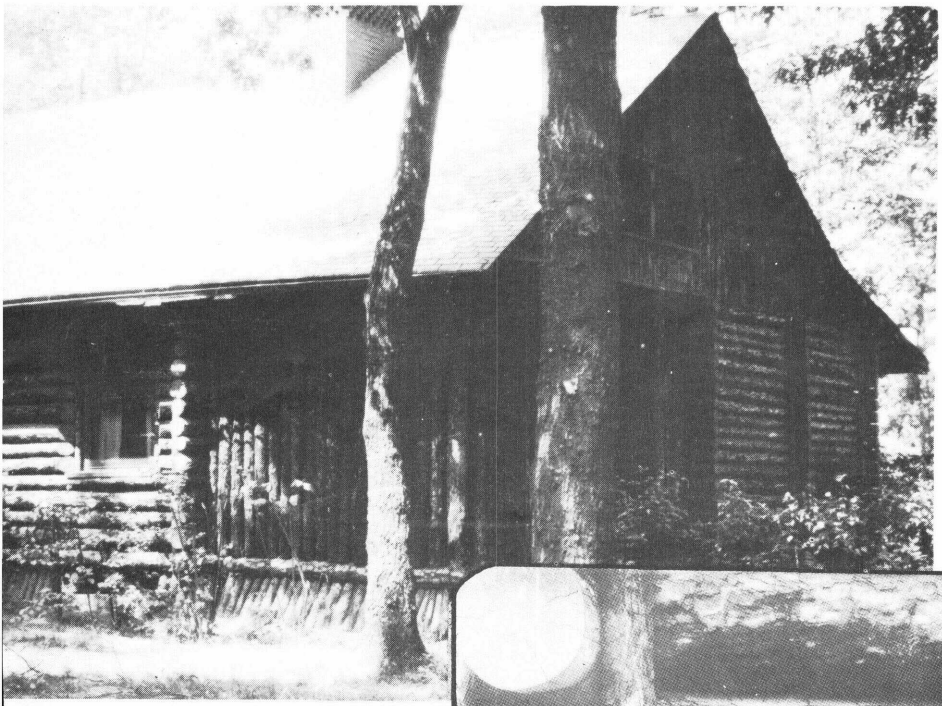
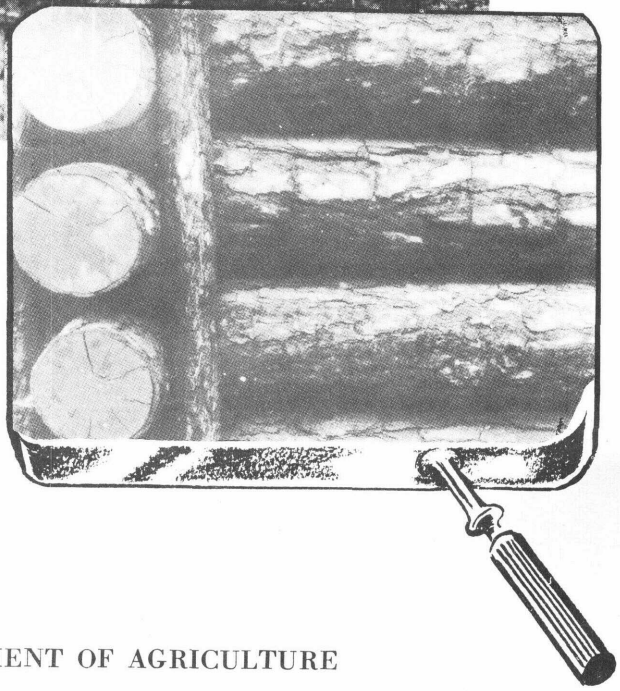
Protecting Log Cabins, Rustic Work and Unseasoned Wood From Injurious Insects in Eastern United States





FARMERS' BULLETIN NO. 2104

UNITED STATES DEPARTMENT OF AGRICULTURE

CONTENTS

This bulletin supersedes Farmers' Bulletin 1582, Protection of Log Cabins, Rustic Work, and Unseasoned Wood from Injurious Insects.

Washington, D.C. **November 1956**

Slightly Revised December 1962

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price 15 cents

Protecting Log Cabins, Rustic Work, and Unseasoned Wood From Injurious Insects in Eastern United States

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Each year there is a considerable demand for information on the protection of log cabins and rustic work from injurious insects. This demand is largely due to the popularizing of National and State forests and parks for recreation. As a result of the increased use of these areas, many rustic bridges, benches, and log cabins have been constructed. There is also a constant demand for information on the construction of rustic summer homes and arbors on private woodlands and estates. In addition, plants using small raw poles in the manufacture of rustic furniture, rustic fences, arbors, shuttle blocks, mallets, and mauls request advice for preventive and control measures.

This bulletin is based on studies conducted in eastern United States, but it is probable that, to a large extent, the preventive and control measures advocated will also apply to closely related insects with similar habits that occur in the western half of the country.

HOW BEETLES AND GRUBS DAMAGE UNSEASONED WOOD

Wood cut during the early spring and summer months, in particular, is subject to attack by beetles that make numerous holes in the bark. Wood that has been infested can be recognized by the type of borings made and whether or not these borings are pushed beyond the bark surface and lodge on the material below. Eggs laid by these beetles soon hatch and the larvae, or grubs, mine between the bark and wood. This mining causes the bark to loosen and fall off. The larvae also bore into the sapwood and sometimes the heartwood, making large holes through the wood. By so doing, they reduce the logs almost to dust within a few months, before the wood becomes well seasoned.

WOODS USED FOR CABINS, RUSTIC WORK, AND CERTAIN WOOD PRODUCTS

The woods mainly used in the construction of log cabins and rustic work in summer homes, furniture, and fences are spruce, fir, hemlock, tamarack, cedar, juniper, pine, cypress, birch, poplar, willow, hickory, and oak. The selection of wood to be used for these purposes is determined largely by the local supply.

Hickory, ash, dogwood, and persimmon used in the manufacture of small wood products, such as shuttle blocks, mallets, and mauls, are also subject to attack, and protective measures described in this bulletin are equally applicable to stock cut for such purposes. Those woods that are probably most subject to insect attack and damage, if cut during certain seasons of the year, as explained later, are hickory, pine, persimmon, spruce, ash, and dogwood, although the others mentioned are by no means immune. The damage can be largely prevented by proper measures.

For durability, the heartwood of cedars, junipers, and white oak rate

the highest of the woods listed above. However, even these woods do not have sufficient durability to justify their use in contact with the ground in important structures such as log cabins. Other woods, such as birch, poplar, and willow, are relatively short lived where they are in contact with the ground.

CLASSES OF INSECTS AND THE DAMAGE THEY DO

The insects responsible for damage in rustic construction where the bark remains on the logs or poles can be conveniently grouped into three main types or classes. Grouping is done according to their structure and the character of work they do, namely, bark beetles, ambrosia beetles, and wood borers. The bark beetles confine their activities to the bark and burrow between it and the sapwood, often scoring the latter; the ambrosia beetles bore directly through the bark into the sapwood and sometimes the heartwood, and the borers may work between the wood and bark or may bore in the sapwood or heartwood also.

All three classes of these insects have four distinct stages, namely, the egg; the larva, also called worm or grub; the pupa or transforming stage; and the adult or beetle stage. Only the larval and adult stages are responsible for damage to wood. The larva of all the classes hatch from eggs laid by the beetles. After the larvae finishes feeding and becomes mature, it makes a cell in which to rest, called the pupal cell, and there becomes an adult beetle. The adult then bores out through the surface.

Bark Beetles

The adults of the first class, the bark beetles, are short, cylindrical, reddish brown to black, varying in length from about one-sixteenth to one-fourth of an inch (fig. 1). They bore through the outer bark to its soft inner part, called the phloem, where they make tunnels of various types, along the sides of which they lay their eggs (fig. 2). While the beetles bore through the bark and construct their tunnels, they push the fine brownish-white sawdustlike particles, or frass, to the entrances. The frass falls on the wood below and attracts attention by its unsightly appearance. This tunneling causes the bark to loosen and fall off. The piles of frass on a log enable ready detection of bark beetles within it. The larvae or grubs are tiny, whitish, cylindrical, slightly curved, and legless (fig. 3). Upon hatching, the larvae extend their mines in all directions, often at right angles to the original (parent) tunnel, and thus aid in loosening the bark.

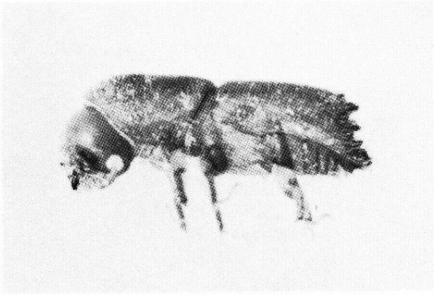

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Figure 1.—An adult bark beetle (*Ips avulsus* (Eich.)), 16 times natural length.

Ambrosia Beetles

The adults of the second class, the ambrosia beetles (fig. 4), closely resemble the bark beetles in general appearance. Their work differs considerably, however, and can easily be distinguished. After the ambrosia beetles enter the bark, they bore immediately into the sapwood and sometimes into the heartwood, where they extend their

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Figure 2.—Linear adult egg tunnels and radiating larval galleries of an Ips bark beetle made in the inner bark of pine. About natural size.

tunnels in all directions, each making a hole about the size of a pinhead (fig. 5). While boring these tunnels they push out sawdustlike particles, which either fall loosely in piles (fig. 6) or form stringlike masses (fig. 7) as if being squeezed from a tube. This frass is white, whereas that of the bark beetles is usually brown to red and falls loosely from the holes in the bark, although in certain borings much of it remains in the tunnels. The tunnels of the ambrosia beetles are round, always free from frass; often their walls are stained black.

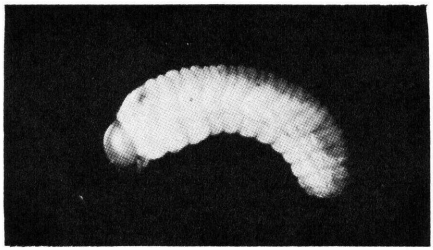

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Figure 3.—Larva or grub of a pine bark beetle (*Ips* sp.), 10 times natural length.

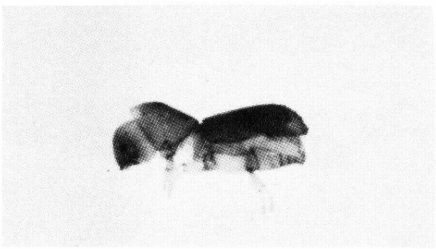

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Figure 4.—An adult ambrosia beetle (*Xyleborus* sp.), about 12 times natural length.

The food of these beetles is not the wood but a substance called "ambrosia," which is a coating formed of a minute fungus that is propagated by the beetles themselves. It is this coating that stains the walls of their tunnels black. The damage by these borers is caused almost entirely by the adult beetles, since the larvae of most species, until they change to adults, do not bore in the wood. Instead, they feed on the ambrosia in the original tunnel or separate cells made by the parent adults who usually care for the larvae by feeding them.

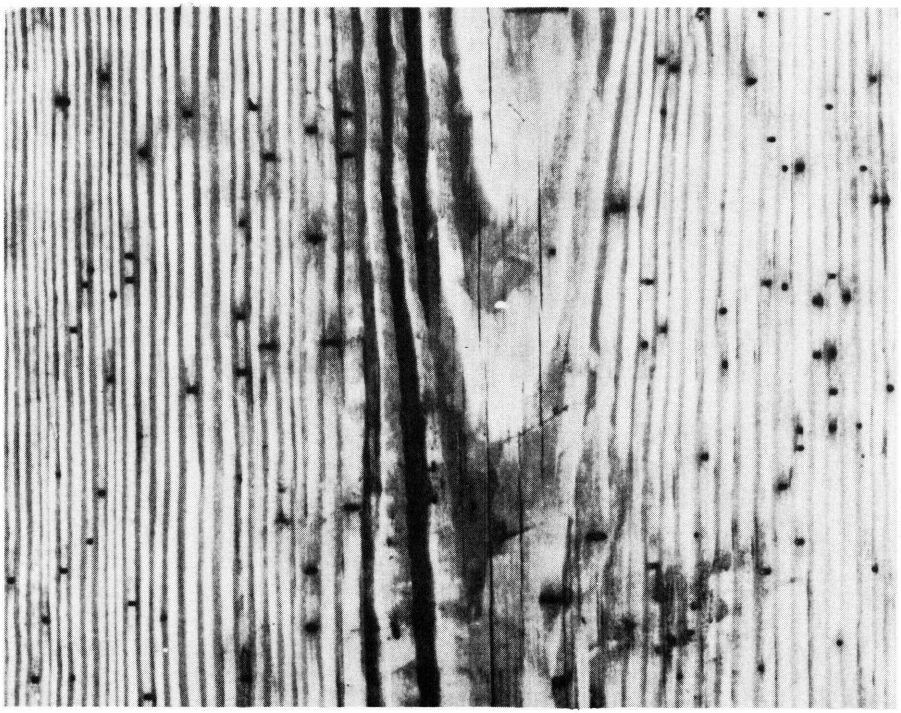

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Figure 5.—Work of adult ambrosia beetles (*Xyloterinus politus* (Say)) in pine. Three-fifths natural size.

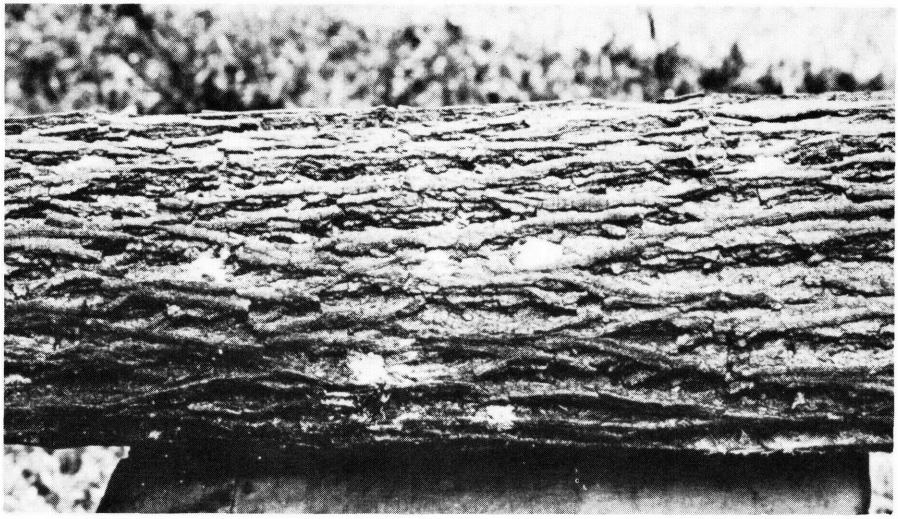

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Figure 6.—Piles of boring dust or frass being pushed out as ambrosia beetles (*Monarthrum* sp.) enter a hickory log. About one-third natural size.

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Figure 7.—Boring dust or frass which certain ambrosia beetles (*Xyloterinus politus* (Say)) push out of the wood in cylindrical casts. About natural size.

Beetles of this group seldom damage log cabins or rustic work made from logs cut in the fall of the year and seasoned before the beetles are active, because such wood is dry and unsuitable for attack. However, if the wood is cut and used during the period of insect activity, it may be attacked immediately by the beetles, and if so, a considerable quantity of boring dust will be extruded. The beetles work in wood only while the moisture content is high, that is, above the fiber saturation point or approximately 30 percent of the ovendry weight.

Wood Borers

The adults of the wood borers do not as a group present so uniform an appearance as do the bark beetles and ambrosia beetles. The wood borers may be divided into three subgroups, namely, powder-post beetles, roundheaded borers, and flatheaded borers.

Powder-Post Beetles

The powder-post beetles are short, cylindrical, reddish-brown to black, hard-shelled insects, ranging from one-eighth to nearly one-half of an inch in length.

In eastern United States there is only one species that seriously damages the class of materials under consideration. This beetle has reddish-brown markings and is about one-fourth of an inch long (fig. 8). It is commonly known as the red-shouldered shot-hole borer and works principally in the wood of hickory and persimmon, although it has been found in elm and other woods. The adult bores through

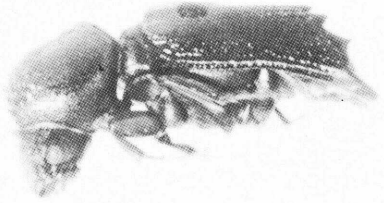

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Figure 8.—An adult of the red-shouldered shot-hole borer (*Xylobiops basilaris* (Say)), one of the powder-post beetles, 10 times natural length.

the bark and into the sapwood, making a cylindrical tunnel around the log just under the surface of the wood and at right angles to the grain (fig. 9). The pores or cells of the wood are opened up, and the female beetle then inserts her eggs into them. The original or egg tunnel is usually bored about 1½ inches on each side of the entrance hole, although it sometimes extends in one direction only. This tunnel can readily be detected by the loose, whitish, dustlike borings that may be found on the bark below the circular entrance hole.

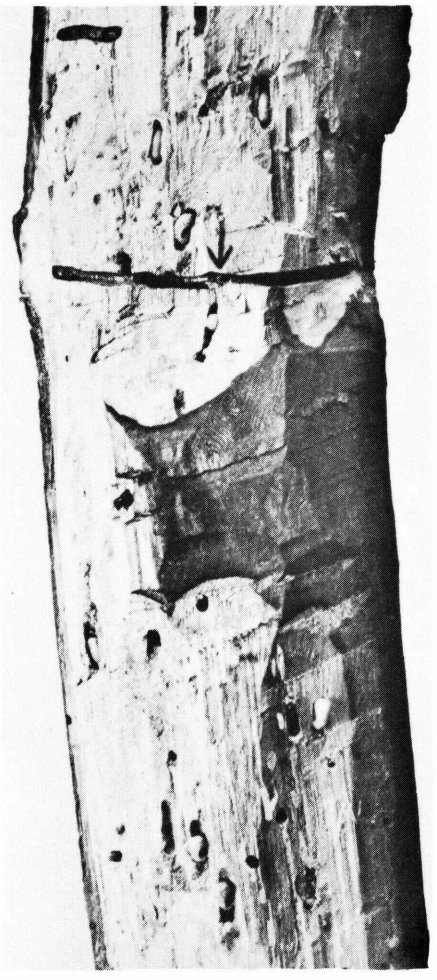

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Figure 9.—Piece of hickory with the bark and a little of the wood removed, revealing tunnel of an adult powder-post beetle (*Xylobiops basilaris* (Say)). Entrance hole is shown at tip of arrow, and the gallery is seen extending on each side. Larvae, pupae, and emerging adults are shown in their cells. Natural size.

The larva or grub of this beetle has a curved form, somewhat similar to that of the grubworms in the garden (fig. 10). This beetle, in marked contrast to the ambrosia beetle, is exceedingly destructive to wood, both in the adult and larval

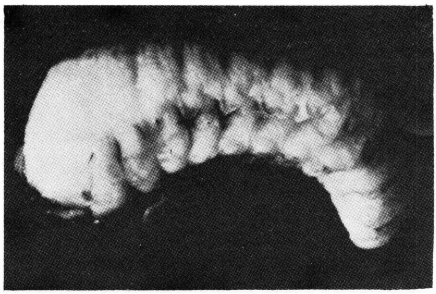

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Figure 10.—Larva or grub of a powder-post beetle (*Xylobiops basilaris* (Say)), 9 times natural length. In this stage the larva does most of its injurious boring.

stages. In wood of small diameter it oftens extends its gallery or tunnel completely around the section, thus greatly weakening the piece and causing it to break off readily. The larvae also extend their work to the pith in such pieces, completely destroying the wood and often literally reducing it to powder. In the larger pieces of wood this insect confines its work more to the sapwood, which may be almost completely destroyed by the time the larvae are full grown (fig. 11). The work of the larval borers is entirely in the interior of the log and cannot be detected without chopping into the wood. The borings are of the same texture as those of the adult ambrosia beetles but are packed tightly in the mines behind the larvae. When the borings are loosened, they break up into cakes. Occasionally the injury is not noticed until the wood has been worked up into the finished product (fig. 12), and the emerging beetles leave holes that indicate the destruction going on unnoticed inside the manufactured article.

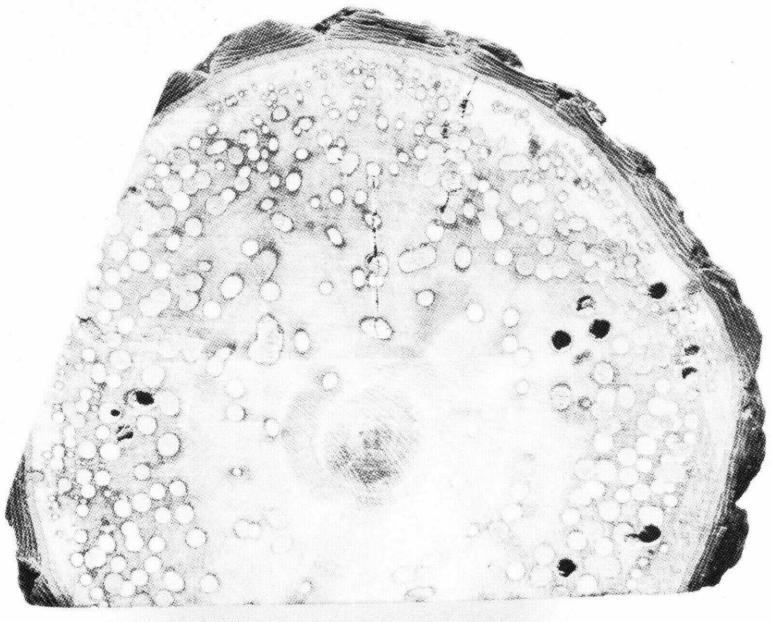

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Figure 11.—Cross section of persimmon log showing the wood destroyed by grubs of the red-shoulder shot-hole borer (*Xylobiops basilaris* (Say)), a powder-post beetle. Natural size.

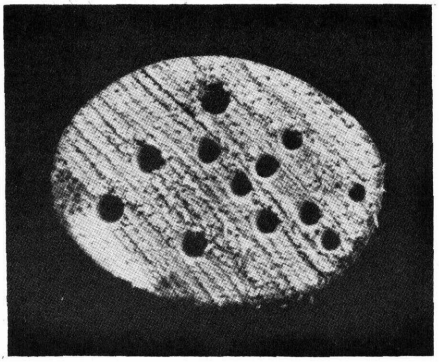

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Figure 12.—Cross section of hickory handle showing damage caused by grubs of the powder-post beetle (*Xylobiops basilaris* (Say)). Some of the tightly packed powderlike borings were removed from near the surface to show more clearly the extent of the damage. Natural size.

Hickory and persimmon woods used in the manufacture of small wood products, such as shuttle blocks, mallets, and mauls, are liable to severe injury by this insect, sometimes amounting to a 50-percent loss (figs. 11 and 12).

Roundheaded Borers

The roundheaded borers have a remarkable variation in general appearance (fig. 13). The beetles range in length from less than ¼ inch to more than 1½ inches. They also vary considerably in the place where they lay their eggs and in their manner of doing so. These differences are due to the habits of the particular species concerned. The adult beetles lay their eggs (1) on the surface of the bark (fig. 14), or (2) if the bark is removed, occasionally on the sapwood, over

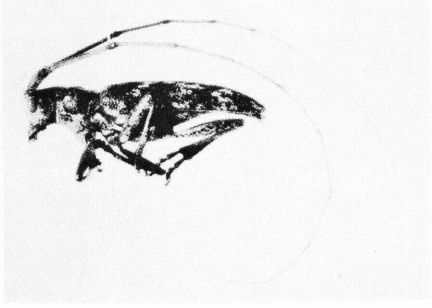

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Figure 13.—Adult beetle of southern pine sawyer (*Monochamus titillator* (F.)), 1½ times natural length.

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Figure 14.—Adult female beetle and egg of the banded hickory borer (*Chion cinctus* (Drury)) on hickory. About natural size.

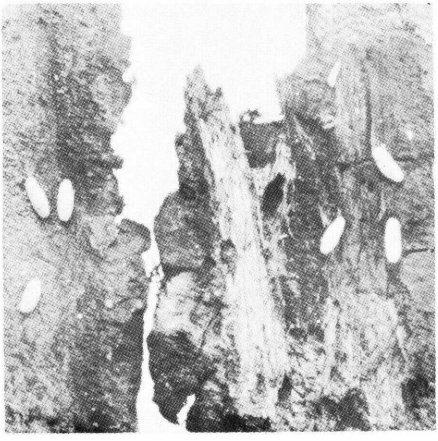

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Figure 15.—Bark removed to show eggs of painted hickory borer (*Megacyllene caryae* (Gahan)) (enlarged 2½ times), which were inserted through crevices.

which they secrete a covering, or (3) in crevices under the bark (fig. 15), or (4) through slits or pits that they gnaw in the bark (fig. 16).

The larvae (fig. 17) that hatch from these eggs are entirely re-

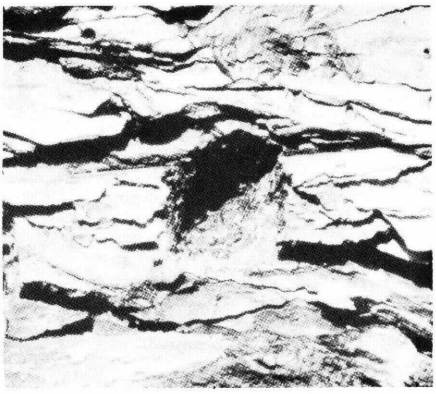

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Figure 16.—Egg scar made by southern pine sawyer (*Monochamus titillator* (F.)) on bark of pine. The eggs are inserted through this opening. About natural size.

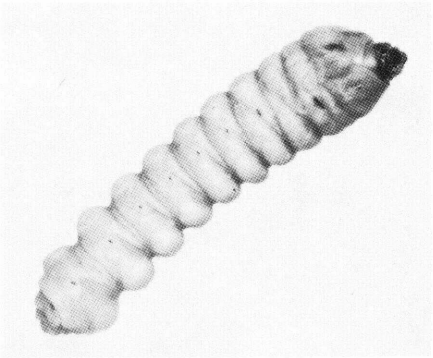

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Figure 17.—Larva or grub of a roundheaded borer (*Megacyllene antennatus* (White)), 2 times natural length.

sponsible for the damage caused to the wood. They are elongate, fleshy, yellowish-white grubs, usually slightly tapering toward the rear. Upon hatching they bore into the soft layers of the inner bark, or phloem, which they begin to mine. Some species confine much of their

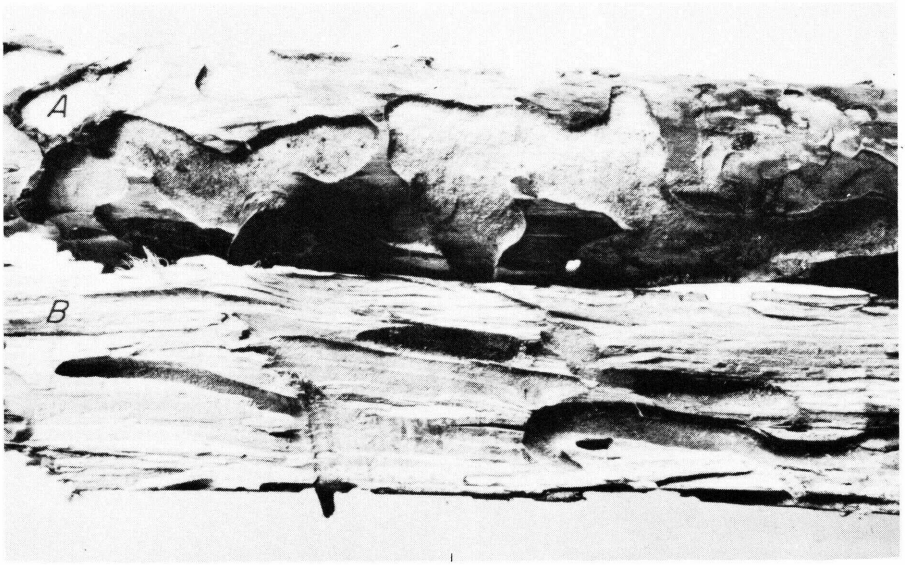

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Figure 18.—Larval mining of the black-horned pine borer (*Callidium antennatum* (Newm.)): *A*, Under the bark, which causes the bark to fall off; *B*, inner mines. Three-fourths natural size.

activity to mining under the bark, thereby loosening it and causing it to fall off; they also mine in the outer sapwood (fig. 18). Others make large oval mines, which extend deeper into the sapwood and heartwood. Sometimes the grubs completely riddle the wood within a few months. As these galleries are often one-half of an inch wide and as much as 2 feet long, they weaken the material and make it unsightly because of the large quantity of frass, which many of the grubs push to the outside during the process of excavation (fig. 19).

Each species also differs somewhat from others in the method of preparing its gallery. Some grubs pack the borings, or frass, tightly behind them (fig. 11); others push it out through the entrance hole (fig. 19). The composition of these borings varies from fine, white, and powdery material (fig. 11) to coarse, brownish particles (fig. 19) or shreds of wood fiber (fig. 20).

These characters, combined with the different patterns made while scoring the wood under the bark, the size and shape of the gallery in the wood, the color of the borings, and the species of wood attacked, make it possible to determine the type of injury, and usually, the identity of the species of insect responsible for the damage. The mature larva transforms into a pupa and then into an adult beetle. When emerging through the surface of the wood or bark, the beetle makes either a round or an oval hole, depending on the species of insect.

Flatheaded Borers

The beetles of the group known as flatheaded borers are more uniform in general appearance than are those of the roundheaded borers. They are slightly flattened, metallic-colored, boat-shaped beetles, which range in length from ¼ inch to nearly 1¼ inches (fig. 21).

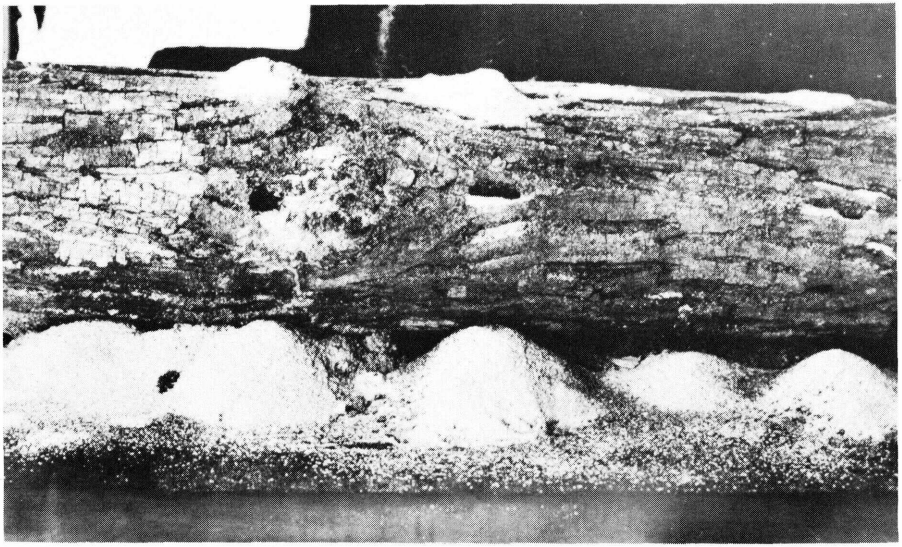

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Figure 19.—Boring dust extruded by the grub of the painted hickory borer (*Megacyllene caryae* (Gahan)), as it mined in the sapwood of hickory. About one-fourth natural size.

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Figure 20.—Coarse shredded frass made by the grubs of the southern pine sawyer (*Monochamus titillator* (F.)), a roundheaded borer, 2 times natural length.

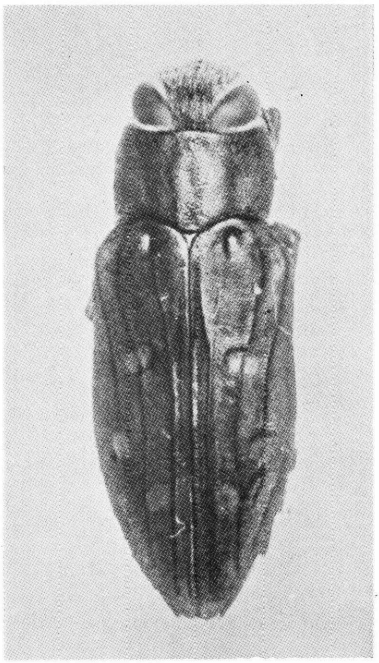

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Figure 21.—Adult beetle of a flatheaded borer (*Chrysobothris octocola* (Lec.)), 4 times natural length.

The eggs are laid singly or in a mass on the bark or in crevices in the bark or wood. The larva is a slender, flattened grub having conspicuously widened segments next to the head (fig. 22). The young borer mines the inner bark or wood, making a flattened, oval, more or less tortuous mine or wormhole which, when completed, widens into a large pupal or resting cell. This cell connects with the outer surface by a short, oval exit hole through which the new beetle emerges. The larval mines may be in either the bark or the wood alone, or as do many, may extend throughout the entire piece and will be filled with tightly packed sawdust-like material (fig. 23).

SEASONAL ACTIVITY OF THE INSECTS

At least some of the insects previously mentioned are at work during the entire growing season, which lasts from April to October in the vicinity of Washington,

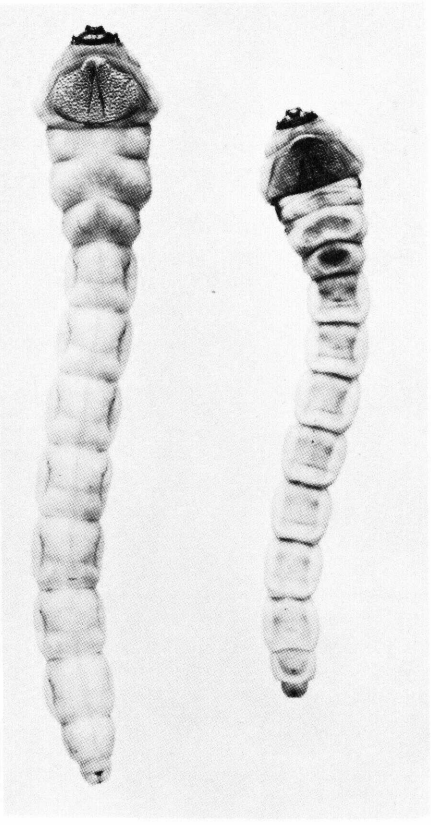

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Figure 22.—Grubs of a flatheaded borer (*Chalcophora angulicollis* (Lec.)), 1½ times natural length.

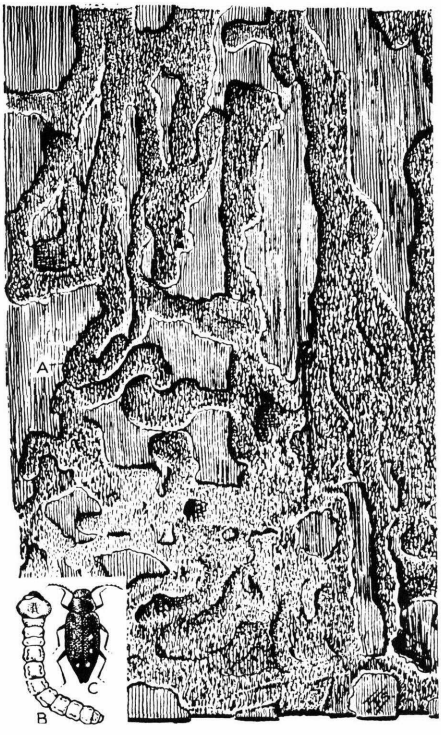

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Figure 23.—Work of the flatheaded eastern hemlock bark borer (*Melanophila fulvoguttata* (Harr.)): *A*, Section of hemlock bark showing larval mines in the inner portion, one-half natural size; *B*, larva; *C*, adult, natural size.

D. C., from February to December in the extreme Southern States, and from May to September in the Northeastern States. During this time beetles are active, looking for favorable woods on which to lay their eggs. During the rest of the year, however, these insects hibernate in various stages and only a very few or no adult beetles are present.

The bark beetles and ambrosia beetles are active nearly the entire period within the months specified. Their numbers vary greatly within the season of activity. These insects mature very rapidly and can develop from the egg to the adult stages in 4 to 6 weeks. They may have as many as 3 and often 5 generations a year in certain parts of the South.

The wood borers are not active for so long a period during the season as are the other two classes of beetles and do not multiply so rapidly. Many of them have 1 generation a year, and others have only 1 every 2 years.

The red-shouldered powder-post beetle is the most destructive of this group and flies in the vicinity of Washington, D. C., mainly from early May to the middle of June, maximum emergence taking place

between May 30 and June 8. Occasionally a partial second generation occurs, and a few beetles emerge during the warm days of late summer and fall and may be seen in flight from August 15 until cold weather. The main brood survive the winter in the mature larval stage and do not emerge as beetles until the following May. Seasonal differences affect the earliness or lateness of the flight period. During the hottest part of the summer it is possible for the beetles to develop from eggs in 60 to 70 days.

The beetles of the roundheaded borers usually fly only a few weeks during the spring and summer months in the vicinity of Washington, D. C., where they have only 1 generation a year. Farther south some species have 2 generations and sometimes a partial third.

The flatheaded borers, as beetles, fly about the same time that those of the roundheaded borers appear. Some species mature in 1 year; others take as long as 2 years.

CONDITIONS FAVORABLE FOR ATTACK

The kind and condition of wood attacked are largely dependent upon the species of insect. Some species prefer freshly cut wood that is in a moist condition, others partly seasoned wood; still others require wood that is dry and well seasoned.

Bark Beetles and Ambrosia Beetles

Two types of insects, the bark beetles and the ambrosia beetles, attack freshly cut logs on which the bark remains and in which the inner bark is still white and active and the sap still present. The ambrosia beetles, however, like equally well logs, with or without bark, that have been submerged in water and which after being removed from the water remain moist, as logs do when placed on the ground in the shade. Such logs may continue to be attacked until the moisture content of the wood is reduced below 30 percent. Wood that is cut during the spring and summer months, when the weather is warm and damp, may be subject to severe injury, especially when placed in close piles on the ground so that it does not receive adequate ventilation. Wood is not likely to be attacked by bark beetles or ambrosia beetles when their active season begins, if the trees are cut in early fall and dry out or season sufficiently during the winter months.

Powder-Post Beetles

Most of the powder-post beetles prefer wood that has been cut several months. They show a decided preference for wood that is cut either in the fall and slowly seasoned over winter or during the active season and dried rapidly. Occasionally they attack recently cut wood, but as a rule they are unsuccessful in establishing themselves in it.

Roundheaded Borers and Flatheaded Borers

Conditions that invite attack by roundheaded and flatheaded borers vary considerably. Many borers prefer recently cut logs, whereas other borers, like the banded hickory borer (fig. 14) and the blackhorned borer (fig. 18), attack logs that have been seasoned for several months. The manner of handling logs after they are cut has a decided influence upon whether or not they will be attached. As each species of these beetles flies and lays its eggs during only a short period, and as each species attacks only 1 or 2 kinds of wood, which must be

in just the right condition to attract it, the danger of attack by any particular species is relatively small.

PREVENTIVE AND CONTROL MEASURES

Methods of preventing insect attack and of checking subsequent injury, once the log is infested, depend largely upon the seasonal history and habits of the insects. By taking advantage of what is known about them, the necessary protection can be obtained.

Rustic Wood

Seasonal Cutting for Rustic Structures

Logs with the bark remaining on them and poles used in the construction of rustic cabins, summer houses, arbors, bridges, and fences should be cut in October or November in the vicinity of Washington, D. C. They should be piled at once, either off the ground or under cover, so that the inner bark may dry rapidly and thoroughly before the beetles begin to fly in the spring. However, species such as juniper or cedar can be felled during August with very little danger of attack if the tree tops are removed and if the poles are laid singly on the ground and turned over once a week for about 3 weeks to expose a fresh surface to the sun. In this way the wood will be seasoned beyond the point where it is attractive to the beetles. Slabs with bark on the outside, to be used over wooden frames, should be handled as are green logs. This method will almost surely prevent damage by the insects that prefer freshly cut wood. Seasoning also can be facilitated by end-racking green slabs prior to piling them. The time required for the wood to dry beyond the limit favorable for attack by ambrosia beetles will depend upon the thickness of the wood and weather conditions. During midsummer a period of 15 days is sufficient. The slabs should be removed from the racks as soon as indications of warping or checking appear.

Seasonal Cutting for Manufactured Products

Poles to be used in rustic furniture, shuttle blocks, mallets, and mauls should be cut in the late fall and winter and either utilized before the first flight of beetles in the spring or placed under closed cover. It may be necessary to screen the poles by using screen cloth having 18 meshes to the inch. If poles must be cut in spring or summer, they should be removed from the forest as fast as they are cut and utilized at once. If they are exposed in the forest for a few days at this time, insect infestation may occur, but the resultant damage to the wood would not be discovered until after the wood had been manufactured (fig. 12). If the poles cannot be removed or utilized at once, they should be sprayed with an insecticide as mentioned below under Chemical Treatments.

Waste materials on which the bark remains, if left about the factory yards while insects are active, may be a breeding place for them. Such material should be destroyed by burning.

Chemical Treatments

Although seasonal cutting will protect rustic woods from attack by most insects, some, like the red-shouldered shot-hole borer and the black-horned pine borer, will attack the following spring. To safeguard against this, as well as against those insects that infest fresh-cut material, the surface of the bark should be sprayed with a toxic insecticide

such as benzene hexachloride (BHC). A fuel oil solution containing 0.5 percent gamma isomer of BHC is effective. It is prepared by diluting 1 gallon of a concentrate containing 1 pound of gamma in 28 gallons of No. 2 fuel oil (diesel).

For manufactured products, where an odor on the bark surface or on the wood might be objectionable, the purified form of the chemical known as lindane can be used. Also, the danger of darkening the surface of the product can be avoided by using a more highly refined oil carrier, such as ultrasene or deobase. These carriers have had most greasy substances removed, and their flash points are higher than those of the other oils mentioned above. The refined oils, therefore, are safer to handle when applied to wood products in buildings.

How to use the chemical mixtures.—Small dimension wood can be treated easily and effectively by immersing the logs, slabs, or raw wood products in a quantity of the chemical placed in an oil drum. Immersion insures that the mixture will penetrate all cracks and crevices.

After the log or slab has been thoroughly treated, it should be placed in a sunny place to dry. Larger poles and logs can be treated more easily by spraying. However, all crevices in the bark must be penetrated by the chemical.

Whenever it is necessary to cut wood during the spring and summer months while the insects are active, the logs should be treated at once with the toxic mixture mentioned above.

Peeled Poles

Where retention of the bark on poles, logs, or slabs used for rustic structures is not especially desired, this wood can be treated by conditioning it and using pressure impregnation or by using one of the diffusion processes. After air seasoning, the material can be pressure impregnated or treated by means of the cold-soaking process. For best results in any treatment it is important that the wood be cut to final size and other modifications made before the treatment.

If the logs, poles, or slabs are cut during the fall and winter months, no insecticidal sprays will be necessary to protect the wood from beetle attack prior to the preservative treatment. However, should the material be cut during the season of insect activity and the bark not removed at once, it will be subject to infestation by all the insects mentioned that attack green wood. Even the logs that are peeled soon after cutting may be infested by ambrosia beetles, if exposed during the preseasoning period. To avoid this, the surface of the bark or wood should be sprayed or dipped in a BHC oil solution as mentioned for treatment of rustic wood.

Pressure Impregnation

Pressure impregnation is generally regarded as the most effective method for the treatment of wood with preservatives. When unseasoned poles or logs are to be pressure treated, they must first be seasoned or conditioned by a process, such as steaming, boiling in a preservative under a vacuum, or vapor drying. Air- or kiln-dried logs do not require such conditioning. A variety of wood preservatives to meet different use requirements are applied by pressure. Arrangements for pressure treatment of cabin logs or rustic work can often be made with commercial wood preserving plants.

Diffusion Processes

Freshly cut, unseasoned logs can be treated by diffusion methods with waterborne preservatives. Simple diffusion or steeping consists of soaking the wood for a period of 1 to 2 weeks in a solution, such as 5 percent zinc chloride. In the double diffusion process—a somewhat more complicated but more effective method—the wood is first steeped in one chemical and then another. The two chemicals diffuse into the wood and react to deposit a wood preserving compound having high resistance to leaching. A patented or proprietary diffusion method can be used in treating green peeled logs by applying the preservative in a thin paste form to all surfaces, then piling the logs closely together, covering the pile tightly with waterproof paper, and allowing the covered pile to stand for a month or more.

Cold Soaking

In using this method, the round, peeled, seasoned logs are soaked for 1 to several days in an unheated preservative, such as a 50–50 solution of coal-tar creosote and light (No. 2) fuel oil, or light fuel oil containing either 5 percent pentachlorophenol, or copper naphthenate with a 1 percent equivalent of copper metal.

TREATMENT AFTER ATTACK

Insects that have attacked fresh-cut logs, poles, or slabs intended for use in rustic work can be controlled by spraying or soaking the material with a toxic chemical, or by fumigating it with a lethal gas. Insects that have infested raw wood products used in manufacturing plants to make rustic furniture, mallets, or mauls also can be controlled by placing the wood in a kiln and applying heat.

Killing the Insects With Chemicals

For control with a toxic chemical, the surface of bark or wood should be thoroughly sprayed with a petroleum oil solution containing 0.5 percent gamma isomer of benzene hexachloride (lindane).

This formulation should be quite effective for controlling bark beetles and borers that have only recently attacked and that as yet have not penetrated deeper than the outer surface of the wood. Material that has been attacked over a period long enough for the insects to have worked their way into the wood should be soaked for a period of 5 minutes or more to obtain the most effective results. This treatment is applicable to materials that can be moved and submerged in tanks or vats, such as poles that have been attacked before they are used in construction, and smaller items of wood that are used for rustic purposes.

Another effective method for killing borers that have penetrated deep into logs or poles before their use is to pile the logs and cover them with a gas-proof tarpaulin. The bottom of the cover can be held firmly in place by sand. A gas, such as methyl bromide, can be injected into the space just beneath the top of the tarpaulin, or one or more ampules containing the proper amount of the gas can be fastened to the inside near the top where it can be reached easily and broken from the outside. The chemical should be applied at the rate of 4 pounds of gas for each thousand cubic feet of air space to be treated. This gas should be confined with the logs for about 72 hours.

Methyl bromide is an oderless gas that is deadly poisonous if inhaled. Sometimes tear gas (chloropicrin) is added to it to serve as a detector for its presence. Since methyl bromide boils at room temperature, it

has to be applied by means of a special dispenser, which can be obtained from the manufacturer.

Applying the Chemicals to Wood in Use

Poles and other wood of cabins and rustic construction in use can be conveniently treated by applying a liberal quantity of the foregoing insect-controlling BHC oil solution either with a good spraying apparatus or with a brush. For best results, all parts of the wood should be treated thoroughly. One gallon of any of the recommended materials is sufficient to cover 5 logs, each 10 feet long and 4 inches in diameter, or approximately 50 square feet of bark surface. Two gallons will saturate approximately 100 square feet of bark surface. A pint is usually sufficient to treat a rustic chair of ordinary size. When dressed timbers in a building are being treated, 1 gallon of the material will cover approximately 150 square feet of surface. For more information on control of insects in seasoned rough or finished wood, see USDA Leaflet 358, 1959.

Precaution in Handling the Chemicals

The chemicals mentioned in this bulletin are poisonous to people and animals; therefore, they should be handled with care. The hands should be protected with rubber gloves, and the body and feet by means of a rubber apron and rubber boots. If the chemicals are accidentally spilled on the body, they should be washed off at once with warm, soapy water. Clothing that has become soaked with the insecticides should be removed as quickly as possible. People who are unfamiliar with methyl bromide gas and its use should seek the aid of a professional pest control operator to apply it for them. **It is too dangerous to handle alone.**

Killing the Insects With Heat

In the manufacture of rustic furniture, it is customary to steam the wood prior to bending, especially the older pieces of small-dimension hickory. This material is often infested by borers. It is usually supposed that the borers can be killed by leaving the wood in water, through which steam is passed, for a period of 15 to 30 minutes. Examination of material in a factory, where this method was used in the manufacture of rustic furniture from hickory, demonstrates that only a very small percentage of the grubs were killed in this short time.

Results of the Department of Agriculture tests have shown that to kill all the grubs in wood 1 inch thick, infested hickory and ash must be subjected to kiln temperatures of 125° to 130° F., after all parts of the wood have reached these temperatures, for a minimum of 1½ to 2 hours. The late Dr. R. C. Fisher, Director, Department of Scientific and Industrial Research, Forest Products Laboratory, England, in verifying these recommendations for control of lyctus beetles, determined the period of time necessary for infested ash or oak of various thicknesses to reach this temperature when placed in a kiln. For safety, the wood should be left in the kiln somewhat longer and then subjected to live steam for 1½ to 2 hours in a saturated atmosphere. E. A. Parkin, also working on this problem in England, extended Mr. Fisher's work to include relatively low temperatures and humidities. From their work a schedule of kiln treatment has been prepared (table 1).

Steaming under high pressure may weaken and discolor the wood and should not be applied to wood to be used for fine finish or where great structural strength is essential. The humidity should be at the saturation point.

TABLE 1.—*Schedule for treating wood to check damage by powder-post beetles*

Relative humidity (percent)	Lethal temperature required	Thickness of timber	Time required to overcome lag after kiln has attained lethal temperature	Additional margin of safety	Time then held at lethal temperature	Total period of exposure after kiln has attained required conditions
	° *F.*	*Inches*	*Hours*	*Hours*	*Hours*	*Hours*
100	130	1	½	½	1½	2½
		2	2	½	1½	4
		2½	3¼	½	1½	5¼
		3	4½	½	1½	6½
80	125	1	½	½	2	3
		2	2	½	2	4½
		2½	3¼	½	2	5¾
		3	4½	½	2	7
	120	1	½	1½	6	8
		2	2	1½	6	9½
		2½	3¼	1½	6	10¾
		3	4½	1½	6	12
	115	1	½	7½	30	38
		2	2	7½	30	39½
		2½	3¼	7½	30	40¾
		3	4½	7½	30	42½
60	125	1	½	1	4	5½
		2	2	1	4	7
		2½	3¼	1	4	8¼
		3	4½	1	4	9½
	120	1	½	2	7	9½
		2	2	2	7	11
		2½	3¼	2	7	12¼
		3	4½	2	7	13½
	115	1	½	9	36	45½
		2	2	9	36	47
		2½	3¼	9	36	48¼
		3	4½	9	36	49½

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☆ U.S. GOVERNMENT PRINTING OFFICE: 1962 O—665971