where damage to fruit or shade trees occurs, careful gathering and burning of the fallen branches during the fall or winter may largely eliminate damage the following year. Also, by keeping trees vigorous and free of small dead twigs, in which the eggs are usually laid, one can reduce damage by this pest.

**Other Species of Borers.**—Besides the borer pests of native hardwood forest and shade trees that have been mentioned, there are many, many others which might well have been included, besides a few which attack pines in south Missouri. Of these, the various species of small bark beetles, a number of flat-headed and round-headed borers which breeds commonly in seasoned firewood or logs cut for lumber, several species of small caterpillar borers similar to the peach tree borer, the wasp-like pigeon tremex found breeding in weak or dead trees, as well as many others, should be mentioned. However, the ones discussed are among the most important species in this State, and methods of controlling these will serve as a guide in controlling the various other species where they are serious.