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THE SHOT HOLE BORER

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THE SHOT HOLE BORER

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The shot hole borer (*Scolytus rugulosus* Ratz.), sometimes called the fruit tree barkbeetle, is a pest of European origin. Within the last few years articles have appeared reporting the shot hole borer as injurious to fruit trees in Argentina, Austria, Crimea, England, Jugoslavia, and Bulgaria. It is believed to have been accidentally introduced into the United States some time prior to 1877. In 1916, Brooks[2] stated that the beetle occurred throughout practically all of the United States east of the Mississippi River, and in many localities to the west and in Canada. The first authentic record of the occurrence of this pest in California is found in the files of E. O. Essig, who discovered it in Ventura County in 1910. At the present time this pest is known to occur in the majority of counties in California. Its known distribution and importance in California are shown in figure 1. During the past two or three years this insect has been responsible for severe injury in some sections of the Santa Clara, San Joaquin, and Sacramento valleys and in parts of southern California.

DESCRIPTION AND LIFE HISTORY

The body of the adult beetle is roughly cylindrical in shape. There is considerable variation in the size of the adults, due to differences in the amount and quality of food obtained by the larva, or immature stage. The majority of adults, however, measure from 0.094 to 0.112 inch in length and from 0.039 to 0.048 inch in diameter. The color is dark brown or black; the legs are generally lighter brown than the body.

The females cut circular holes in the bark, generally in the centers of lenticels as shown in figure 2. The lenticels are raised and roughened areas of the bark, which contain soft spongy tissue, adapted to the exchange of gases. Such situations afford the beetles better footing and are less resistant than smooth bark. From these holes, tunnels are constructed through the bark to the beginning of the

[1] Research Assistant in Entomology and Parasitology.

[2] Brooks, F. E. Orchard barkbeetles and pinhole borers, and how to control them. U. S. Dept. Agr. Farmers' Bul. 763:1–15. 1916.

wood. Here the females generally work up or down the length of the limb and continue to construct their tunnels through the inner bark and cambium. Generally these tunnels are cut slightly into the wood, so that when the bark and frass, or undigested food deposited by the

Fig. 1.—Present distribution and importance of the shot hole borer in California.

larvae, are removed from a heavily infested limb the adult burrows are indicated by shallow grooves in the wood. As soon as the females have constructed a short length of tunnel they begin to lay eggs along the sides. The eggs are white and spherical, and are enclosed only in a thin membranous shell. In order to protect the eggs, the females

shred some of the bark and wood, and cement it along the sides of the burrow until the eggs are completely imbedded. These protecting walls can be seen in figure 3, where the whiter wood contrasts with the darker bark. The females continue the tunnels until they are from 1 inch to 1¼ inches in length. Eggs are laid along the sides of the tunnels as they are excavated. These tunnels are called the primary, or egg, tunnels. In the work of excavation each female is generally accompanied by a male, which is frequently seen standing on the bark near the mouth of the burrow. When the burrow is completed and all of the eggs are laid the female backs to the opening of the burrow and dies there with the posterior end of the body projecting. The body of the female thus blocks the opening and prevents the entrance of parasites, or predators which might kill the eggs or young larvae.

The eggs hatch within a few days after being laid. The young, or larvae, are very small at first, and can scarcely be seen by the unaided eye. They immediately begin feeding on the cambium and inner bark and advance through it generally at right angles to the egg tunnel. They grow rapidly and the burrow, which they construct by feeding, becomes larger as they advance. These burrows, constructed by the immature beetles, are called secondary, or larval, burrows. They differ from the primary burrows in that they are packed full of frass or undigested material, whereas the egg tunnels are open; also, they are very small at the beginning and widen rapidly, whereas the primary tunnels are of uniform bore. The tunnels of a single, isolated female and her progeny somewhat resemble a centipede, wherein the primary burrow represents the body and the secondary burrows represent the legs. Such a formation is practically never seen, because of the fact that when the beetles are present in sufficient numbers to be of economic importance, the primary burrows are close together and the larval burrows are completely intertwined. In heavy infestation the entire inner bark is reduced to powder. Young feeding larvae are pinkish in color because of the ingested bark which is visible through their bodies. The full-grown larvae are white with small brown heads sunken into the enlarged anterior part of their bodies. They are legless and their bodies are generally curved. The fully matured larvae generally burrow toward the center of the limb and penetrate the wood for a distance of about 1/16 inch. They then turn up or down the limb and construct a cell in which to pupate, or transform to the adult. The short burrow leading to the pupal cavity is tightly packed with chewed wood. Some of the larvae of the summer broods pupate in the bark, but the overwintering generation all pupate in the wood (fig. 4). The length of the larval period is imper-

Fig. 2.—Entrance holes made by females constructing egg tunnels. These holes represent sufficient brood to give rise to the condition in figure 4, when the next generation of beetles emerge. (Enlarged two times.)

Fig. 3.—The inside of the same piece of bark shown in figure 2. This shows how the inner bark may be reduced to powder while very few holes appear on the outside of the bark. The more distinct burrows are egg tunnels. The white spots are masses of chewed wood which form the outer portions of the plugs protecting the pupal chambers. (Enlarged two times.)

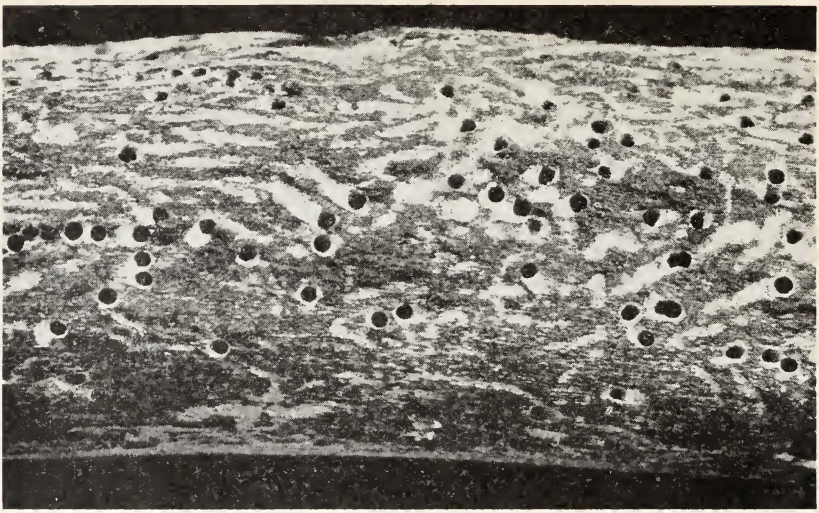

Fig. 4.—Wood with bark removed, showing holes through which adults have emerged. The round white spots are plugs protecting pupal cells from which adults have not yet emerged. (Enlarged two times.)

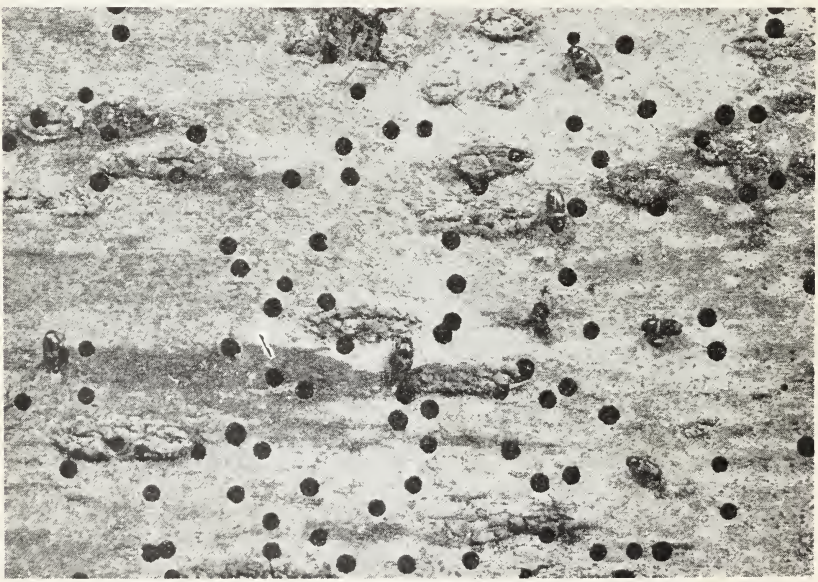

Fig. 5.—Adult beetles and exit holes in bark of French prune. (Enlarged two times.)

fectly known but during the summer months it is probably a little longer than one month.

In the pupal cells, the larvae molt and transform to pupae. These are white, motionless bodies which indistinctly show the form of the adult. After some time the pupae molt and change to adult beetles. These are white at first but soon turn brown, and then black. The adults remain in the pupal cells for a few days, then cut their way through the bark (fig. 5) and begin the cycle again.

SEASONAL HISTORY

The shot hole borers pass the winter as larvae living and feeding, to some extent, in the inner bark. Some of these overwintering larvae pupate in the wood during the winter. The remainder pupate very early in the spring. In 1931 the first beetles emerged from cut wood in cages on March 27, and some may have emerged from woodpiles even earlier. The last adults from overwintering larvae emerged before the middle of May. At this time the majority of adults from the overwintering brood had laid eggs, which had hatched some time earlier than the middle of May, so that the first spring generation was represented mainly by large larvae on May 15. No pupae were found at this time. By the middle of June the development of the first generation was estimated as follows: larvae 40 per cent, pupae 50 per cent, and new adults 10 per cent. Since April 15 represents the peak of emergence of the overwintering brood, the complete cycle from overwintering adults to the time of emergence of the greatest number of adults of the first spring generation, was roughly two months. By the middle of July the broods overlapped, that is, eggs, larvae, pupae, and adults were all present in such numbers that no conclusions could be drawn as to the generations represented. The beetles continued to breed through the summer and fall. A few adults still constructed egg tunnels and deposited eggs in the early part of November. Eggs and young larvae were very common at this time; only a very small percentage of larvae had constructed pupal chambers in the wood, and none had pupated. With a generation completed every two months and a breeding season extending from the latter part of March to the latter part of October, it would seem that three complete generations and a partial fourth are possible.

INJURY TO TREES

Injury to the trees caused by the shot hole borer, is the result of feeding of both adults and larvae. The injury by the adults falls into two fairly distinct groups which may be designated as twig injury and limb injury. In producing twig injury the adults bore short holes in the new wood at the bases of the buds. The adults work

Fig. 6.—Twigs of French prunes showing gumming as a result of punctures made by the shot hole borer at the bases of buds and spurs.

in such places only for a short time. This is evidently a method of feeding when suitable larger limbs are not available. Laboratory tests showed that when terminal growth and suitable limbs were both present, the beetles entered the limbs and rarely attacked the twigs. Such punctures, made by the adults at the bases of the buds and fruit spurs, exude a considerable amount of gum, as shown in figure 6.

Some twig injury is done by the first brood since an appreciable amount of gumming was seen by the middle of May. This type of gumming increases throughout the summer and in severe cases, nearly all the terminals on the tree may be gummed by fall. Eggs are rarely laid in twig growth which is less than ½ inch in diameter.

Limb injury by the adults is due to tunneling through the inner bark and cambium. Entrance holes are frequently cut into limbs and trunks where the sap flow is still strong. The beetles abandon these holes and gum exudes from them freely. Occasional trees, particularly young trees which are suffering from lack of water, become studded throughout the trunk, limbs, and twigs with masses of gum. In favorable situations, that is, in the limbs and trunks of very weak trees, where the sap flow is much reduced, the beetles continue their tunnels and lay their eggs. However, since they nearly always turn up or down the limb, they rarely girdle it.

The injury by the larvae frequently results in girdling the limb since they tend to travel at right angles from the vertical, primary burrow, and hence work around the limb. It is possible, however, that a branch which is so reduced in vitality that it cannot repel the adults, and is suitable for egg-deposition could not survive even in the absence of beetle injury.

In the Santa Clara Valley the shot hole borer attacks chiefly prunes and cherries. In the Sacramento and San Joaquin valleys, peaches, prunes, apricots, and almonds are frequently attacked. Essig[3] gives the following host list: almond, apple, apricot, loquat, mountain ash, cherry, choke cherry, elm, hawthorn, Juneberry, nectarine, peach, pear, plum, prune, and quince.

CONTROL

The most important fact bearing upon the control of this pest, is that it cannot live in healthy, vigorous trees. The factor which is almost solely responsible for the present epidemic of the shot hole borer is drought. Trees may be suffering so slightly from lack of water that no ill effects are visible but they may be weakened so that they are attractive to the beetles. The beetles appear to be able to select a weakened tree which frequently shows no outward sign of sickness. It is on such trees of low vitality that the beetles inflict injury at the bases of the buds on the year-old wood. The following

[3] Essig, E. O. Insects of western North America. p. 511. Macmillan Co., New York, 1926.

year these trees are considerably weakened as a result of bleeding through numerous beetle punctures, so that the beetles are able to attack the larger limbs.

It is of the utmost importance therefore to keep the trees as strong and vigorous as possible. The chief aid to the tree, to enable it to withstand the attack of the shot hole borer, is water. In the center of one of the most heavily infested areas, several orchards have been almost completely protected from beetle attack by heavy irrigation, whereas trees on all sides which were suffering from lack of water were seriously injured by this insect.

Other practices which increase the vigor of the trees, such as reducing the tops, cutting back, and fertilizing, should be followed when the beetle is established in the vicinity. Cody[4] recommends 4 or 5 pounds of sulfate of ammonia or nitrate of soda to the tree to stimulate new and vigorous growth.

Next in importance in keeping the trees vigorous, is the need for careful orchard sanitation. Many growers have already suffered severe injury to their trees in the immediate vicinity of woodpiles. Dead and dying wood which is removed from the trees during the late fall and winter contains the overwintering larvae. If such wood is cut up and piled for home use, the beetles will emerge from it without difficulty the following spring. In dispersing from such a center of infestation the adults stop and feed on the terminal growth of trees in the immediate vicinity, and in the course of one season may severely injure, or even completely kill these trees. The majority of the beetles fly on to other more distant trees until they are fairly uniformly distributed and their injury does not show a definite connection to the woodpile. The grower should not let this mislead him regarding the seriousness of holding over the beetles in stove wood. Such wood should be burned before the end of February.

When a large amount of wood has been removed, representing a considerable value as stove wood, it would seem desirable to treat it in some way to kill the overwintering larvae. It must be borne in mind that this treatment is normally very difficult, owing to the fact that the beetles are, in part, in pupal cells in the wood, with the entrance to the cell protected by a dense plug of chewed wood. Laboratory tests on a small scale have demonstrated that the brood can be killed by fumigating the wood for 24 hours with carbon bisulfide at the rate of 25 pounds per 1,000 cubic feet. Spraying the wood thoroughly from all sides with stove distillate likewise killed all of the overwinter-

[4] Cody, L. R. Bark beetles' control studied. Sunsweet Standard 14(6):6. 1930.

ing beetles, in a small-scale test. Whether or not these methods can be satisfactorily developed to fit field conditions remains to be proved. Any work of this sort undertaken by the growers had best be done in close cooperation with the local farm advisor or agricultural commissioner. Infested wood which has been cut and piled during the winter may serve as a source of adult beetles until the early part of June, at which time all of the overwintering brood will have emerged. Such wood is never reinfested, that is, no eggs are laid in it, so that it is then no longer a menace and may be kept indefinitely.

Wood from healthy, noninfested trees, which may be removed for various reasons during the winter, may retain enough sap to be acceptable to the beetles the following spring and may serve as food for the first spring brood.

Dead trees and limbs left in the orchard also present a serious menace and serve as a means of carrying the beetles through the winter, precisely as does the cut wood. Severe twig injury is commonly found on trees adjacent to a dead tree. All dead trees and limbs should be removed and burned before the end of February.

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