CHAPTER 6

OTHER WOOD-DESTROYING INSECTS

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Know what to advise lumber and construction companies and consumers to do to prevent wood-boring beetle infestations.
- Know the various families of wood-boring beetles and their characteristics.
- Know inspection, management, and control methods for wood-boring beetle infestations.
- Know which longhorned beetle is a structural pest, how to identify it and control it, and how to prevent structural damage.
- Know the signs of carpenter ant infestations and what areas to inspect for excess moisture.
- Know the habits and habitats of carpenter ants and where to inspect for nest locations.
- Know procedures for preventing and controlling carpenter ant infestations.
- Know how to identify carpenter bees and understand their habits and habitat.
- Know procedures for preventing and controlling carpenter bee damage to wood.

Wood-destroying organisms other than subterranean termites cause millions of dollars in damage to wood products each year. These organisms and their prevention and control are discussed here.

PREVENTION OF WOOD-BORING BEETLES

The wood-boring beetles of economic concern include the **true powderpost beetles, false powderpost beetles, furniture and deathwatch beetles**, and the **old house borer**. Most of the procedures that will prevent attack on wood before it is used are the responsibility of those who harvest, mill, or store the wood. Those who use wood must take precautions to reduce the chances of building an infestation into structures and furniture.

Though the pest management professional is usually called in after an infestation is suspected, it is important that this person be a knowledgeable consultant to the lumber and construction industries, as well as to consumers, on the prevention of damage by wood-boring beetles. Steps that can be taken to prevent beetles from infesting buildings include:

- Inspect wood prior to purchase.
- Use properly kiln- or air-dried wood.
- Seal wood surfaces.
- Use chemically treated wood.
- Ensure good building design.

Using kiln- or air-dried wood in construction is one of the least expensive and most practical preventive measures. A few beetle species can survive and reinfest wood that has been properly dried. Sealing wood surfaces with varnish, shellac, or paint eliminates the habitat necessary for egg laying, but it is usually not feasible to seal the surfaces of structural timbers. Using chemically treated wood (treated by fumigation, wood preservatives, or insecticides) will provide beetle-free wood, but using treated wood is usually cost prohibitive. In addition, fumigation will not protect the wood from future infestation. Using good building design and practices such as proper ventilation, drainage, and clearance between wood and soil will tend to reduce the moisture content of wood in a structure, creating less favorable conditions for beetle development. Central heating and cooling systems also speed up the wood drying process.

POWDERPOST BEETLES

Three families of beetles have at least some members that are called "powderpost beetles." These are the true powerderpost beetles in the family Lyctidae, the false powerderpost beetles of the family Bostrichidae, and the furniture and deathwatch beetles of the family Anobiidae.

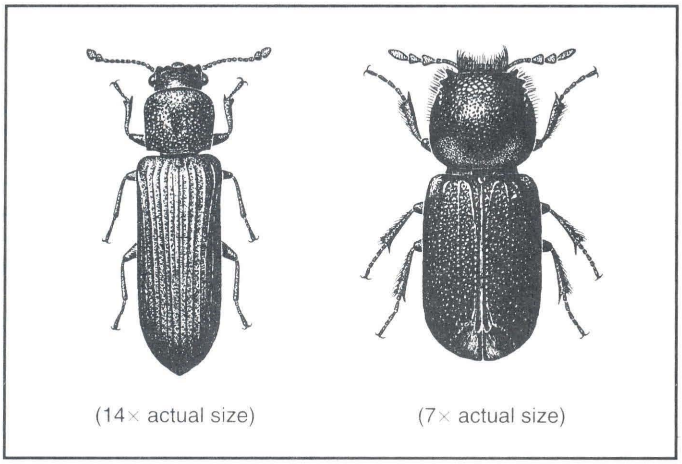

Figure 6.1. Two of the insects referred to as powderpost beeltes . *Left: Lyctus planicollis*, one of the true powderpost beetles of the family Lyctidae. Note the two-segmented antennal club typical of the members of the family. *Right: Scobicia declivis*, a false powderpost beetle of the family Bostrichidae. Note the more cylindrical body shape and the three-segmented antennae characteristic of most members of this family (Provonsha).

They all damage wood in about the same manner and require the same control measures. The surface of infested wood is perforated with numerous small "shot-holes," each about the size of a pencil lead. Any jarring of the wood causes powder to sift from these holes. Cutting or breaking infested wood may reveal masses of packed powder that is produced by the feeding of grublike larvae and, to a lesser extent, by the adult beetles.

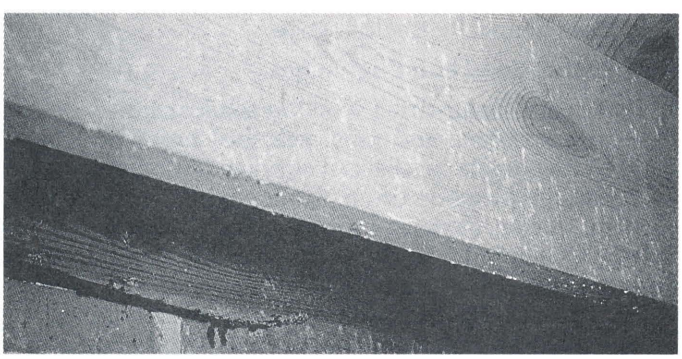

Figure 6.2. Anobiid beetle damage in pine floor joist—note frass being pushed out of old exit holes (USDA Forest Service).

True Powderpost Beetles

Family Lyctidae

The **true powderpost beetle** is small, slender, flattened, and reddish brown to black. It varies in length from about 1/8 to 1/4 inch long. The female lays her eggs in the pores of the wood. These beetles attack only hardwoods, eating only the sapwood, which contains the starch required in their diet. Once hatched, young larvae bore into the wood. Unlike termites, they are unable to digest cellulose. Consequently, most of the wood eaten passes through the larvae and is left behind as a powdery *frass*. Thus, lyctid damage is characterized by the fine powder falling from the surface holes in hardwoods.

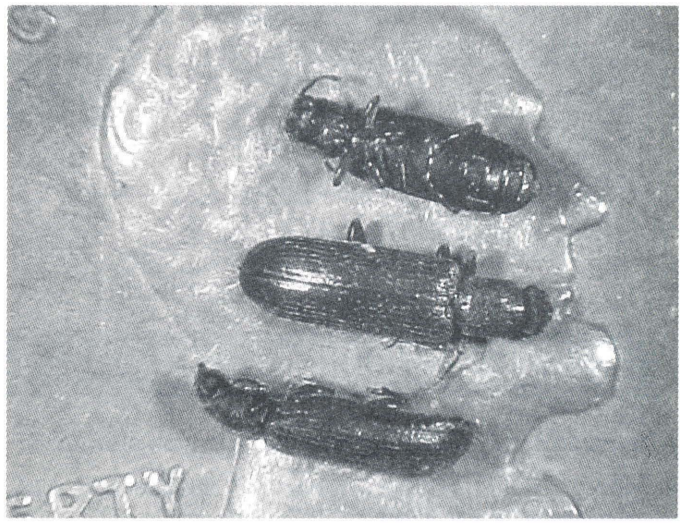

Figure 6.3. True powerderpost beelte adults (Lyctidae)—*Lyctus* spp (H. Russell, Michigan State University Diagnostics Services).

Figure 6.4. True powderpost beetle adult (Lyctidae)—*Lyctus brunneus*—laying eggs between a glass slide and a cardboard (USDA Forest Service).

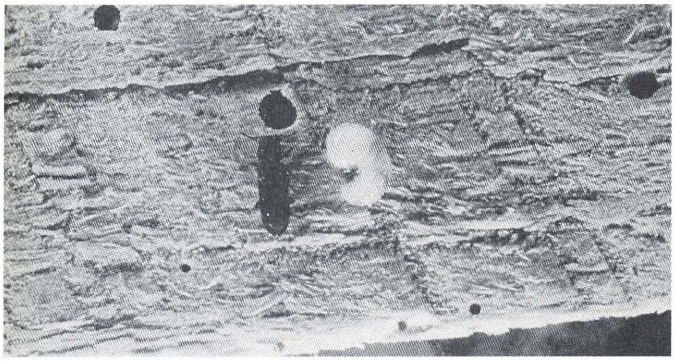

Figure 6.5. True powderpost beetle adult and larva—*Lyctus brunneus*—by an exit hole (USDA Forest Service).

False Powderpost Beetles

Family Bostrichidae

The adult of the **false powderpost beetle** is more robust than that of the true powderpost beetle. Its body is cylindrical with a roughened thorax surface. Its head usually is not visible from above. Color varies from dark brown to black, and length ranges from 1/8 to 3/8 inch. Like the true powderpost beetles, it digests the starch in the wood but not the cellulose. However, false powderpost beetles will attack softwoods as well as hardwoods. Unlike lyctid and anobiid beetles, female bostrichid beetles bore directly into wood to lay eggs.

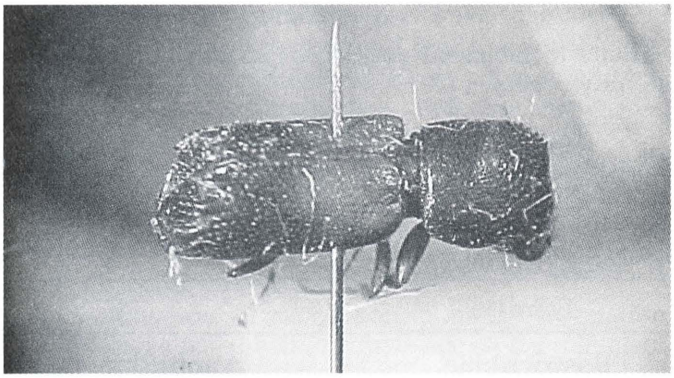

Figure 6.6. False powderpost beetle adult (Bostrichidae)—redshouldered shothole borer, *Xylobiops basilaris* (H. Russell, Michigan State University Diagnostics Services).

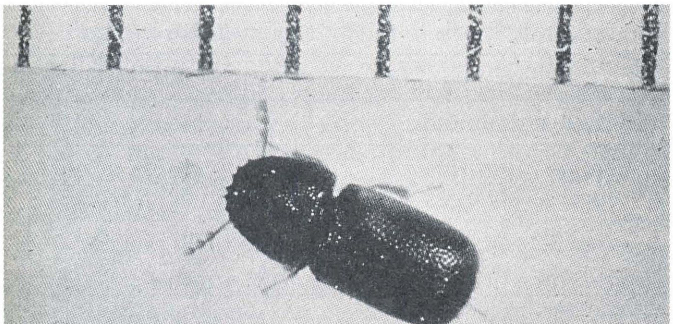

Figure 6.7. False powderpost beetle adult (Bostrichidae)—bamboo powderpost beetle, *Dinoderus minutus* (USDA Forest Service).

Furniture and Deathwatch Beetles

Family Anobiidae

Anobiid beetles are usually slightly less than 1/3 inch long and red to brown to black. They deposit their eggs in cracks and crevices of all types of seasoned wood, though these beetles seem to prefer the sapwood of softwood trees. Unlike the other powderpost beetles, anobiids have a digestive enzyme that allows them to digest cellulose. An infestation is characterized by a coarse, powdery frass containing bun-shaped fecal pellets.

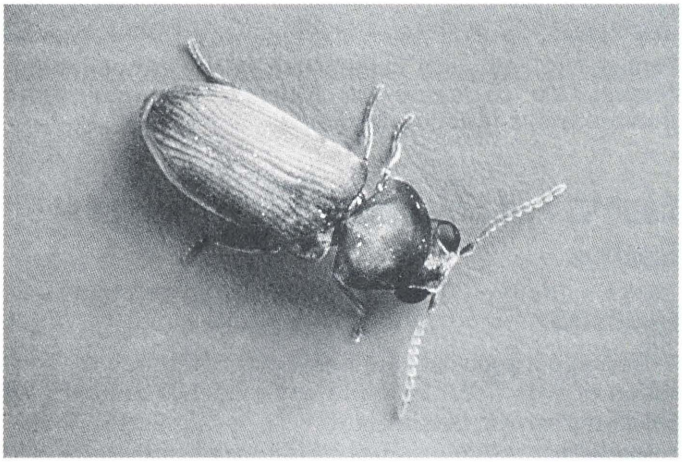

Figure 6.8. Anobiid beetle adult—*Euvrilletta peltatum* (USDA Forest Service).

Figure 6.9. Anobiid beetle larva—*E. peltatum*. Note frass and damaged wood (USDA Forest Service).

Within this group, the **furniture beetle** will infest structural wood as well as furniture. The **deathwatch beetle** prefers structural timbers in damp areas. Its name comes from the ticking sound made by the adult, which can be heard in the quiet of the night. Joists, subflooring, hardwood flooring, sills, plates, and interior trim are the parts of buildings that deathwatch beetles most frequently attack. In addition, they may damage furniture and other products.

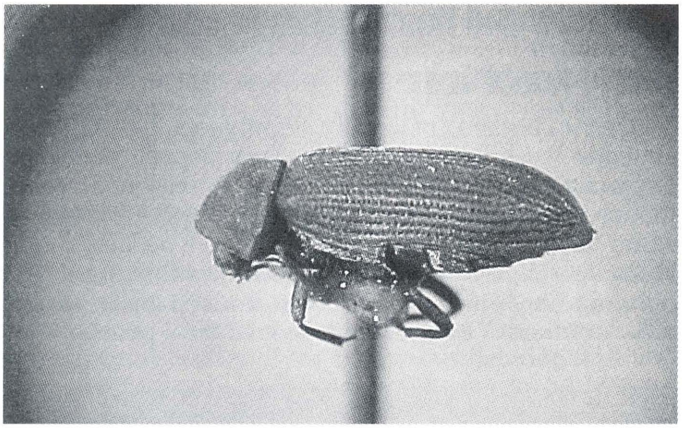

Figure 6.10. Eastern deathwatch beetle (Anobiidae)—*Hemicoelus carinatus* (H. Russell, Michigan State University Diagnostics Services).

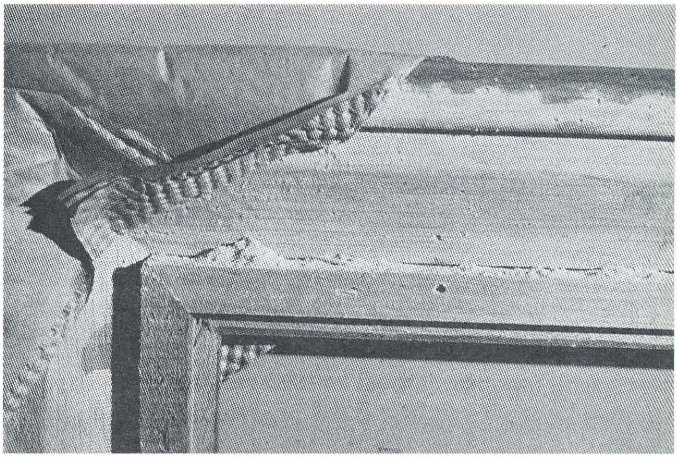

Figure 6.11. Lyctid beetle damage in framing around mirror (USDA Forest Service).

Control and Management of Powderpost Beetles

Inspection

Periodic inspections are needed to determine the condition of wood and to locate any evidence of attack by wood-destroying beetles.

- Visually examine all exposed surfaces of wood (painted and unpainted); also sound by tapping or probe wood with a knife.
- Interview homeowner or building occupants and ask whether they have noticed any signs of beetle infestation (beetles, holes in wood, frass, etc.).
- Look for evidence of beetle attacks in attics, crawl spaces, and unfinished basements and storage areas. The signs are more likely to be undisturbed in these areas, and the absence of finishes on wood leaves more wood surface exposed to reinfestation.
- Collect beetles, larvae, frass, wood samples, or any other evidence that needs to be closely examined with good light and magnification to determine the identification of the attacking beetles.
- To be certain that the infestation is active, try to find fresh frass, which is the color of newly sawed wood, or live larvae or adults in the wood.

Refer to Tables 6.1 and 6.2 for information on how to identify beetles.

Table 6.1. Comparative biological information on the three families of powderpost beetles.

Characteristic	Family: Lyctidae	Family: Bostrichidae	Family: Anobiidae
Size	1/12 to 1/5 inch	1/8 to 1/4 inch	1/8 to 1/3 inch
Shape	Flattened	Cylindrical, roughened pronotum	Oval, compact
Color	Brown to black	Brown to black	Reddish brown
Head visible from above	Yes	No	No
Antennal club	2-segmented	3- to 4-segmented	None
Egg placement of hardwoods	Deposited in pores of hardwoods	Female bores into wood to lay eggs	Laid in cracks or old exit holes in wood
Required moisture content of wood*	6 to 30 percent	6 to 30 percent	13 to 30 percent
Average life cycle	1 year	1 year	1 to 3 years

* Wood found in structures is considered dry with a moisture content less than 20 percent.

Source: M.P. Levy, *A Guide to the Inspection of Existing Homes for Wood-inhabiting Fungi and Insects*, U.S. Department of Housing and Urban Development, Washington, D.C., 1975.

Table 6.2. Timbers attacked by common wood-boring insects.

	Timbers Attacked					
	Unseasoned	Seasoned	Softwood	Hardwood	Sapwood	Heartwood
Lyctids		+		+	+	
Bostrichids	-	+	-	+	+	
Anobiids		+	+	-	+	-
Round-headed borers	+		+	+	+	-
Old house borers		+	+		+	
Flat-headed borers	+	-	+	+	+	+
Wharf borers		+	+	+	+	+
Scolytids	+		+	+	+	+

Note: + means yes; - means occasionally.

Source: M.P. Levy, *A Guide to the Inspection of Existing Homes for Wood-inhabiting Fungi and Insects,* U.S. Department of Housing and Urban Development, Washington, D.C., 1975.

Habitat Modification

Alteration of environmental conditions might one day be the only procedure necessary to eliminate some infestations of wood-boring beetles. No wood-destroying beetles in buildings develop rapidly in dry wood. If the use of vapor barriers, ventilation, and central heat can dry wood and keep it dry, the use of other control measures may not be necessary. Here are some techniques to reduce favorable habitat for wood-destroying beetles:

- **Moisture meters** can be used to determine the moisture level in the wood. Every effort should be made to reduce the moisture content of the wood to be protected to below 20 percent.
- Where economical and practical, infested wood should be removed and replaced.
- Electric current treatment and heat control may be used in some wood-boring beetle infestations.

Every situation of wood-boring beetle infestation needs to be evaluated before you decide on the treatment method or combination of methods to be used.

Pesticide Application

There are certain similarities in control measures recommended for the control of wood-boring beetles, but in many instances specialized techniques are required. If it can be determined that the damage in a particular instance was caused by one of the true powderpost beetles, it will be necessary to concentrate control activities on articles made of hardwoods. In most cases, this will involve a thorough application of insecticide to all exposed hardwood surfaces.

If the infestation involves bostrichid or anobiid beetles, the scope of the treatment is altered to some extent. Unless the professional can make a definite species determination and thereby establish the various woods subject to attack, it must be assumed that the pest endangers both softwoods and hardwoods. In addition to determining the type of wood being attacked, each problem must be analyzed in light of the severity of infestation, the possibility of reinfestation, the area of the structure being attacked, the speed of control needed, and the cost the property owner can bear. Some guidelines follow.

- Residual sprays provide effective control in most cases. Sprays should be applied at low pressure (to reduce splashing) using a flat-fan nozzle to obtain thorough coverage.
- The best penetration to tunnels is provided by a fumigant, but the danger in handling these materials and the fact that they have no effective residual life limit their desirability. Fumigation may be necessary when it is impossible to control powderpost beetles via insecticidal sprays. An example is when the beetles have moved into walls and other inaccessible areas.
- Water-based insecticide emulsions, in most cases, are considered safer and more effective than oil-based emulsions. Oil solutions present a possible fire hazard, greater expense, greater hazard and discomfort to the applicator, and danger of damaging plants near the treatment area.
- Do not allow any treated surface to be walked on or handled until it is thoroughly dry.

In treating finished wood, such as furniture or flooring, it is best to use an oil solution to avoid spotting or in any way changing the appearance of the finish. To be certain the oil-based solution will not damage the finish, apply only a small amount to an out-of-the-way area and allow it to dry before making a complete treatment. Insecticide should be applied to the entire surface of the infested wood using a flat-fan nozzle at low pressure, or by using a soft-bristled paintbrush. If there are only scattered patches of infestation, treat only the infested boards. Avoid overtreating (i.e., until the solution runs off or puddles), particularly on hardwood floors laid over asphalt paper or asphalt-based mastic. The asphalt will be dissolved by excess oil and may bleed through the finished floor. Any excess solution should be wiped up immediately. Be careful not to mar the surface if the spray has temporarily softened the finish. An oil carrier may have a solvent action on some wood finishes. Therefore, keep all objects off treated areas for about 24 hours or until all stickiness has disappeared.

Follow-up

Check for signs of reinfestations of lyctid and anobiid beetles. Bostrichid beetles will rarely reinfest structural timbers.

WOOD-BORING WEEVILS

Family Curculionidae

Though they are not particularly common, several species of weevils will infest structural timbers. Because they are found in wet and rotting wood, they are considered a secondary problem to the wood rot. They are capable of extensive tunneling and will make a wood rot problem far worse.

Weevils are easily recognized by the presence of an elongated snout. The wood-boring weevils are small insects about 1/8 inch long. They leave small tunnels about 1/16 inch in diameter in the heartwood or sapwood of softwoods, hardwoods, or even plywood.

Control is usually restricted to the removal and replacement of damaged wood. The wood is frequently already damaged by moisture by the time the weevils arrive. It may be appropriate to lower the moisture of the wood in conjunction with an application of borate insecticides, but these decisions will need to be made on a case-by-case basis.

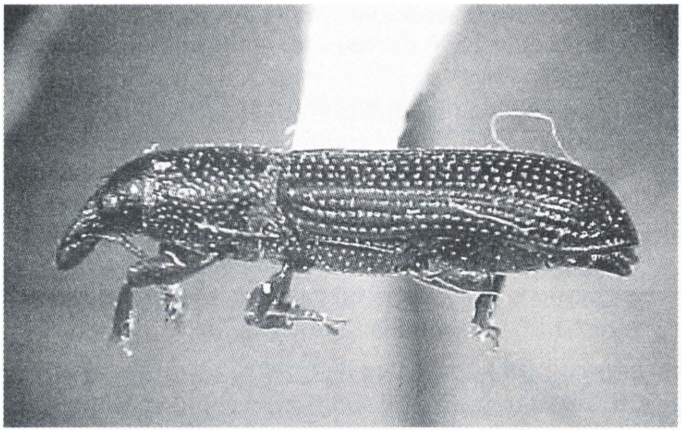

Figure 6.12. Wood-boring weevil, *Cossonus* spp. (H. Russell, Michigan State University Diagnostics Services).

LONGHORNED BEETLES

Family Cerambycidae

Species in this family (more than 1,200 species recorded in the United States) feed as larvae on living trees, recently felled trees and logs, and seasoned lumber. Indoors, the only species of major economic importance that can reinfest dry, seasoned wood is the **old house borer** (*Hylotrupes bajulus*). Larvae hollow out extensive galleries in seasoned softwood (e.g., pine). The old house borer is frequently a pest of new structures, although it is found in older buildings.

Adults are about 3/4 inch long and grayish brown to black with two white patches on the ***elytra***. The dorsal surface is densely covered with light-colored hairs. On the ***pronotum*** are two black, shiny bumps. The long, gray hairs surrounding these bumps give an owl-like appearance.

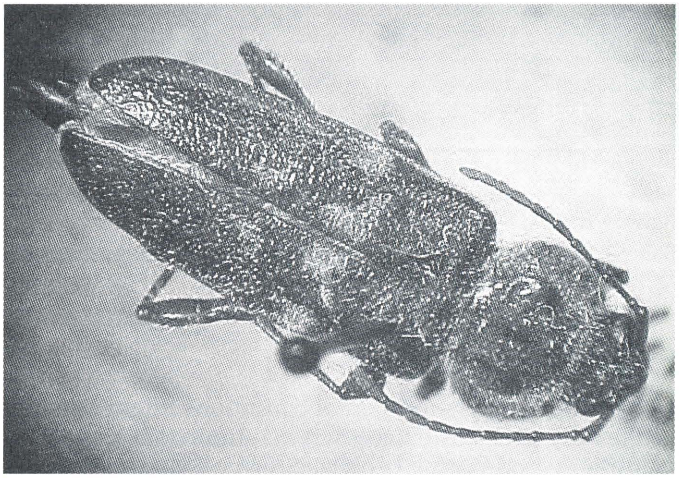

Figure 6.13. Old house borer adult (Cerambycidae)—*Hylotrupes bajulus* (H. Russell, Michigan State University Diagnostics Services).

The beetles of this family lay their eggs in cracks or crevices in bark or on the surface of rough-sawn timbers. The larvae are wood borers. Mature larvae are large, varying from 1/2 inch to 3 or 4 inches long. The body is long and narrow and a light cream color. The rear portion of the head is partly drawn into the body, so that only the mandibles and other mouthparts are easily seen. Larvae are called **round-headed borers**.

The life cycle of the old house borer ranges between 3 and 12 years. Because this beetle has a very long life cycle and can infest the same piece of wood again and again, it

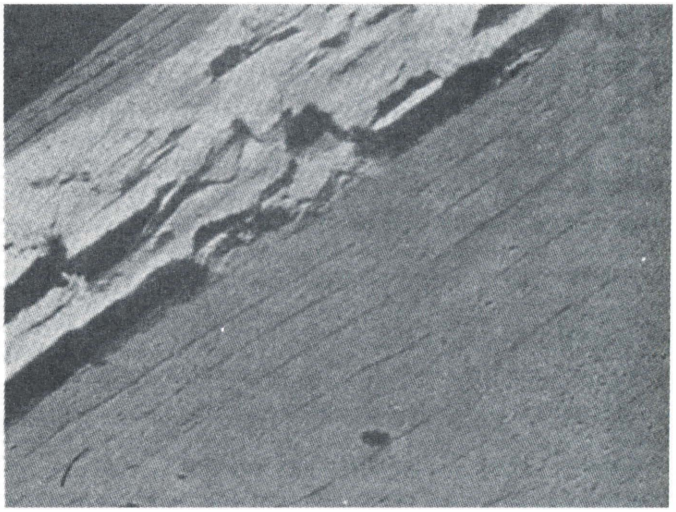

Figure 6.14. Old house borer damage with oval exit hole and powder-filled galleries in interior of wood.

may be many years before serious structural damage is recognized. The exit holes of emerging adults do not occur in very large numbers until the infestation has been established for several years. This, along with the fact that larvae will do extensive feeding without breaking through the surface of the wood, make it necessary to inspect infested wood very carefully to detect old house borer damage. Refer to Table 1 in Appendix C for a comparison of old house borers with other wood-boring insects.

Control and Management of Longhorned Beetles

Inspection

Rough wood should be probed or struck to detect weaknesses or the presence of boring dust. If exit holes are present, they will be broadly oval and about 1/4 to 3/8 inch in diameter.

Habitat Modification

A common source of these beetles is firewood brought indoors. Thus, firewood should be brought indoors only when it will be used soon after.

Keeping wood dry will slow down larval development—larvae grow faster in wood that provides a protein source in the form of wood-decaying fungi.

Pesticide Application

Control programs involve only the treatment of softwoods, to which this pest is restricted. Infestations of this beetle often involve extensive excavations, and larvae may be considerable distances from the obvious points of infestation. If the infestation is too widespread for spot treating with residual sprays, fumigation may be necessary. Other long-horned beetles require no control.

Follow-up

Careful and thorough inspection is necessary to determine the extent of a newly found infestation. Old house borers are the only longhorned beetles that will reinfest structural timbers, and damage may not be noticed for several years.

CARPENTER ANTS (*Camponotus* spp.)

There are many species of carpenter ants in North America; few enter structures to forage and fewer nest in structures. But these two habits (foraging and nesting inside), coupled with their large size and vigorous activity, make these invaders impossible to ignore. In Michigan, the black carpenter ant is the primary pest species. As their name implies, carpenter ants work in wood but do not digest it.

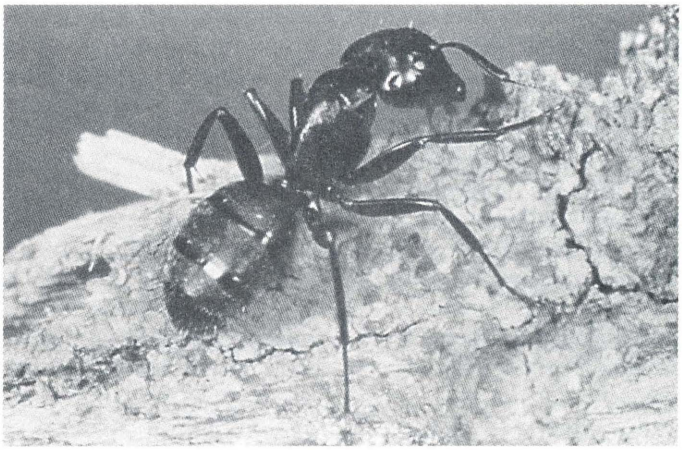

Figure 6.15. Carpenter ant, *Camponotus pennsylvanicus*.

BLACK CARPENTER ANT (*Camponotus pennsylvanicus*)

The workers range in size from 1/4 to almost 1/2 inch; the queen is 3/4 inch. Outside workers can be confused with field ants (*Formica*), which do not enter structures. Carpenter ants have an even, smooth, arching profile beginning just behind the head and descending to the waist, or ***petiole***, which has one ***node***. Field ants and most other ants have bumps or spines along the profile of the ***thorax***, particularly near the petiole. The black carpenter ant's abdomen is covered with gray or yellowish hairs, but the basic black color is still obvious. The head and thorax are black in the majority of individuals, but the sides of the thorax and parts of the legs of a few may be dull red.

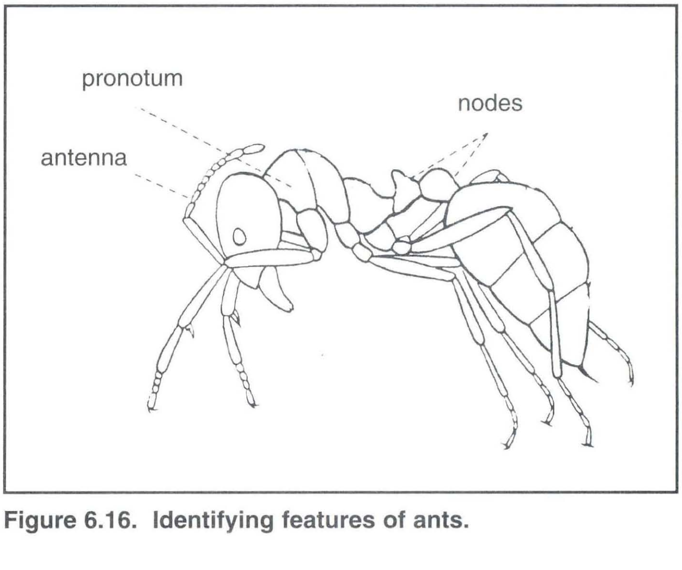

Figure 6.16. Identifying features of ants.

A carpenter ant colony begins in isolation but not necessarily in wood. This first brood may be under a stone, in a roll of tarpaper, or in innumerable other secretive spots, but the colony soon moves into wood (such as a fallen log, tree hole, stump, or structure wall). When carpenter ant workers excavate nest galleries, they use their jaws as gouges and make tunnels by shaving out small pieces. Unlike termites, they do not eat the wood. It has no nutritional value to them, and they discard it by dropping it out of the nest area or by piling in one place and discarding the whole pile later. This pile of carpenter ant shavings, called sawdust, is very soft and is made up of pieces like those a fine chisel would make. Gritty construction sawdust in attics or on sills can be left over from construction or repairs and might suggest carpenter ant shavings to those who do not know the difference. The process of ant gallery excavation results in galleries with very smooth sides. No mud is involved (like that in the tunnels of subterranean termites), and there is no dust or pellets (like those produced by wood borers or dry wood termites), only numerous large, smooth, brown-stained tunnels that provide harborage for the carpenter ant colony (see Table 6.3). A nest or colony might harbor several thousand inhabitants. Large colonies of carpenter ants in critical areas of structures can cause structural damage, but the colony more likely resides partially in structural wood and partially in void spaces (e.g., between roof boards, between studs under windows, or between subflooring and shower bases).

Figure 6.17. Carpenter ant shavings.

The most common outdoor harborage is a living tree with a rotted spot inside. Other common sites are stumps or firewood. The carpenter ant is a valuable link in the reduction of plant cellulose. It is not surprising that mature wooded neighborhoods often have structural carpenter ant problems. New neighborhoods or developments built on cleared woodlots can inherit ant colonies from trees. Some colonies are brought in with building materials. Rustic cabins, summer homes, and park structures will likely become infested sooner or later.

Black carpenter ant workers forage for food such as honeydew, insects, and juices from ripe fruit. Indoors, they like sweets, meats, fruit juices, and moist kitchen refuse. Carpenter ants always prefer a humid atmosphere. Vines on building walls, branches, and telephone wires provide a bridgelike access into structures. Carpenter ants will invade both decayed and new wood inside structures.

ANT AND TERMITE SWARMERS

The swarming of small, dark insects near or inside a structure panics people who fear their homes are infested by termites. Pest management professionals must be able to distinguish between ant and termite reproductives and communicate the differences clearly and confidently to their clients.

Principal differences are:

- ***Ants*** have a complete metamorphosis—that is, they go through the egg, larva, pupa, and adult stages, all of which look different from the others. Ant workers are adults.

  Termites have a gradual metamorphosis. They go through the egg, nymph, and adult stages. Nymphs look like adult workers. Reproductives are dark-bodied.

- ***Ants*** have a thin or "wasp" waist (called the **petiole**) between the thorax and abdomen.

  Termite waists are NOT narrow. Termite bodies are straight-sided with no constriction. Thorax and abdomen blend together.

- ***Ants*** have elbowed antennae. A long, straight segment connects to the head. Remaining segments flex and bend.

  Termite antennae are entirely flexible. They are made of many small segments strung out like beads. Termites wave them in front, using them to touch and feel.

- ***Ant*** reproductives have two pairs of wings. The front pair is wider and markedly longer than the back pair. Often ants have a black dot near the tip of the front wings, and dark wing veins can be seen. Ant wings do not break off easily.

  Termite wings are long and narrow; both pairs are the same shape and almost the same length. Termite wings break off with a touch. If termite swarmers have been crawling, their broken wings litter the swarm area. Termite wing veins cannot be seen with the naked eye.

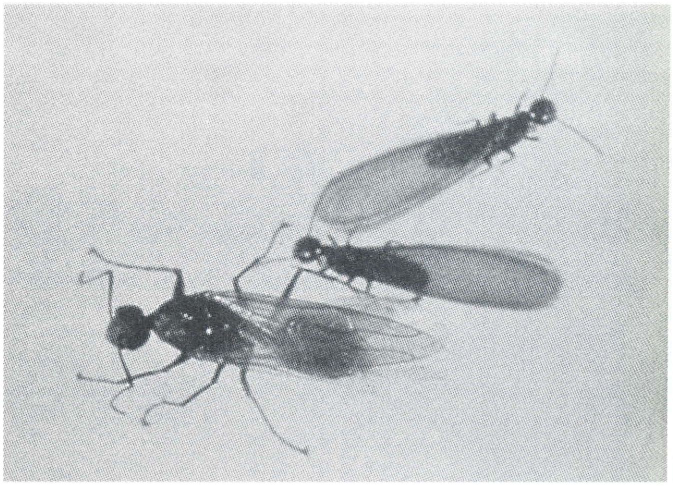

Figure. 6.18. Ant vs. termite reproductives.

Control and Management of Carpenter Ants

Inspection

It is important to discover whether carpenter ants are nesting inside or outside. If nesting inside:

- Their presence usually indicates a moisture problem in the building.
- They may have excavated galleries for harborage in structural wood.

Black carpenter ants are often associated with moisture problems. In the majority of cases, carpenter ants make their nests in wood that has been wet and infested by a brown rot fungus. Dark fungus stains on the wood indicate the presence of such moisture. Moisture in wood can be caused by:

- Improper attachment of wooden additions, dormers, and hollow wooden columns that absorb moisture.
- Patios or porch floors, door sills, downspouts, or grading where water collects or drains toward the structure.
- Regular gutter overflow that pours rainwater down the side of the building as well as back onto roof boards, fascia, soffits, etc.
- Leaking roof valleys.
- Improper ***flashing*** around chimneys, vents, and skylights.
- Improper roofing or holes in the roof.
- Window sills directly exposed to rain.
- Lack of ventilation in any area where moisture accumulates.

Inside, moisture accumulates:

- Around any leaking plumbing or drains (especially shower drains).
- Unvented attics and crawl spaces.
- Unvented dishwashers, washing machines, icemakers, etc.

The many nesting sites, foraging entrances, and food and moisture sources offer clues for inspection and location of the nest. The area where the majority of ant activity is seen may identify a nest site if entry from the outside can be ruled out. Carpenter ants are more active at night, and inspection at that time may be helpful.

Habitat Modification

- Where nests are located inside, remove and replace infested structural wood.
- Stop the intrusion of moisture.
- Caulk and screen actual and potential ant entryways.
- Ventilate areas where moisture accumulates, regrade where necessary, and repair roofing, guttering, etc.
- Recommend trimming trees where branches touch a structure or overhang roofs. Tree removal may be necessary.

Pesticide Application

- Eliminating colonies and nesting sites is a primary way to eliminate carpenter ant infestation.
- Use pesticidal dust or pressurized canned aerosols when nests are in wall voids. Sprays are less effective.
- When indirect treatment is required, liberal placement of acceptable bait stations can be used.
- Dust, spray, or bait can be used on outside colonies (e.g., in tree rot).
- Professionals should evaluate trees with rotted places.
- Honeydew-producing insects involved in feeding carpenter ants should be treated with pesticides (e.g., oils and pesticidal soaps) that will not eliminate parasites and predators.

Follow-up

Carpenter ant infestations often cannot be controlled in one visit. Painstaking inspection is needed to make management effective.

CARPENTER BEES (*Xylocopa* spp.)

Carpenter bees are solitary insects that live only one year. The most common carpenter bee, *Xylocopa virginica*, is distributed throughout the eastern half of North America. This bee is a large insect with a hairy, yellow thorax and a shiny, black abdomen. Superficially, it resembles yellow and black female bumblebees, which are social and more closely related to honeybees. Western carpenter bees are also large, shiny, sometimes metallic, and shaped like bumblebees.

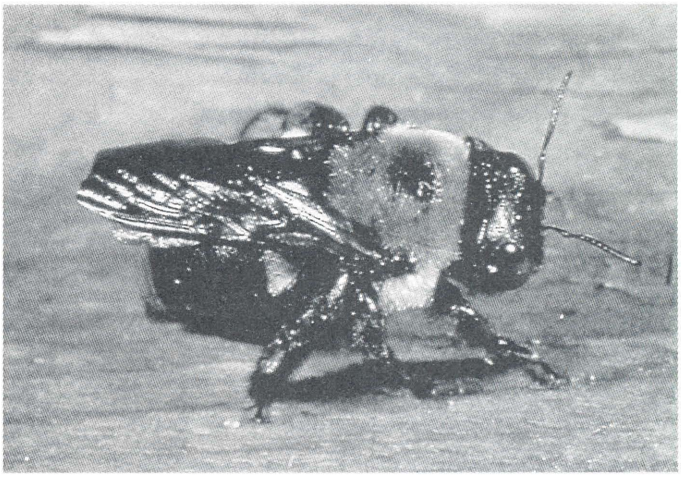

Figure 6.19. Carpenter bee, *Xylocopa* spp.

Carpenter bees bore in wood and make a long tunnel provisioned with pollen for their eggs. They prefer to enter unpainted wood and commonly tunnel in redwood and unpainted deck timbers. They will also go into painted wood, especially if any type of start hole is present. New females reuse old tunnels year after year. They are also attracted to areas where other females are tunneling. Egg laying and tunnel provisioning occur in the spring.

Males hover around the tunnel entrance while the female provisions the nest and lays eggs.

Figure 6.20. Carpenter bee damage.

Males dart at intruders belligerently but they can do no harm—they have no stingers. Because these bees are not social, there is no worker caste to protect the nest. Stings by females are rare.

New adults emerge after the middle of summer and can be seen feeding at flowers until they seek overwintering sites, sometimes in the tunnels.

Control and Management of Carpenter Bees

Carpenter bees drill into the end grain of structural wood or into the face of a wooden member, then turn and tunnel with the grain.

Dust tunnels or inject with pressurized liquid insecticide. Insert a dusted plug of steel wool or copper gauze in the tunnel. Fill the opening with caulk, wood filler, or a wooden dowel. A dusted plug stops new adults that otherwise would emerge through shallow caulking. Caution should be taken, especially if technicians are working on ladders and if they are not experienced with these rather harmless bees.

SUMMARY

Wood-destroying insects other than termites are capable of causing significant damage to structures, furniture, and other wood products. Pest management professionals must be able to distinguish between wood damage caused by termites and damage by other wood-destroying pests. These signs are often characteristic of the pest species involved. Proper identification of the pest species will allow application of the appropriate control techniques. In many cases, habitat alteration (such as reduction of moisture in wood) is all that is needed to control the pest adequately.

CHAPTER 6

Review Questions

Chapter 6: Other Wood-destroying Insects

Write the answers to the following questions and then check your answers with those in the back of the manual.

1. Who is most responsible for ensuring that the procedures for preventing attack on wood before it is used are done?

   A. Homeowners and pest management professionals

   B. Building inspectors and construction workers

   C. People who harvest, mill, or store wood

   D. All of the above

2. What can the pest management professional advise lumber and construction industries and consumers to do to prevent wood-boring beetle infestations?

3. There are a few beetle species that can survive and reinfest wood even after it has been properly kiln dried.

   A. True

   B. False

4. What aspects of building construction will help keep wood dry?

5-18. Match the following families of powderpost beetles with the appropriate description.

A. Lyctidae

B Bostrichidae

C. Anobiidae

D. All of the above

____ 5. Also known as false powderpost beetles.

____ 6. Also known as true powderpost beetles.

____ 7. Small "shot-hole" openings in wood surfaces are an indication of infestation.

____ 8. Includes furniture and deathwatch beetles.

____ 9. Reddish brown, 1/8 to 1/3 inch long, oval-shaped and compact body.

____ 10. Deposits eggs in pores of hardwoods.

____ 11. Brown to black, 1/8 to 1/4 inch long, cylindrical body with roughened pronotum.

____ 12. When infested wood is cut or broken, the interior may reveal masses of packed powder that is produced by the feeding of grublike larvae and to a lesser extent by the adult beetles.

____ 13. Will not attack softwoods.

____ 14. Brown to black, 1/12 to 1/5 inch long, flattened body.

____ 15. Female bores into wood to lay eggs.

____ 16. Have a digestive enzyme that allows them to digest cellulose.

____ 17. Eggs laid in cracks or old exit holes in wood.

____ 18. Powderlike frass contains bun-shaped fecal pellets.

19. Which powderpost beetle gets its name from making a ticking sound?

A. Furniture beetle

B. Deathwatch beetle

C. True powderpost beetle

D. False powderpost beelte

20. What are the signs of powderpost beetle infestation?

21. It is not necessary to examine the surfaces of painted wood for powderpost beetle infestation.

A. True

B. False

22. Habitat alteration alone may be all that's needed to control certain powderpost beetle infestations.

A. True

B. False

23. If true powderpost beetles are identified as causing damage, where should control activities be concentrated?

A. All softwood surfaces

B. All hardwood surfaces

C. Both hardwood and softwood surfaces

D. None of the above

24. If bostrichid or anobiid beetles are identified as causing damage, where should control activities be concentrated?

A. All softwood surfaces

B. All hardwood surfaces

C. Both hardwood and softwood surfaces

D. None of the above

25. Which pesticide application method is the most effective at penetrating into tunnels for wood-boring beetle control but is also the most dangerous to handle?

A. Fumigation

B. Residual sprays

C. Baiting

D. Oil-based emulsion

26. In most cases, residual sprays provide effective control of wood-boring beetle infestations.

A. True

B. False

27. Why are oil-based insecticide solutions considered more dangerous to use than water-based solutions?

28. In treating finished wood, such as furniture or flooring, it is best to use an oil solution to avoid spotting or in any way changing the appearance of the finish.

A. True

B. False

29. What are some precautions to take when treating wood flooring with oil-based insecticide solutions?

30. The old house borer is a member of which beetle family?

A. Powderpost

B. Longhorned

C. Anobiid

D. Bostrichid

31. Which is NOT a characteristic of the old house borer?

A. Oval exit holes, 1/4 to 3/8 inch in diameter.

B. Infest softwood.

C. Long-lived (3 to 12 years).

D. Damage appears shortly after infestation.

32. The old house borer is frequently a pest of new structures, though it is found in older buildings.

A. True

B. False

33. What distinguishes a carpenter ant infestation from a termite or wood-boring beetle infestation?

A. Galleries with very smooth sides; brown-stained tunnels.

B. Mud-lined tunnels; presence of dust or pellets.

C. Galleries with very smooth sides; presence of dust or pellets.

D. Smooth brown-stained, mud-lined tunnels.

34. Carpenter ants forage for ________ to sustain themselves and the colony.

A. Honeydew, sugars, and insects

B. Wood

C. Honeydew alone

D. Pheromones

35. Indicate whether the following statements are characteristic of ants or termites.

A. Ant

B. Termite

____ Front pair of wings is wider and longer than the back pair.

____ Have "petiole" between thorax and abdomen.

____ Young are nymphs.

____ Undergo complete metamorphosis.

____ Thorax and abdomen blend together; not narrow.

____ Wing veins not visible with the naked eye.

____ Leave many broken wings in swarm area.

____ Have elbowed antennae.

36. If the carpenter ant colony is found outside but the ants are a problem inside the building, advise the client to:

A. Use pressurized canned aerosols in wall voids.

B. Trim trees where branches overhang or touch roofs.

C. Use electric current and heat treatment.

D. Caulk and/or screen to prevent ant entryways.

E. B & D

37. What areas should be inspected for the presence of moisture to prevent carpenter ant infestations?

38. Which is NOT true about control of carpenter ant infestations?

A. Inspecting during the day when carpenter ants are more active may be helpful.

B. Dust, spray, or bait can be used on outside colonies (e.g., in tree rot).

C. Use pesticidal dust or pressurized canned aerosols when nests are in wall voids.

D. When indirect treatment is required, liberal placement of bait stations can be used.

E. Use oils and pesticidal soaps to help control honeydew-producing insects involved in feeding carpenter ants.

39. Which is NOT a characteristic of carpenter bees?

A. Prefer unpainted wood.

B. Females reuse tunnels year after year.

C. Males have no stingers.

D. Frass found in tunnels.

E. Pollen and eggs placed in long tunnels.

40. Describe the procedure for managing carpenter bee infestations.

CHAPTER 7

WOOD-DAMAGING FUNGI

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Know the characteristics of fungi that invade wood—i.e., their classification, reproduction, appearance, etc.
- Know the environmental conditions in wood that favor fungal growth.
- Know the two main groups of wood-damaging fungi, the types of fungi found in each, and the signs and symptoms of the damage they cause.
- Know which insects are associated with wood-destroying fungi and the environmental conditions that favor them.
- Know where and how to inspect for evidence of wood-damaging fungi.
- Be familiar with the techniques needed to prevent infestations by wood-destroying fungi.
- Be familiar with habitat modification techniques for controlling wood-destroying fungi.
- Know which chemicals are used to treat wood and control wood-destroying fungi, the relative effectiveness of each, and how they can be applied safely.

Wood is subject to attack and degradation by fungi and insects. These organisms attack in a variety of ways, some utilizing wood substances for food, some using it for shelter, and others for food and shelter. Pest management professionals must recognize and understand the nature of these wood-attacking organisms to prescribe the appropriate treatment and to assure proper performance of their treated products.

Fungi are a major cause of wood degradation. Fungi used to be classified in the plant kingdom but are now classified in a kingdom separate from plants and animals. Like animals, fungi are heterotrophic—i.e., they must consume preformed organic matter rather than manufacture their own food as plants do during photosynthesis. Fungi consist of microscopic threads called ***hyphae*** that are visible to the naked eye only when many of them occur together. Deadwood conks and mushrooms are easily visible examples of the fruiting bodies of fungi from which the reproductive spores are produced and disseminated. Some fungi merely discolor wood, but wood-decaying fungi can change the physical and chemical properties of wood, thus reducing its strength. Therefore, the many wood-inhabiting fungi can be divided into two major groups, depending on the damage they cause:

- Wood-decaying fungi (wood-rotting fungi).
- Wood-staining fungi (sapstaining fungi, molds).

All fungi produce spores (which are like tiny seeds) that are distributed by wind and water. The spores can infect moist wood during storage, processing, and use.

All fungi have certain basic requirements:

- Favorable temperatures(usually ranging between 50 and 90 degrees F. The optimum is about 70 to 85 degrees F. Wood is basically safe from decay at temperatures below 35 and above 100 degrees F.
- Adequate moisture(fungi will not attack dry wood (i.e., with a moisture content of 19 percent or less). Decay fungi require a wood moisture content (M.C.) of about 30 percent (the generally accepted fiber saturation point of wood). Thus, air-dried wood, usually with an M.C. not exceeding 19 percent, and kiln-dried wood, with an M.C. of 15 percent or less, may be considered safe from fungal damage.

- Adequate oxygen—most fungi cannot live in water-saturated wood.
- Food source—wood substance (cellulose, hemicellulose, lignin).

WOOD-DECAYING FUNGI

The sapwood and heartwood of most tree species are susceptible to decay. Decay fungi grow in the interior of the wood or appear on wood surfaces as fan-shaped patches of fine, threadlike, cottony growths or as rootlike shapes. The color of these growths may range from white through light brown, bright yellow, and dark brown. The spore-producing bodies are the ***fruiting bodies*** of the fungus and may take the form of mushrooms, shelflike brackets, or flattened, crustlike structures. Fine, threadlike fungal strands called ***mycelia*** grow throughout the wood and digest parts of the wood as food. In time, the strength and other properties of the wood are destroyed.

Once decay has started in a piece of wood, the rate and extent of deterioration depend on the duration of favorable conditions for fungal growth. Decay will stop when the temperature of the wood is either too low or too high or when the moisture content is lower than the fungi's requirements. Decay can resume when the temperature and moisture content become favorable again. Early decay is more easily noted on freshly exposed surfaces of unseasoned wood than on wood that has been exposed and discolored by the weather.

Wood decay fungi can be grouped into three major categories: brown rot, white rot, and soft rot.

Brown Rot

Poria monticola, Serpula lacrymans

Fungi that cause brown rot are able to break down primarily the ***cellulose*** component of wood for food, leaving a brown residue of ***lignin***. Wood infested with brown rot can be greatly weakened even before decay is visible. The final stage of wood decay by the brown rots can be identified by:

- The dark brown color of the wood.
- Excessive shrinkage.
- Cross-grain cracking.
- The ease with which the dry wood substance can be crushed to a brown powder.

Brown rot fungi are probably the most important cause of decay of softwoods used in aboveground construction in the United States. Brown rot-decayed wood, when dry, is sometimes called "dry rot." This is a poor term, because wood must have moisture and will not decay when it is dry.

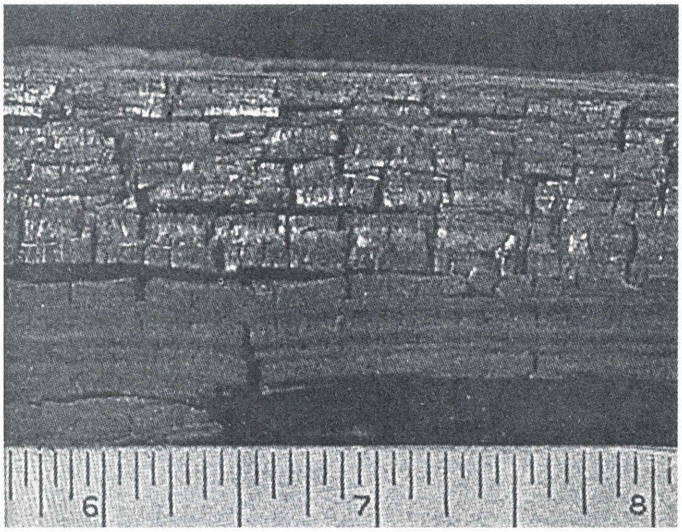

Figure 7.1. Brown rot with characteristic cracks along the grain.

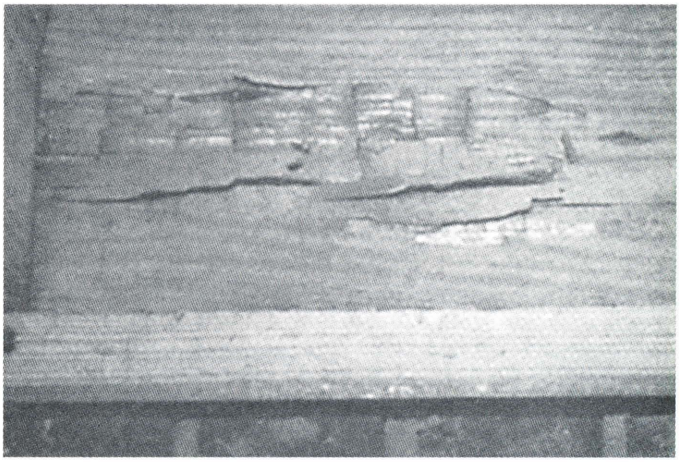

Figure 7.2. Wood damaged by *Poria*, with apparently sound surface and severe rot below surface.

A few fungi that can decay relatively dry wood have water-conducting strands (rootlike structures called ***rhizomorphs***) that can carry water from damp soil to wood in lumber piles or buildings. These fungi can decay wood that otherwise would be too dry for decay to occur. They are sometimes called the "dry rot fungi" or "water-conducting fungi."

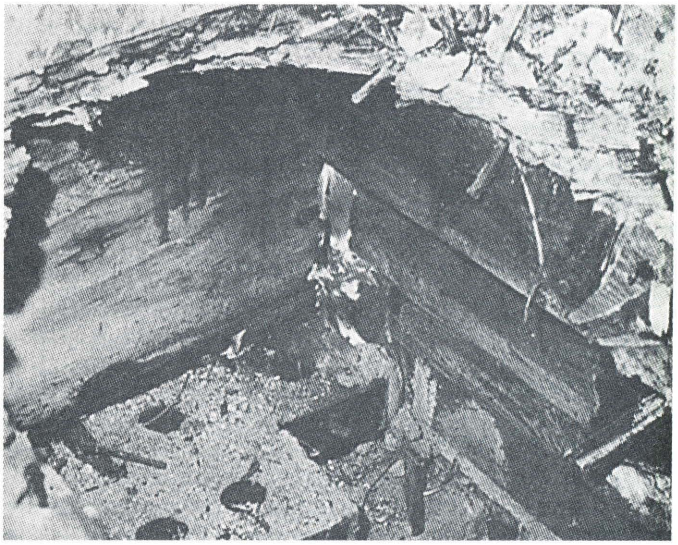

Figure 7.3. Rhizomorphs of *Poria* growing from earth-filled porch.

- Adequate oxygen—most fungi cannot live in water-saturated wood.
- Food source—wood substance (cellulose, hemicellulose, lignin).

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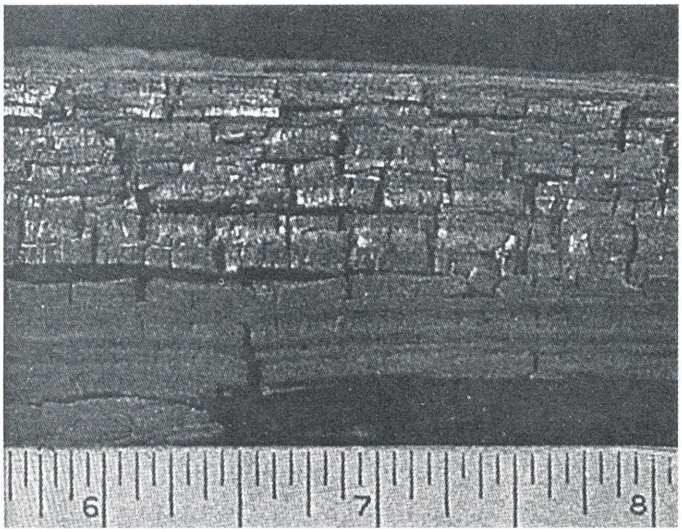
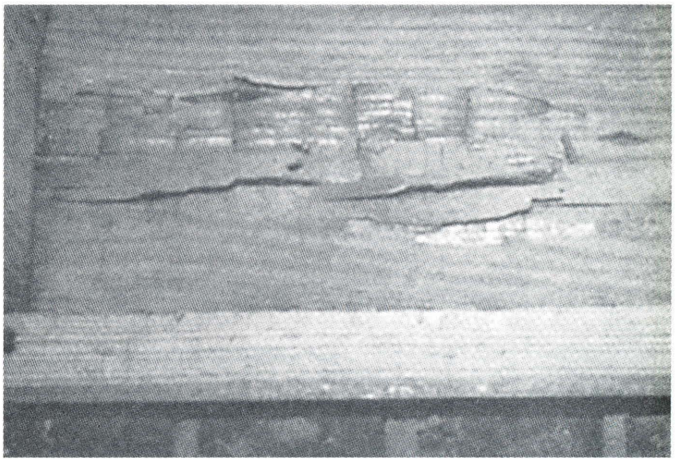


Figure 7.1. Brown rot with characteristic cracks along the grain.



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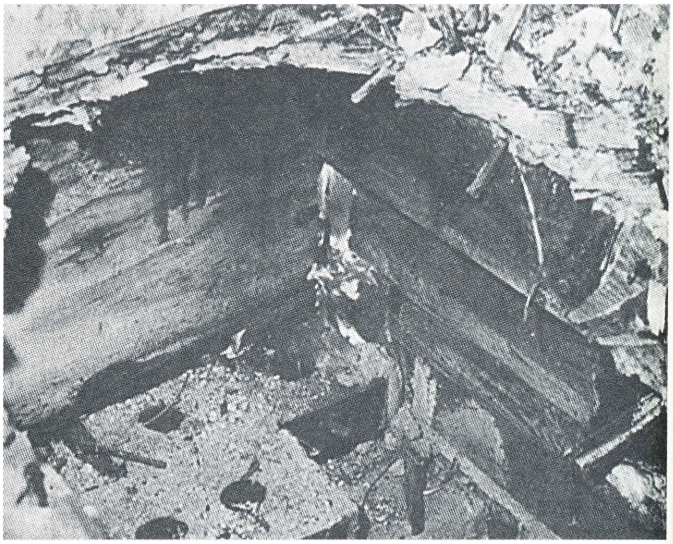


Figure 7.3. Rhizomorphs of *Poria* growing from earth-filled porch.

White Rot

Phellinus megaloporus, Poria contigua

White rot fungi, which break down both lignin and cellulose, have a bleaching effect that may make the damaged wood appear whiter than normal. Affected wood shows normal shrinkage and usually does not collapse or crack across the grain as with brown rot damage. It loses its strength gradually until it becomes spongy to the touch. Sometimes white rot fungi cause thin, dark lines to form around decayed areas, referred to as ***zone lines***. The wood does not shrink until decay is advanced. White rot fungi usually attack hardwoods, but several species can also cause softwood decay.

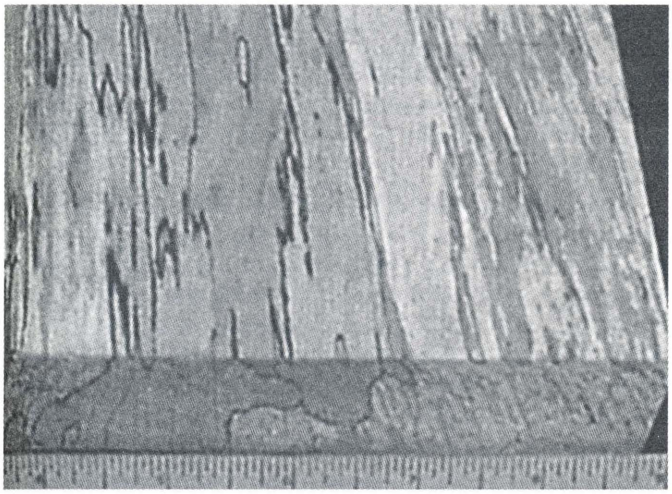
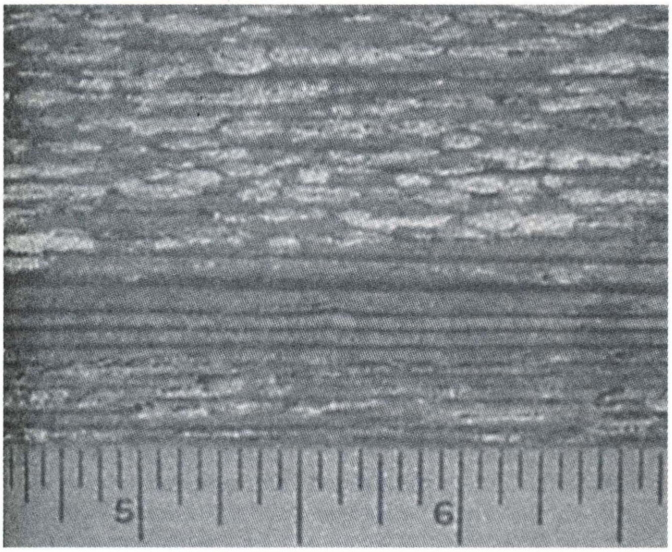


Figure 7.4. White rot with black zone lines sometimes found in the early stages of decay.

One species of white rot fungi, called white pocket rot, attacks the heartwood of living trees. The decayed wood contains numerous small, spindle-shaped, white pockets filled with the fungus. These pockets are generally 1/8 to 1/2 inch long. When wood from infected trees is seasoned, the fungus dies. Therefore no control is necessary. White pocket rot generally is found in softwood lumber.



7.5. White pocket rot.

Soft Rot

Chaetomium globosum

Soft rot fungi usually attack green (high-moisture) wood, causing a gradual and shallow softening from the surface inward that resembles brown rot. The affected wood surface darkens, and this superficial layer, up to 3 to 4 mm deep, becomes very soft, giving the decay its name.

WOOD-STAINING FUNGI

Stain fungi are usually visible as a discoloration of the wood, often bluish, and are of little importance as destroyers of wood. Sometimes lumber stores will even sell wood with blue stains for a higher price because of its decorative value. Though the stain fungi are feeding on the wood in their active stage, they do so at a very slow rate and do not cause much damage. Their presence as an active growth indicates that conditions are right for potential growth of other fungi that may be a problem, however.

Sapstaining Fungi

Ceratostomella spp., *Diplodia* spp.

These fungi penetrate and discolor sapwood, particularly of softwood species. Typical sapstain, unlike staining by mold fungi, cannot be removed by brushing or planing. Sapstain fungi may become established in the sapwood of standing trees, sawlogs, lumber, and timbers soon after they are cut and before they can be adequately dried. The strength of the wood is not greatly affected, but the wood may not be fit for use where appearance is important (such as siding, trim, furniture, and exterior millwork that is to be clear-finished).

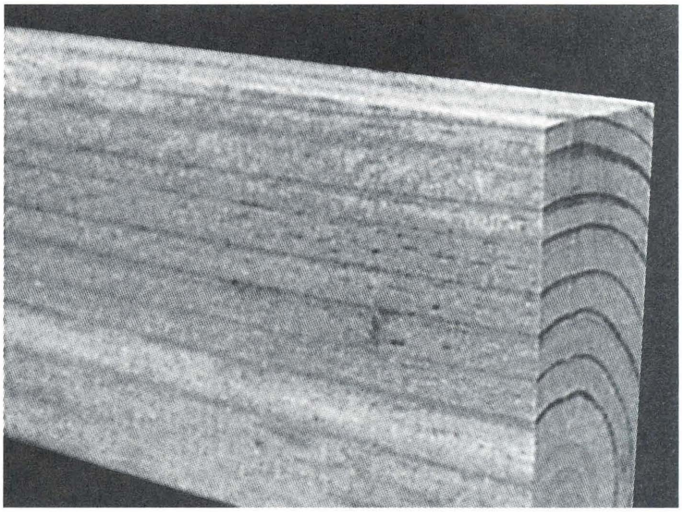


Figure 7.6. Sapstain fungi in pine sapwood.

Sapstaining fungi include several fungus types. Some of the most common are called blue stain fungi. They commonly produce a bluish, threadlike fungal growth deep within the wood that gives it a bluish color. The blue color may completely cover the sapwood, or it may be visible as specks, streaks, or patches in varying shades of blue.

The color of the stain depends on the kind of fungus and the species and moisture content of the wood. Other stains may be yellow, orange, purple, or red.

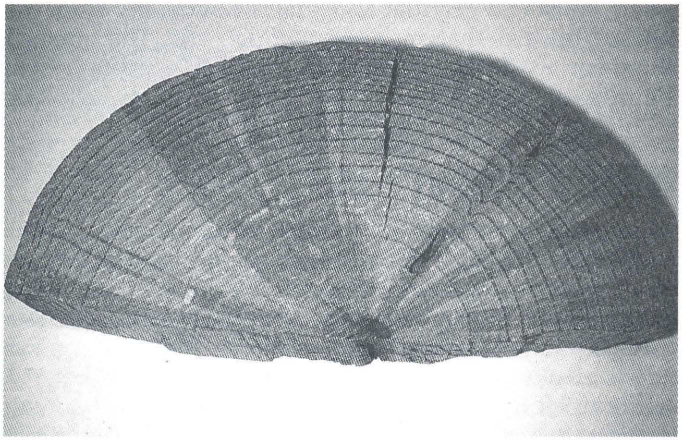


Figure 7.7. Blue stain fungi (Michigan State University).

Mold Fungi

Fusarium spp., *Penicillium* spp.

These fungi first become noticeable as green, yellow, brown, or black, fuzzy or powdery surface growths on the wood surface. The colored spores they produce can usually be brushed, washed, or surfaced off. On open-pored hardwoods, however, the surface molds may cause stains too deep to be easily removed. Freshly cut or seasoned wood stockpiled during warm, humid weather may be noticeably discolored with mold in less than a week. Molds do not reduce wood strength, but they can increase the capacity of wood to absorb moisture, thus increasing the potential of attack by decay fungi.

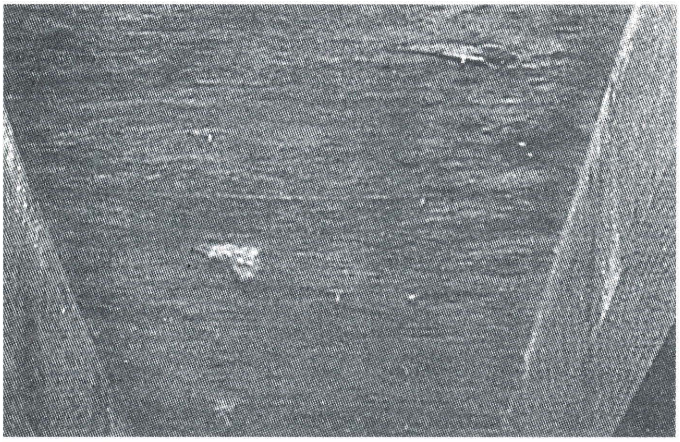


Figure 7.8. Surface molds on plywood attic.

Chemical Stains

Chemical stains may resemble blue or brown stains but are not caused by fungi. These stains result from chemical changes in the wood of both softwoods and hardwoods. Staining usually occurs in logs or in lumber during seasoning and may be confused with a brown sapstain caused by fungi. The most important chemical stains are brown stains that can downgrade lumber for some uses. They usually can be prevented by rapid air drying or by using relatively low temperatures during kiln-drying.

INSECTS ASSOCIATED WITH WOOD-DESTROYING FUNGI

Many insect pests are encouraged to take up residence in wooden structures by excessive moisture conditions. Termites, particularly the dampwood termites and subterranean termites, require moisture in their living quarters. Subterranean termites provide moisture for themselves by bringing moisture and soil up from their subsurface colonies and placing it within the wood as they feed on it or around the outside of wood to form their enclosed runways. In some cases, subterranean termites may be found separated from soil contact when sufficient moisture, in the form of water leaks, is found inside a structure.

The retention of moisture is not the only important water-related factor in the life of the termite. The warm, moist conditions that prevail within the closed system of the nest provide an ideal site for the growth of microorganisms, particularly fungi, which provide a source of protein and vitamins essential to the termite. The accumulation of termite fecal material in the nest, in turn, helps to promote the growth of the fungi.

The most striking fact of this intricately interdependent system is the delicacy with which it is balanced. It is not uncommon to discover the remains of a termite colony that is slowly being crowded out by the growth of fungi that has for some reason progressed at such a rate that the termites could not keep up with it. If sudden temperature shifts or other factors result in the accumulation of water within the galleries, the termites may drown.

A number of beetles are associated with excessive moisture and fungus problems in structures. The furniture beetle, an anobiid beetle, is commonly attracted to moisture and fungus. Anobiid larvae eat the wood, and the beetle may reinfest over many generations, reducing the wood to little more than powder. Anobiid larvae will not survive in wood with a moisture content below 12 percent. The drier the wood, the slower their growth.

Other families of beetles are also associated with excessive moisture in structures, but with all these families, it is the fungus growth to which they are attracted. These "fungus beetles" include:

- Cisidae—the minute fungus beetles.
- Cryptophagidae—he silken fungus beetles.
- Lathridiidae—minute brown scavenger beetles.
- Tenebriodiae—darkling beetles.
- Cucujidae—flat bark beetles.

These beetles and their larvae feed on fungus growth on wood, such as *Poria*, or may be present in damp foods where even tiny amounts of fungus growth or fungal spores are present. The fungus beetles are not wood-damaging pests but are associated with moisture problems and are a good indication that such problems are present.

Carpenter ants are another group of insects that are attracted to moist wood. They prefer to do their tunneling in wood that has been softened in some way and is easier to chew through. They do not feed on the wood but merely excavate large chambers to create a suitable place to live and rear their larvae. Control of moisture sources will help to keep these pests out of the structure as well.

In addition to the beetles and ants, a number of other pests are attracted to moisture conditions in buildings. Most are merely nuisances that cause no problem beyond their mere presence. Some of these are springtails, silverfish, mites, millipedes, fungus gnats, and booklice.

CONTROL AND MANAGEMENT OF WOOD-DESTROYING FUNGI

Inspection

The inspector may use the **pick test** to detect loss of wood toughness and the presence of wood decay at as little as 5 to 10 percent loss of weight. In this test, a sharp pointed object, such as an icepick, is used to poke into and pry up a segment of wood, especially to "latewood" areas of darker rings. In decayed wood, the pried-up section will break abruptly, directly over the tool, whereas in sound wood the break will occur at a point away from the tool. This test is very subjective, but it is possible to detect very early stages of decay by both brown rot and white rot.

The surface molds and stain fungi grow more rapidly than decay fungi and often appear on wood during construction. Fungus growth will not continue after construction if the wood dries out. However, the presence of stain fungi indicates that conditions at one time were suitable for decay, and an inspection using a moisture meter should be conducted to see if the wood is still moist enough to support decay fungi.

Measuring wood moisture with a moisture meter is an important method to determine:

- Whether wood has a moisture content (20 percent or above) that will lead to decay.
- Small changes in the moisture content of wood to demonstrate the success of a moisture control program over time.
- The likelihood of infestation or reinfestation by wood-boring insects.
- Whether fungi seen on the wood surface are still actively growing.

The electric resistance of wood decreases as its moisture content increases. This is the basis for the operation of portable **moisture meters**. They measure the resistance between two needles inserted into wood and give a direct readout of moisture content. The higher the meter reading (decreasing electric resistance), the higher the amount of moisture in the wood. Moisture meter readings can be affected by the wood species involved, moisture distribution, grain direction, chemicals in the wood, weather conditions, and temperature. Thus, directions and information supplied with the meter must be understood and followed to ensure accurate readings. Some common sources of moisture in structures are listed below. These areas should be inspected for signs of wood-decaying fungi and moisture above 20 percent.

- Water vapors from the combustion of natural gas that improperly vent into the attic or other enclosed areas.
- Condensation on windows flowing down onto and into sills.
- Moisture from crawl spaces and the dirt below (up to 100 pounds/day/1,000 square feet).
- Absent or improperly placed drain pipes, downspouts, etc.
- Leaking roofs.
- Poor side wall construction.
- Improperly sealed foundations, basement walls.
- Direct contact of wood with soil or concrete, allowing "wick" action that pulls water into wood.
- Improper drainage of water away from structure or out of crawl spaces.
- Improperly fitted flashings at roof lines or shingles with improper overhang.
- Improper moisture barriers under stucco, shingles.
- Sweating water pipes.
- Improper exterior grade that allows water to drain toward the structure and remain in contact with it.
- Dripping air conditioners or swamp coolers.
- Leaking plumbing, appliances, toilets, shower stall pans.
- Improper seals or caulk around bathtubs and showers.
- Lack of vents or windows in bathrooms that allow moisture from baths and showers to accumulate.
- Plugged or leaking downspouts from roof gutters.

Condensation is free water or ice extracted from the atmosphere and deposited on any cold surface. The term **relative humidity** is a means of describing the amount of water vapor held by air. If more water vapor is injected into air than the air can hold at that temperature, the excess condenses into visible droplets.

In recent years, the shift in building practices to larger homes that are more airtight has led to additional condensation problems. Energy conservation practices have increased the airtightness of buildings. Also, emphasis has been placed on the installation of humidifiers in heating units to create a more comfortable environment. The also increase the likelihood of moisture problems in wood. Finally, improperly installed insulation may contribute to moisture problems.

There are numerous sources of water vapor in buildings. Mopping floors, washing clothes, cooking, baking, and so forth introduce an estimated 1 pound of water per day into the air of an average home. A poorly ventilated crawl space may produce up to 100 pounds of water per day per 1,000 square feet. These moist environments are favorable for the reproduction and survival of decay fungi, termites, and other moisture-loving insects.

Prevention

Simply maintaining a building properly by fixing leaky pipes and faucets, repairing a leaky roof, etc., is often all that is needed to control wood-destroying fungi. Simple repairs such as these will often save thousands of dollars by preventing damage and expense from wood-destroying fungi. Prevention, however, begins even before the maintenance stages—the structure must be built properly to begin with.

When wood is used in the construction of a building, it should be well seasoned so that it does not contain enough natural moisture to support decay fungi. Wood should not be used in those parts of construction where it can be moistened by wet soil. In extremely wet or humid areas, construction lumber is frequently treated with preservative chemicals to prevent fungus damage.

Water should drain away from a properly constructed building. This is accomplished through proper grading and roof overhang and the use of gutters, downspouts, and drain tile. Proper grading should be taken care of before construction; it is usually an expensive task if done later. The other methods should be used to move water away from the foundation walls. It is important that condensation (e.g., from air conditioners) be properly drained. Indoors, dehumidifiers should be used where moisture in the air is likely to be a problem

Proper ventilation in crawl spaces can be obtained by installing 1 square foot of opening for each 25 linear feet of wall. These openings should be located so as to provide cross-ventilation. This opening should be unobstructed. Where screening, wire mesh, or louvers are used, the total opening should be greater than 1 square foot per 25 feet of wall. Provision should be made to close vents off during the winter.

Attic vents are recommended at the rate of 1 square foot of vent for every 150 to 300 square feet of attic floor space. Vents should be located both near the ridge and at the eaves to induce airflow. Where louvered openings cannot be used, globe ventilators, fan exhaust ventilators, or special flues incorporated in a chimney may be best. Inlet openings under the cornice or roof overhang are required in all cases. Flat roofs where the same framing is used for ceiling and roof require openings between the joists. Any opening provided should be screened and protected from the weather.

Vapor barriers are a preventive measure usually applied to the subareas of buildings. Installation of a vapor barrier on the soil surface will cause soil moisture to condense on the barrier and return to the soil rather than condense on the floor and joists above. Covering the soil with roofing paper or 4-mil to 6-mil polyethylene sheets can make adequate barriers. Proper installation of these barriers is essential; a small portion of the soil surface should be left uncovered. Leaving spaces between strips, for example, allows the subarea to "breathe" better and any standing water will have a place to go. This is particularly important if the subarea is very wet prior to installation. This will also allow wood in the crawl space to dry slowly, minimizing warping and cracking. Inspection 1 to 3 weeks after installation will allow for proper adjustments of the vapor barrier so that the wood can slowly recover from excess moisture.

Habitat Modification

The first step in correcting a fungus condition is to determine the source of moisture and eliminate it, if possible. All badly rotted wood should be removed and replaced with sound, dry lumber. When it is not possible to eliminate the source of moisture entirely, the replacement lumber should be pressure treated with a wood preservative before installation. Wood should not be allowed to remain in contact with the soil.

Chemical Control

In most cases, spraying chemicals will not control wood-decaying fungi. Eliminating moisture sources and replacing decayed wood with pressure-treated wood is the recommended control. Chemical use, however, may be warranted in situations where wood cannot be easily dried.

Prevention

Chemical wood preservatives are an effective means of preventing wood decay. Pressure treatment with preservatives such as creosote, zinc chloride, pentachlorophenol, and/or copper naphthenate has been used extensively. The pest management professional needs to be aware of the high toxicity of these chemicals. Pentachlorophenol, for example, is no longer readily available to the consumer in either the ready-to-use (5 percent penta) or the concentrated (40 percent penta) formulation because of its high toxicity and status as a carcinogen. Pest management professionals should be careful when handling pretreated wood. Wear rubber gloves and long-sleeved clothing and wash thoroughly after handling. ***Never dispose of preservative-treated wood by domestic incineration or use as a fuel in fireplaces or wood-burning stoves.*** Treated wood, end pieces, wood scraps, and sawdust should be disposed of at a sanitary landfill. Small quantities may be disposed of with household trash.

Control

Less toxic, more environmentally friendly fungicides than the pressure-treated wood preservatives are commercially available. These fungicides are often borate-based. To control fungi on existing wood structures, the wood should be kept clean with periodic high-pressure washings and a fungicide application to kill remaining fungal spores to prevent reinfestations. It is most important to point out that the application of fungicides or insecticides to fungus-infested wood or soil will not stop the wood decay. Only by eliminating the moisture source can wood decay be completely controlled. Therefore, the application of chemicals by pest management professionals is of minor importance in fungus control work.

Before the application of toxic chemicals for wood-destroying fungus control (as is true for any aspect of pest control), all physical, sanitary, and other means of control must be implemented. Not only will the control be more effective in the end, but fewer chemicals, or none at all, will be placed into the environment where humans and animals may come into contact with them. Removal of all sources of excessive moisture and replacement of obviously fungus-infested wood with sound timber are the keys to fungus control in structures.

Borates as fungicides

A number of boron-containing products are available and referred to generically as "borates." The borate known as disodium octaborate tetrahydrate (DOT) is actually a combination of several borates. Borates are well suited to fungus control because they are low hazard, easy to apply, long lasting, and quite effective against both fungi and wood-destroying insects. Part of their success as a wood treatment can be attributed to their high solubility in water. They are easy to mix in a water carrier and are carried along by water diffusing through the wood.

They are available in a variety of formulations that allow spraying, brush-on, gel, and foam applications. There is also a formulation available consisting of solid rods that are inserted into holes drilled into the wood. These are designed for use in wood with high moisture content that cannot be easily dried.

SUMMARY

The pest management professional must be able to distinguish the signs and symptoms of wood-damaging fungi from insect damage. Damage from fungi is often more easily controlled than insect damage with less dependence on pesticides. Prevention by controlling moisture sources, limiting soil to wood contact, and replacing damaged wood with chemically treated wood offer the best control.

CHAPTER 7

Review Questions

Chapter 7: Wood-damaging Fungi

Write the answers to the following questions and then check your answers with those in the back of the manual.

1. What are the two main groups of wood-damaging fungi?

2. Which is NOT true about fungi?
   A. Reproduce by spores.
   B. May discolor wood.
   C. Include mushrooms and conks.
   D. Belong to the plant kingdom.

3. Which environmental conditions would favor the growth of fungi?
   A. Temperature below 35 degrees F, moisture content of air-dried wood less than 19 percent.
   B. Temperature between 35 and 100 degrees F, water-saturated wood.
   C. Temperature above 100 degrees F, moisture content of air-dried wood 19 to 30 percent.
   D. Temperature between 35 and 100 degrees F, moisture content of air-dried wood 19 to 30 percent.

4. What is considered the optimal temperature range for fungal growth?
   A. 10 to 35 degrees F
   B. 35 to 70 degrees F
   C. 70 to 85 degrees F
   D. 85 to 100 degrees F

5. Which is NOT a characteristic of decay fungi?
   A. Attack sapwood and heartwood of most tree species.
   B. Mycelial fans appear on wood surfaces.
   C. Fruiting bodies may be mushrooms, shelflike brackets, or crusty, flattened structures.
   D. Early decay is more easily noted on weathered, discolored wood than on freshly exposed, unseasoned wood.

6-14. Match the following decay fungi to the appropriate description.

A. Brown rot

B. White rot

C. Soft rot

____ 6. Usually attacks green (water-saturated) wood.

____ 7. Probably the most important decay of soft woods used in aboveground construction.

____ 8. Symptoms include excessive shrinkage and cross-grain cracking of wood.

____ 9. Both lignin and cellulose are broken down; wood looks bleached.

____ 10. Wood infected with this fungus can be greatly weakened before decay is visible.

____ 11. Affected wood shows normal shrinkage, does not collapse or crack across the grain, and loses strength gradually until spongy to the touch.

____ 12. Affected wood surface darkens and a superficial layer up to 3 to 4 mm deep becomes very soft.

____ 13. The affected wood is easily crushed to a brown powder.

____ 14. Includes a few fungi that can infect relatively dry wood because of water-conducting strands.

____ 15. Breaks down cellulose, but not lignin.

16. What should the pest management professional do if white pocket rot is found in a home?

A. Recommend treatment

B. Replace infested wood

C. Nothing

D. A & B

17. "Dry rot" refers to brown rot fungi infecting completely dry wood.

A. True

B. False

18. Which is NOT true of wood-staining fungi?

A. Often cause a bluish discoloration of wood.

B. Significantly reduce the strength of wood.

C. Their presence indicates favorable conditions for the growth of other fungi.

D. Feed on wood at a very slow rate.

19-26. Match the following to the appropriate description.

A. Sapstaining fungi

B. Mold

C. Chemical stains

D. All of the above

____ 19. Discolor sapwood, particularly of soft wood species.

____ 20. Commonly produce a bluish, threadlike fungus growth deep within wood.

____ 21. First noticeable as green, yellow, brown, or black, fuzzy or powdery surface growths on the wood.

____ 22. Blue or brown stain not caused by fungi.

____ 23. Colored spores can usually be brushed, washed, or surfaced off.

____ 24. Fungal stains can not be removed by brushing or staining.

____ 25. Includes *Penicillium* species.

____ 26. Can downgrade the value of lumber.

27. When do chemical stains occur? How might they be prevented?

28. Describe the interdependent relationship between fungi and termite colonies.

29. Termite colonies may be crowded out by rapid fungal growth.

A. True

B. False

30. Which of the following fungus-associated insects actually feeds on wood?

A. Anobiid beetle

B. Carpenter ant

C. Fungus beetle

D. Millipede

31. Describe the pick test as a diagnostic tool of wood decay. To what level (percent) does the pick test indicate wood decay?

32. What important factors about wood can be indicated with the use of a moisture meter?

33. List factors that can affect moisture meter readings.

34. List at least 5 common sources of moisture in structures.

35. The shift in recent years to larger houses that are more airtight has decreased condensation and moisture problems in homes.

A. True

B. False

36. A poorly ventilated crawl space may produce up to 100 pounds of water per day per 1,000 square feet.

A. True

B. False

37. What methods can be used to move water away from foundation walls?

38. Which is the appropriate spacing of openings for proper ventilation in crawl spaces?

A. 1 square foot of opening per 25 feet of wall.

B. 1 square foot of opening per 50 feet of wall.

C. 1 square foot of opening per 75 feet of wall.

D. 1 square foot of opening per 100 feet of wall.

39. Which in an appropriate spacing for vents in attics?

A. 1 square foot of vent for every 50 to 150 square feet.

B. 1 square foot of vent for every 150 to 300 square feet.

C. 1 square foot of vent for every 300 to 450 square feet.

D. 1 square foot of vent for every 450 to 600 square feet.

40. What is the purpose of installing a vapor barrier?

41. When installing a vapor barrier, make certain the entire soil surface is covered.

A. True

B. False

42. What is the first step in correcting a fungus condition?

A. Replace all badly rotted wood with sound, dry lumber.

B. Determine moisture sources and eliminate them.

C. Insert borate rods.

D. Apply fungicides to the area.

43. When working with wood treated with pressure-treated chemical preservatives, what precautions should you take?

44. The application of fungicides or insecticides is the only treatment necessary to stop wood decay.

A. True

B. False

45. List some positive aspects of using borates as fungicides.

APPENDIX A

ANSWERS TO REVIEW QUESTIONS

Chapter 1 Laws Concerning Control of Wood-destroying Pests

(1) False. Pest management professionals may use many other activities (prevention, habitat modification, etc.) besides pesticide application to control pests. These other practices increase the overall effectiveness of the control program.

(2) B (3) B (4) D (5) C (6) A

(7) False. Category 7B commercial applicators must consider the possibility that endangered or threatened species may be affected by pesticides applied in and around buildings.

(8) C (9) D

(10) Definition, general description, why pesticide is used, general toxicity information (i.e., compound type, where applied, exposure information, amount/rate applied, label compliance), precautionary measures, and instructions to customer on site preparation, precautions, etc.

(11) True

(12) False. Category 7B commercial applicators must consider air circulation patterns and ventilation systems when spraying inside buildings and must also consider the possibility of off-target drift when spraying outside of buildings.

(13) D

(14) Unless otherwise specified by the product label, applicators must wear long pants, protective footwear, long-sleeved clothing (short-sleeved allowed if wash water or waterless soap is immediately available), and gloves impervious to the pesticide.

(15) False. According to Rule 13 of Regulation 637, such statements are prohibited.

(16) Site evaluation, description, inspection, and monitoring; the concept of threshold levels; the relationship between pest biology and pest management methods; pest population reduction and pest prevention; development and implementation of an IPM program that reduces the possible impact of pesticides; evaluation of an IPM program to determine effectiveness; record-keeping requirements of an IPM program.

(17) D

Chapter 2 The Biology of Termites and Other Wood-destroying Pests

(1) A (2) B (3) B (4) E (5) C (6) A (7) A
(8) D (9) B (10) C (11) C (12) A (13) D
(14) B (15) B (16) C (17) A (18) C (19) C
(20) E (21) C (22) A

(23) Maintaining the proper levels of temperature and moisture is essential to the survival of the colony. Warm, moist conditions provide an ideal site for the growth of microorganisms, particularly fungi, which are a source of protein and vitamins essential to the termite. The accumulation of termite fecal material in the nest, in turn helps to promote the growth of fungi. The type of soil will also affect the ability of the subterranean termite to flourish. Sand is preferred over clay.

(24) E (25) D (26) D (27) A (28) B (29) D
(30) C (31) E (32) D (33) E (34) C (35) B

(36) A (37) B (38) B (39) B

Chapter 3 Equipment and Methods

(1) C (2) B (3) A (4) A (5) D (6) C (7) D

(8) Because the smallest opening in the spray line determines the actual capacity for delivery, regardless of the size of the hose. If the diameter of the coupling is smaller than the diameter of the hose, it will decrease the delivery rate and the desired volume of spray will not be delivered.

(9) B

(10) Without accurate calibration of sprayers, the amount of pesticide delivered will be incorrect. Overdosage will contaminate the spray area or result in runoff. Less than the recommended dosage might fail to control the pest.

(11) A flow meter and timer. It is measured as the amount of time it takes to deliver 1 gallon of liquid per unit area.

(12) The type of soil that termiticides are being injected into—i.e., its composition, compaction, etc.; the method used to inject the insecticide; and the type of construction being treated.

(13) A (14) D (15) C

(16) The well's location from the foundation, the depth of the well, where the supply line enters the structure, and the depth to water.

(17) True

(18) Flashlight, steel tape, folding rule, rolling measuring device, penknife, etc. Wear coveralls, bump hat, and gloves for inspecting crawl spaces and other non-basement areas.

(19) The presence of swarmers or their shed wings, live or dead termites, damaged wood, brown mudlike material lining galleries, mud tubes out in the open, or mudlike material covering cracks between boards and other areas.

(20) Termites construct mud tubes so that they can travel from one feeding site to another in a protected environment (maintaining proper conditions of temperature and moisture). Single mud tubes out in the open are about the diameter of an ordinary lead pencil.

(21) Termites remove only the soft layers (spring wood) within the annual rings of the wood grain, penetrating the hard layers only to get from one soft layer to another. This frequently leaves a damaged piece of wood looking very much like pages of a book. Also, they line their galleries with a brown, mudlike material in an irregular pattern.

(22) D

(23) An adequate diagram of the structure on cross-ruled paper accompanied by a description of the structure and the problems to be solved. The drawing should include the type of construction, all crosswalls, stairways, doorways, porches, stoops, and other parts of the structure that will affect the method of treatment. It must be drawn to scale, revealing blind areas that are often sites of severe infestation. Every place where live termites are found should be indicated on the diagram. All existing damage, inaccessible areas, and other unusual situations should be indicated. All details of construction, including:

- The materials of which the outside walls and foundations are made (e.g., concrete block, stone, etc.) and whether the foundation extends below grade.
- The places where it will be necessary to drill through the concrete floor, such as in door ways, and driveways.
- Whether the building has a basement or a crawl space or is a concrete slab on grade.
- The locations where ventilators should be installed.
- The conditions that may be conducive to termite attack (such as improper grade).
- Other pertinent information.

(24) 1) Sanitation of the building site, 2) structural and construction defects, and 3) barriers (mechanical or chemical).

(25) Remove all tree roots and stumps from the building site before starting construction. Remove spreader boards and grade stakes before concrete sets. Remove form boards and wood scraps from soil before filling or backfilling.

Do not bury wood in the backfill, under porches, or under steps—this may attract termites.

(26) D (27) A (28) True (29) B (30) D (31) C

(32) False. Soil treatment should be used as a supplement to good construction, not as a substitute for it.

(33) Treatment of the entire soil surface under any area to be covered with concrete, including garage and basement floors, entrance platforms, and filled porches.

Treatment with additional amounts of chemical to the soil beneath those areas that lie adjacent to foundation walls, beneath interior walls, around sewer and utility openings and at other possible points of entry.

Treatment of footings and backfill outside foundation walls and inside walled areas where there is a crawl space. Accessible areas such as these could be treated later, but it's easier to do it at construction time.

Treatment of empty spaces or voids in concrete blocks.

(34) A (35) True (36) B (37) D (38) D (39) E
(40) C (41) A (42) A (43) A

(44) B (45) C (46) D (47) F

(48) Momentary immersion by bulk dipping, pressure, or combination pressure/diffusion treatment, treatment of composite boards and laminated products by treatment of the wood finish, hot and cold dip treatments and long soaking periods, spray or brush-on treatments with borate slurries or pastes, and placement of fused borate rods in holes drilled in wood already in use.

(49) A (50) C

(51) Foams penetrate into hard-to-reach cavities and voids and improve termiticide distribution in soils. Liquid termiticide is combined with air to create uniform, small-diameter bubbles. The foam carries the liquid termiticide in the spaces between the bubbles. As the foam breaks down, it leaves a thin residue on the surfaces it had contact with. The fact that foam is less dense than liquid enables it to dispense uniformly. The foaming agent delays collapse of the bubbles providing more time for the insecticide to reach desired areas. ***Surfactants*** in the foam improve penetration of the chemical into the soil; thus, a more uniform and continuous residual barrier is established.

(52) C (53) E (54) C (55) B (56) A (57) C

(58) They must be non-repellent, slow acting, and readily consumed by termites.

(59) The toxic material in the bait must kill slowly enough to allow foraging termites to return to the colony and spread the bait through food sharing (trophallaxis). Other factors include dose dependency, learned avoidance (e.g., dead termites accumulating around the toxic material and repelling other termites from feeding), suitable temperature and moisture, and early detection.

(60) A (61) B

(62) Bait placement and number depend on the product used, the characteristics of the site, and the amount of termite activity.

(63) Often placed every 10 to 20 feet around the perimeter of the building 2 feet out from the foundation.

(64) Aboveground bait systems are placed in the path of the termites (in mud tubes or in areas of wood damage and termite presence), so that the termites come in direct contact with the bait. More immediate colony elimination can be obtained than by placing baits in the soil around the structure.

(65) D (66) D

(67) Baits fit well into an IPM program as an addition to existing termite control methods such as eliminating conditions conducive to termite infestation, judicious use of liquid soil products as a spot or limited barrier application, and use of wood treatment products.

Chapter 4 Soil Treatment for Subterranean Termites

(1) B (2) D (3) C (4) A (5) B (6) C (7) B

(8) Rodding is the injection of termiticide into the soil through a long pipe inserted at appropriate intervals so that insecticide can be carried to the level of the footing. Trenching is removing soil to with in about 1 foot above the footing and treating the soil with insecticide as it is replaced. The soil is saturated with chemical to the top of the footing.

(9) C (10) True (11) A (12) D (13) A (14) C

(15) When floor covering, plumbing (bathtubs, sinks, showers), cabinets, or other furnishings obstruct access to drilling from the inside.

(16) A (17) A

(18) It has the added advantage over short rodding of possible access behind concrete porches. A disadvantage is that long rodding for any significant distance may leave untreated areas because the rod may veer away from the foundation down into the soil.

(19) Termites may come from (1) the subslab area, (2) up through the expansion joint at the edge of the slab, and (3) up though a crack in the floor beneath a wood partition. A fourth possible termite entry point would be through concrete block voids.

(20) A sharp bit and steady pressure are required when drilling terrazzo to prevent chipping around the edge of the drill hole. One method is to apply light pressure on the drill while quickly hitting and releasing the trigger. This prevents the bit from jumping about and damaging the surface of the floor. Terrazzo may be patched by saving the drilling dust so that a portion of the dust can be mixed with cement and made to match the original floor. If this method is not acceptable to the property owner, a professional terrazzo floor company can be contacted to patch the drill holes.

(21) The main problem areas are limited to the openings for pipes, plumbing, soil lines, etc., any faults or cracks in the slab, and any grading stakes or embedded articles that termites might use to gain access through the slab.

(22) When there is a veneer of brick, stone, or stucco that extends below grade.

(23) B (24) A

(25) False. No routine treatment of wood is done in monolithic slab construction. Wood treatment is done only when there is a specific reason for doing so.

(26) C

(27) Dig a trench 6 to 8 inches wide and a few inches deep next to the walls or piers, taking care not to go below the top of the footing. If the land slopes or if the footing is more than 12 inches deep, make crowbar, pipe, or rod holes about 1 inch in diameter and a foot a part in the bottom of the trench. The holes should go to the footing—this will help distribute the chemical evenly along the wall.

(28) Make a trench along the exterior foundation wall 6 to 8 inches wide and about a foot deep. If needed, holes can be made in the trench bottom the same as for the trench along the interior wall.

(29) B

(30) It is necessary to treat the soil to a greater depth than is required for other types of houses. The trench is prepared in the same way, but the pipe or rod holes should extend down to the top of the footing to aid in proper distribution of the chemical to all parts of the wall.

(31) Where the termites are coming from beneath the concrete floor in the basement, remove any wood that may extend into the ground, treat the soil, and then seal cracks or holes with a dense cement mortar. When the infestation is located between the floor and wall (expansion joint) or around a furnace, make a series of holes, spaced about 1 foot apart, through which a chemical can be poured or injected. Holes along a wall should be made about 6 to 8 inches from it so as to clear the footing and reach the soil beneath.

(32) Termiticide may seep into and contaminate the structure.

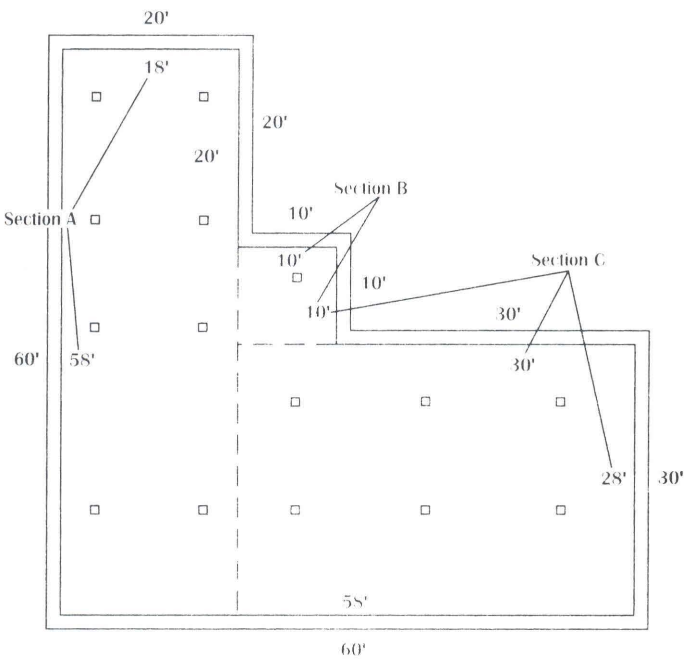
(33) A

Solutions for Example 1: Pier and Beam Foundation

Foundation wall is 1 foot thick.

Piers are 3 feet in circumference.

Depth from grade to footing is 2 feet for piers and foundation wall.



34. How many linear feet are there in the structure above?

exterior: 20 ft.+20 ft.+10 ft.+10 ft.+30 ft.+30 ft. +60 ft.+60 ft. =240 ft.

interior: 18 ft.+20 ft.+10 ft.+10 ft.+30 ft.+28 ft. +58 ft.+58 ft. = 232 ft.

piers: 15 x 3 ft. = 45 ft.

240 linear ft. exterior of foundation wall + 232 linear ft. interior of foundation wall +45 ft. (15 piers x 3 linear ft.) = 517 linear feet

35. How many gallons of spray mix would be needed to treat the linear feet in this structure using the standard rate of mixture (4 gal./10 linear ft./ft. of depth) for vertical treatment?

$$\frac{\text{517 linear ft. x 2 ft. of depth x 4 gal.}}{\text{10 linear ft./ft. of depth}} = \text{413.6 gallons}$$

36. How many gallons of "Termite-Icide" would be needed to treat the linear feet at the 0.5 percent rate?

$$\frac{\text{1.25 gal. “Termite-Icide”}}{\text{96 gal. spray mix}} = \frac{\text{X gal. “Termite-Icide”}}{\text{413.6 gal. spray mix}}$$

$$\frac{517}{96} = \text{5.38 gallons “Termite-Icide”}$$

37. How many square feet are within the foundation wall of the drawing above?

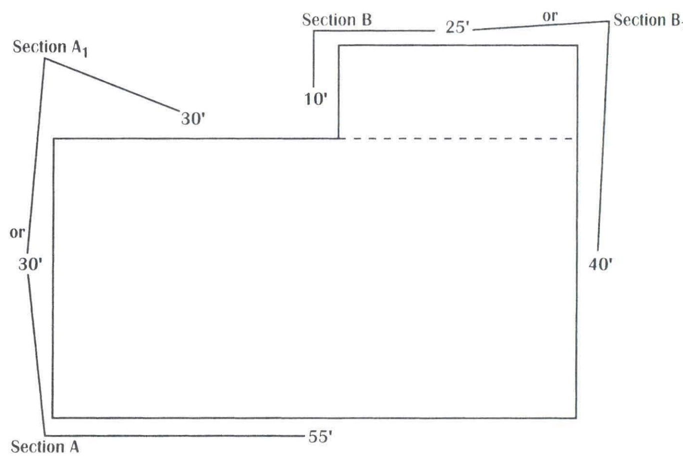
Section A (18 ft. x 58 ft.) + Section B (10 ft. x 10 ft.) + Section C (40 ft. x 28 ft.) = 1,044 sq. ft. + 100 sq. ft. + 1120 sq. ft. = 2,264 sq. ft.

38. How many gallons of spray mix would be needed to treat the horizontal surface (square feet) using the standard volume for a 0.5 percent rate if the substrate is fill sand?

$$\frac{\text{2,264 sq. ft. x 1 gal.}}{\text{10 sq. ft./gal}} = \text{226.4 gallons}$$

Solutions for Example 2: Monolithic Slab

Monolithic slab with 1 foot from grade to bottom of perimeter beam



39. How many square feet are in the monolithic slab surface?

Section A (30 ft. x 55 ft.) + Section B (10 ft. x 25 ft.) = 1,900 sq. ft. [or Section A1 (30 x 30) + Section B1 (40 x 25)]

40. How many linear feet would be treated for a perimeter treatment?

30 ft. + 30 ft. + 10 ft. + 25 ft. + 40 ft. + 55 ft. = 190 ft.

41. If "Termite-Icide" costs $97 for a 2.5-gallon jug, how much will the chemical cost to treat the horizontal surface of the monolithic slab at the 0.5 percent rate?

$97/2.5 gal. concentrate X 1.25 gal. concentrate/ 96 gal. solution X 1 gal. solution/10 sq. ft. X 1,900 sq. ft. = $95.99

42. How much would it cost to treat the perimeter at the 0.5 percent rate?

$97/2.5 gal. concentrate X 1.25 gal. concentrate/ 96 gal. solution X 4 gal. solution/10 linear ft. X 190 linear ft. =$38.40

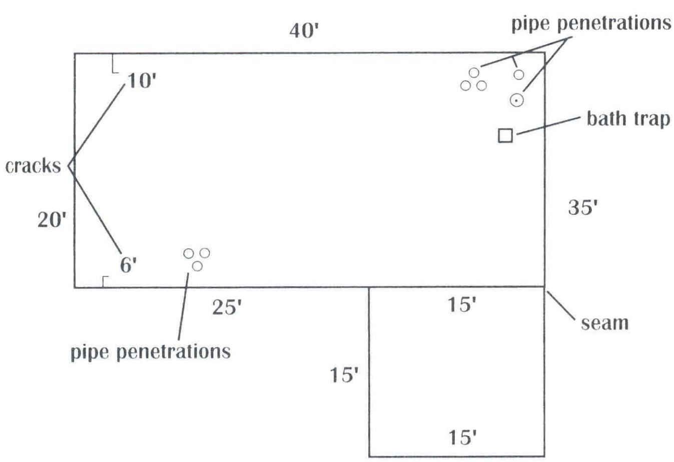
Solutions for Example 3: Monolithic Slab with a Patio

Depth from soil grade to bottom of slab is 2 feet.

Bath trap is 2 square feet.

7 pipe penetrations are less than 6 inches in diameter.

1 pipe penetration is 8 inches in diameter.



43. Using the label instructions, how many holes would be drilled in the slab to treat cracks, seam, and pipe penetrations in the drawing above?

16 ft. of crack = 16 holes
15 ft. seam = 15 holes
7 <6-inch pipe = 7 holes
1 8-inch pipe = 2 holes
Total = 40 holes

44. How many gallons of 0.5 percent emulsion would be required to treat the cracks, seam, pipe penetrations, and bath trap?

31 ft. cracks & seams x 4 gal./10 linear ft. = 3.1 x 4 gal. = 12.4 gal.
7 <6-inch pipe = 7 x 1.5 gal. = 10.5 gal.
1 8-inch pipe = 2 x 1.5 gal. = 3.0 gal.
2 sq. ft. bath trap x 3 gal./sq. ft. = 6.0 gal.
Total 31.9 gal.

45. How many gallons of emulsion would be needed to treat the building perimeter?

40 ft. + 35 ft. + 15 ft. + 15 ft. + 25 ft. + 20 ft. = 150 linear ft.

150 linear ft. x 4 gal./10 linear ft. = 60 x 2 ft. of depth = 120 gallons

Chapter 5 Other Treatments for Subterranean Termites

(1) B (2) A (3) D (4) C

(5) Close off all vents, turn on the fan for the air system, and check each hole for air flow. If air flow is detected, plug the holes and do not treat them.

(6) Any termiticide deposits in ducts must be cleaned out. An industrial wet vac is usually the best method to get liquid material out of the ducts. Charcoal filters should be used over heat registers. Check and follow the termiticide label for instructions on chemical deactivation. Contact the termiticide manufacturer for up-to-date information.

(7) D

(8) Cut the wooden members at least 4 inches above floor level, then remove the portion that extends through the floor. The soil underneath should be thoroughly treated with termiticide, and then concrete poured into the hole and into a form extending to the remaining portion of the wooden members for support.

(9) C

(10) Ideally, wooden sills should be replaced with concrete. If not, walls and voids in wooden sills should be treated with termiticide, starting as close as possible beneath the window to ensure thorough coverage. The ground outside the window should also be treated.

(11) D (12) B

(13) Wooden porches with outside ground contact should have all wood cut off above ground level and supporting concrete placed under it.

(14) Sometimes termiticide will leak through hollow block, tile, and rubble foundations, or vapor will escape from the uncapped tops of hollow blocks, causing residue problems. To prevent this, make sure all cracks and openings are sealed. If the mortar joins of rubble walls are in poor condition, the wall should be sealed with concrete.

(15) D (16) C (17) B

(18) The outside foam should be removed to 6 inches above and below the grade level to allow for proper treatment and future inspection. Control may be achieved by trenching and treating soil and backfill where insulation board has been removed to below grade. This will create a soil barrier that interrupts termite access through the insulation.

(19) True (20) A (21) C (22) A

Chapter 6 Other Wood-destroying Insects

(1) C

(2) Inspect wood prior to purchase. Use properly kiln- or air-dried wood. Seal wood surfaces. Use chemically treated wood. Ensure good building design.

(3) True

(4) Use good building design and practices such as proper ventilation, drainage, and clearance between wood and soil to reduce the moisture content of wood in a structure. Central heating and cooling systems also speed up the wood drying process.

(5) B (6) A (7) D (8) C (9) C (10) A (11) B (12) D (13) A (14) A (15) B (16) C

(17) C (18) C (19) B

(20) "Shot-hole" exit holes in unfinished wood about the size of a pencil lead (powder sifts from holes), frass (fresh frass from active infestations is the color of newly sawed wood), larvae, or adults (live insects indicate active infestation).

(21) False. All exposed surfaces of wood (painted and unpainted) should be examined.

(22) True (23) B (24) C (25) A (26) True

(27) Oil solutions present a possible fire hazard, greater expense, greater hazard and discomfort to the applicator, and danger of damaging plants near the treatment area.

(28) True

(29) To be certain it will not damage the finish, apply only a small amount of an oil-based solution to an out-of-the-way area and allow it to dry before making a complete treatment. Insecticide should be applied to the entire surface of the infested wood using a flat-fan nozzle at low pressure or a soft-bristled paintbrush. If there are only scattered patches of infestation, treat only the infested boards. Avoid overtreating (i.e., if the solution runs off or puddles), particularly on hardwood floors laid over asphalt paper or asphalt-based mastic. The asphalt will be dissolved by excess oil and may bleed through the finished floor. Any excess solution should be wiped up immediately. Be careful not to mar the surface if the spray has temporarily softened the finish. An oil carrier may have a solvent action on some wood finishes. Therefore, keep all objects off treated areas for about 24 hours or until all stickiness has disappeared.

(30) B (31) D (32) True (33) A (34) A (35) A, A, B, A, B, B, B, A (36) E

(37) Improper attachment of wooden additions, dormers, and hollow wooden columns that absorb moisture. Patios or porch floors, door sills, downspouts, or grading where water collects or drains toward the structure. Regular gut ter overflow pouring rainwater down the side of the building as well as back onto roof boards, fascia, soffits, etc. Leaking roof valleys. Improper *flashing* around chimneys, vents, and skylights. Improper roofing or holes in the roof. Window sills directly exposed to rain. Lack of ventilation in any area where moisture accumulates. Inside moisture accumulates: around any leaking plumbing or drains (especially shower drains), in unvented attics and crawl spaces, in areas with unvented dishwashers, washing machines, icemakers, etc.

(38) A (39) D

(40) Dust tunnels or inject with pressurized liquid insecticide. Insert a dusted plug of steel wool or copper gauze in the tunnel. Fill the opening with caulk, wood filler, or a wooden dowel. A dusted plug stops new adults that otherwise would emerge through shallow caulking.

Chapter 7 Wood-damaging Fungi

(1) Wood-destroying (decay fungi) and wood-staining (sapstaining fungi, molds).

(2) D (3) D (4) C (5) D (6) C (7) A (8) A (9) B (10) A (11) B (12) C

(13) A (14) A (15) A (16) C

(17) False. The wood must have some moisture in it to decay. Dry rot fungi can infest relatively dry wood because of water-conducting strands that can carry water from damp soil to wood.

(18) B (19) A (20) A (21) B (22) C (23) B (24) A (25) B (26) D

(27) Chemical stains occur in logs or in lumber during seasoning. These can be prevented by rapid air drying or by using relatively low temperatures during kiln drying.

(28) Termites bring moisture and soil up into wood from the subsurface colonies. They feed on wood or around the outside of wood to form their enclosed runways. The warm, moist conditions that prevail within the termite nest also support the growth of fungi, which provide a source of protein and vitamins essential to the termite. The accumulation of termite fecal material in the nest helps to promote the growth of the fungi.

(29) True (30) A

(31) A sharp-pointed object such as an icepick is used to poke into and pry up a segment of wood, especially in "latewood" areas of darker rings. In decayed wood, the pried-up section will break abruptly directly over the tool, whereas in sound wood the break will occur at a point away from the tool. The pick test will indicate the presence of wood decay at as little as 5 to 10 percent loss of weight.

(32) Whether wood has a moisture content (20 percent or above) that will lead to decay, small changes in the moisture content of wood to demonstrate the success of a moisture control program over time, the likelihood of infestation or reinfestation by wood-boring insects, and

whether fungi seen on the wood surface are still actively growing.

(33) The wood species involved, moisture distribution, grain direction, chemicals in the wood, weather conditions, and temperature.

(34) Any five of the following:

Water vapors from the combustion of natural gas that improperly vent into the attic or other enclosed areas.

Condensation on windows flowing down onto and into sills

Moisture from crawl spaces and the dirt below (up to 100 pounds/day/1,000 square feet).

Absent or improperly placed drain pipes, drainspouts, etc.

Leaking roofs.

Poor side wall construction.

Improperly sealed foundations, basement walls.

Direct contact of wood with soil or concrete, allowing wicking action to pull water into wood.

Improper drainage of water away from structure or out of crawl spaces.

Improperly fitted flashing at roof lines or shingles with improper overhang.

Improper moisture barriers under stucco, shingles.

Sweating water pipes.

Improper exterior grade that allows water to drain toward the structure and remain in contact with it.

Dripping air conditioners or swamp coolers.

Leaking plumbing, appliances, toilets, shower stall pans.

Improper seals or caulk around bathtubs and showers.

Lack of vents or windows in bathrooms that allows moisture from baths and showers to accumulate.

Plugged or leaking downspouts from roof gutters.

(35) False. More airtight buildings have increased water condensation and moisture problems.

(36) True

(37) Proper grading, roof overhangs, the use of gutters, downspouts, and drain tile.

(38) A (39) B

(40) To cause moisture to condense on the barrier and return to the soil rather than condensing on the floor and joists above in the subareas of buildings.

(41) False. Some area of the soil surface should be left uncovered to allow wood in the crawl space to dry slowly.

(42) B

(43) Wear rubber gloves and long-sleeved clothing and wash thoroughly after handling. Never dispose of preservative-treated wood by domestic incineration or use as a fuel in fireplaces or wood-burning stoves.

(44) False. Only by eliminating the moisture source can wood decay be completely controlled.

(45) Borates are low hazard, easy to apply, long lasting, and quite effective. They are easy to mix in a water carrier and are available in a variety of formulations that allow spraying, brush-on, gel, and foam applications. For wood with a high moisture content that cannot be easily dried, a formulation is available that consists of solid rods that are inserted into holes drilled into the wood.

APPENDIX B

GLOSSARY

Glossary of Terms for Management of Wood-destroying Pests

ABSORPTION—The movement of a chemical into plants, animals (including humans), and/or microorganisms.

ACTIVE INGREDIENT—The chemical or chemicals in a pesticide responsible for killing, poisoning, or repelling the pest. Listed separately in the ingredient statement.

ACUTE TOXICITY—The capacity of a pesticide to cause injury within 24 hours following exposure. LD_{50} and LC_{50} are common indicators of the degree of acute toxicity. (See also ***chronic toxicity***.)

ADJUVANT—A substance added to a pesticide to improve its effectiveness or safety. Same as additive. Examples: penetrants, spreader-stickers, and wetting agents.

ADSORPTION—The process by which chemicals are held or bound to a surface by physical or chemical attraction. Clay and high organic soils tend to adsorb pesticides.

AEROSOL—A material stored in a container under pressure. Fine droplets are produced when the material dissolved in a liquid carrier is released into the air from the pressurized container.

ALATES—The winged primary reproductives (both male and female) of the termite colony (alate=winged). (See also ***swarmers***.)

ANTI-SIPHONING DEVICE—A device attached to the filling hose that prevents backflow or ***back-siphoning*** from a spray tank into a water source.

ANTIDOTE—A treatment used to counteract the effects of pesticide poisoning or some other poison in the body.

ATTRACTANT—A substance or device that will lure pests to a trap or poison bait.

BACK-SIPHONING—The movement of liquid pesticide mixture back through the filling hose and into the water source.

BACTERIA—Microscopic organisms, some of which are capable of producing diseases in plants and animals. Others are beneficial.

BAIT—A food or other substance used to attract a pest to a pesticide or to a trap.

BARRIER APPLICATION—Application of a pesticide in a strip alongside or around a structure, a portion of a structure, or any object.

BIOLOGICAL CONTROL—Control of pests using predators, parasites, and and/or disease-causing organisms. May be naturally occurring or introduced.

BIOMAGNIFICATION—The process whereby one organism accumulates chemical residues in higher concentrations from organisms it consumes.

BRAND NAME—The name or designation of a specific pesticide product or device made by a manufacturer or formulator; a marketing name.

BRICK VENEER—A facing of brick laid against and fastened to ***sheathing*** of a frame wall or tile wall construction.

BUDDING—Another means (other than ***swarming***) for termites to form a new colony. Budding occurs when a number of individuals, including one or more wingless secondary reproductives, leaves a well established colony to start a new one.

CALIBRATE, CALIBRATION OF EQUIPMENT, OR APPLICATION METHOD—The measurement of dispersal or output and adjustments made to control the rate of dispersal of pesticides.

CARBAMATES (N-methyl carbamates)—A group of pesticides containing nitrogen, formulated as insecticides, fungicides, and herbicides. The N-methyl carbamates are insecticides and inhibit ***cholinesterase*** in animals.

CARCINOGENIC—The ability of a substance or agent to induce malignant tumors (cancer).

CARRIER—An inert liquid, solid, or gas added to an active ingredient to make a pesticide dispense effectively. A carrier is also the material, usually water or oil, used to dilute the formulated product for application.

CASTE—A specialized form within the termite colony that carries out a particular function within the colony. Termite castes include ***reproductives***, ***workers***, and ***soldiers***.

CELLULOSE—A polysaccharide that is the chief part of plant cell walls and the main food source for termites.

CERTIFIED APPLICATORS—Individuals who are certified to use or supervise the use of any restricted-use pesticide covered by their certification.

CHEMICAL NAME—The scientific name of the active ingredient(s) found in the formulated product. This complex name is derived from the chemical structure of the active ingredient.

CHEMICAL CONTROL—Pesticide application to kill pests.

CHEMOSTERILANT—A chemical compound capable of preventing animal reproduction.

CHEMTREC—The Chemical Transportation Emergency Center has a toll-free number (800-424-9300) that provides 24-hour information for chemical emergencies such as a spill, leak, fire, or accident.

CHLORINATED HYDROCARBON—A pesticide containing chlorine, carbon, and hydrogen. Many are persistent in the environment. Examples: chlordane, DDT, methoxychlor. Few are used in structural pest management operations today.

CHOLINESTERASE, ACETYLCHOLINESTERASE—An enzyme in animals that helps regulate nerve impulses. This enzyme is depressed by N-methyl carbamate and organophosphate pesticides.

CHRONIC TOXICITY—The ability of a material to cause injury or illness (beyond 24 hours following exposure) from repeated, prolonged exposure to small amounts. (See also ***acute toxicity***.)

COMMERCIAL APPLICATOR—A certified applicator who uses or supervises the use of any pesticide classified for restricted use for any purpose or on any property other than that producing an agricultural commodity.

COMMON NAME—A name given to a pesticide's active ingredient by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names, but each active ingredient has only one recognized common name.

COMMUNITY—The various populations of animal species (or plants) that exist together in an ecosystem. (See also ***population*** and ***ecosystem***.)

CONCENTRATION—Refers to the amount of active ingredient in a given volume or weight of formulated product.

CONTAMINATION—The presence of an unwanted substance (sometimes pesticides) in or on plants, animals, soil, water, air, or structures.

CRAWL SPACE—A shallow space below the living quarters of at least a partially basementless house, normally enclosed by the foundation wall.

CULTURAL CONTROL—A pest control method that includes changing human habits—e.g., sanitation, work practices, cleaning and garbage pickup schedules, etc.

DECONTAMINATE—To remove or break down a pesticidal chemical from a surface or substance.

DEFECT ACTION LEVELS—The maximum levels for defects such as the presence of insect fragments, mold, or rodent hairs in food products allowed by the Food and Drug Administration (FDA).

DEGRADATION—The process by which a chemical compound or pesticide is reduced to simpler compounds by the action of microorganisms, water, air, sunlight, or other agents. Degradation products are usually, but not always, less toxic than the original compound.

DEPOSIT—The amount of pesticide on treated surfaces after application.

DERMAL TOXICITY—The ability of a pesticide to cause acute illness or injury to a human or animal when absorbed through the skin. (See ***exposure route***.)

DETOXIFY—To render a pesticide's active ingredient or other poisonous chemical harmless.

DIAGNOSIS—The positive identification of a problem and its cause.

DILUENT—Any liquid, gas, or solid material used to dilute or weaken a concentrated pesticide.

DISINFECTANT—A chemical or other agent that kills or inactivates disease-producing microorganisms. Chemicals used to clean or surface-sterilize inanimate objects.

DOSE, DOSAGE—Quantity, amount, or rate of pesticide applied to a given area or target.

DRIFT—The airborne movement of a pesticide spray or dust beyond the intended target area.

DUCTS—In a house, usually round or rectangular metal pipes for distributing warm air from the heating plant to rooms, or cold air from a conditioning device, or as cold-air returns. May be embedded in or placed beneath concrete slabs. Ducts are also made of asbestos and composition material.

DUST—A finely ground, dry pesticide formulation containing a small amount of active ingredient and a large amount of inert carrier or diluent such as clay or talc.

ECOSYSTEM—The pest management unit. It includes a community (of ***populations***) with the necessary physical (***harborage***, moisture, temperature) and biotic (food, hosts) supporting factors that allow an infestation of pests to persist.

ELYTRA—A pair of thickened, leathery, or horny front wings (found in the beetle family).

EMULSIFIABLE CONCENTRATE—A pesticide formulation produced by mixing or suspending the active ingredient (the concentrate) and an emulsifying agent in a suitable carrier. When added to water, a milky emulsion is formed.

EMULSIFYING AGENT (EMULSIFIER)—A chemical that aids in the suspension of one liquid in another that normally would not mix together.

EMULSION—A mixture of two liquids that are not soluble in each other. One is suspended as very small droplets in the other with the aid of an emulsifying agent.

ENCAPSULATED FORMULATION—A pesticide formulation with the active ingredient enclosed in capsules of polyvinyl or other materials; principally used for slow release.

ENDANGERED SPECIES—A plant or animal species whose population is reduced to the extent that it is near extinction and that a federal agency has designated as being in danger of becoming extinct.

ENTRY INTERVAL—See ***re-entry interval***.

ENVIRONMENT—All of our physical, chemical, and biological surroundings, such as climate, soil, water, and air, and all species of plants, animals, and microorganisms.

ENVIRONMENTAL PROTECTION AGENCY OR EPA—The federal agency responsible for ensuring the protection of humans and the environment from potentially adverse effects of pesticides.

EPA ESTABLISHMENT NUMBER—A number assigned to each pesticide production plant by the EPA. The number indicates the plant at which the pesticide product was produced and must appear on all labels of that product.

EPA REGISTRATION NUMBER—An identification number assigned to a pesticide product when the product is registered by the EPA for use. The number must appear on all labels for a particular product.

ERADICATION—The complete elimination of a (pest) population from a designated area.

EXPOSURE ROUTE OR COMMON EXPOSURE ROUTE—The manner (dermal, oral, or inhalation/respiratory) by which a pesticide may enter an organism.

FIFRA—The Federal Insecticide, Fungicide, and Rodenticide Act; a federal law and its amendments that control pesticide registration and use.

FLASHING—Strips of aluminum, lead, tin, or copper that are worked into the slates or shingles around dormers, chimneys, and other rising parts of buildings to prevent leaking.

FLOATING SLAB—A type of foundation construction in which the foundation wall and footing are separated from the slab floor by an expansion joint. The slab floor is concrete, while the foundation wall can be a variety of materials, such as solid block, hollow block, or concrete.

FLOW METER—Used to measure the application or delivery rate of a chemical—i.e., the amount of chemical delivered per unit area. Flow meters are useful when ***calibrating*** large-volume sprayers. These meters can also measure the amount of termiticide injected into each hole for subslab applications.

FLOWABLE—A pesticide formulation in which a very finely ground solid particle is suspended (not dissolved) in a liquid carrier.

FOOTING—A masonry section, usually concrete, in a rectangular form wider than the bottom of the ***foundation*** wall or ***pier*** it supports.

FORMULATION—The pesticide product as purchased, containing a mixture of one or more active ingredients, carriers (inert ingredients), and other additives making it easy to store, dilute, and apply.

FOUNDATION—The supporting portion of a structure below the first-floor construction, or below grade, down to and including the ***footings***.

FRASS—Solid larval insect excrement; mixed with wood fragments in wood-boring and bark-boring insects.

FRUITING BODY—The part of the fungi from which the reproductive spores are produced (e.g., conks, mushrooms, etc.).

FUMIGANT—A pesticide formulation that volatilizes, forming a toxic vapor or gas that kills in the gaseous state. Usually, it penetrates voids to kill pests.

FUNGICIDE—A chemical used to control fungi.

FUNGUS (plural, fungi)—A group of small, often microscopic, organisms that cause rot, mold, and disease. Fungi need moisture or a damp environment (wood rots require at least 19 percent moisture). Fungi are extremely important in the diet of many insects.

GENERAL-USE (UNCLASSIFIED) PESTICIDE—A pesticide that can be purchased and used by the general public. (See also ***restricted-use pesticide***.)

GRANULE—A dry pesticide formulation. The active ingredient is either mixed with or coated onto an inert carrier to form a small, ready-to-use, low-concentrate particle that normally does not present a drift hazard. Pellets differ from granules only in their precise uniformity, larger size, and shape.

GROUNDWATER—Water sources located beneath the soil surface from which spring water, well water, etc., are obtained. (See also ***surface water***.)

HARBORAGE—Any place or site that shelters and provides other elements (i.e., food, water) required for survival of a particular organism.

HARDWOOD—Wood from non-evergreen trees such as maple, oak, ash, etc.

HAZARD—See ***risk***.

HEARTWOOD—A cylinder of dark-colored, dead wood in the center of the tree that is no longer active in conducting sap or water.

HERBICIDE—A pesticide used to kill plants or inhibit plant growth.

HOST—Any animal or plant on or in which another lives for nourishment, development, or protection.

HYPHA (plural, hyphae)—usually, one of the threadlike structures of a fungus.

INERT INGREDIENT—In a pesticide formulation, an inactive material without pesticidal activity.

INGREDIENT STATEMENT—The portion of the label on a pesticide container that gives the name and amount of each active ingredient and the total amount of inert ingredients in the formulation.

INHALATION—Taking a substance in through the lungs; breathing in. (See ***exposure route***.)

INSPECTION—To examine for pests, pest damage, other pest evidence, etc. (See ***monitoring***.)

INTEGRATED PEST MANAGEMENT (IPM)— A planned pest control program in which various methods are integrated and used to keep pests from causing economic, health-related, or aesthetic injury. IPM includes reducing pests to a tolerable level. Pesticide application is not the primary control method but is an element of IPM—as are cultural and structural alterations. IPM programs emphasize communication, monitoring, inspection, and evaluation (keeping and using records).

JOIST—One of a series of parallel beams, usually 2 inches in thickness, used to support floor and ceiling loads, and supported in turn by larger beams, girders, bearing walls, or foundation.

LABEL—All printed material attached to or on a pesticide container.

LABELING—The pesticide product label and other accompanying materials that contain directions that pesticide users are legally required to follow.

LARVA (plural, larvae)—An early developmental stage of insects with complete metamorphosis. Insects hatch out of the egg as larvae before becoming ***pupae*** (resting stage), and then adults.

LC_{50}—Lethal concentration. The concentration of a pesticide, usually in air or water, that kills 50 percent of a test population of animals. LC_{50} is usually expressed in parts per million (ppm). The lower the LC_{50} value, the more acutely toxic the chemical.

LD_{50}—Lethal dose. The dose or amount of a pesticide that can kill 50 percent of the test animals when eaten or absorbed through the skin. LD_{50} is expressed in milligrams of chemical per kilogram of body weight of the test animal (mg/kg). The lower the LD_{50}, the more acutely toxic the pesticide.

LEACHING—The movement of a substance with water downward through soil.

LIGNIN—a complex structural polymer that imparts rigidity to certain plant cell walls, especially walls of wood cells.

MATERIAL SAFETY DATA SHEETS (MSDS)—These data sheets contain specific information on toxicity, first aid, personal protective equipment, storage and handling precautions, spill and leak cleanup and disposal practices, transportation, physical data, and reactivity data. MSDS are available from manufacturers.

MESOTHORAX—The second segment of an insect's ***thorax***. One pair of legs and usually one pair of wings are attached.

METAMORPHOSIS—A change in the shape, or form, of an animal. Usually used when referring to insect development.

METATHORAX—The third segment of an insect's ***thorax***. One pair of legs and often one pair of wings are attached.

MICROBIAL PESTICIDE—Bacteria, viruses, fungi, and other microorganisms used to control pests. Also called biorationals.

MICROORGANISM—An organism so small it can be seen only with the aid of a microscope.

MODE OF ACTION—The way in which a pesticide exerts a toxic effect on the target plant or animal.

MOISTURE METER—A device used to measure moisture content in wood. A moisture content greater than 20 percent indicates conditions that will lead to decay.

MOLT—Periodic shedding of the outer layer (e.g., an insect's ***exoskeleton*** is shed periodically).

MONITORING—On-going surveillance. Monitoring includes inspection and record keeping. Monitoring records allows technicians to evaluate pest population suppression, identify infested or non-infested sites, and manage the progress of the management or control program.

MONOLITHIC SLAB—A type of foundation constructing in which the foundation footing and the slab floor are formed as one continuous unit. Concrete is the material used in this type of slab foundation.

MUD TUBES—See ***shelter tubes***.

MYCELIUM (plural, mycelia)—An aggregation of hyphae of a fungus.

NODE—Nodes are swollen segments found at the narrow connection between the thorax and abdomen of ant species. The nodes may be helpful in identifying ant species—most ant species have one node; others have two.

NON-RESIDUAL PESTICIDE—Pesticides applied to obtain effects only during the time of treatment.

NON-TARGET ORGANISM—Any plant or animal other than the intended target(s) of a pesticide application.

ORAL TOXICITY—The ability of a pesticide to cause injury or acute illness when taken by mouth. One of the common exposure routes.

ORGANOPHOSPHATES—A large group of pesticides that contain the element phosphorus and inhibit ***cholinesterase*** in animals.

PARASITE—A plant, animal, or microorganism living in, on, or with another living organism for the purpose of obtaining all or part of its food.

PARESTHESIA—A reaction to dermal exposure to some pesticides (especially pyrethroids) with symptoms similar to sunburn sensation of the face and especially the eyelids. Sweating, exposure to sun or heat, and application of water aggravate the disagreeable sensations. This is a temporary effect that dissipates within 24 hours. For first aid, wash with soap and water to remove as much residue as possible, and then apply a vitamin E oil preparation or cream to the affected area. Persons susceptible to paresthesia should choose a pesticide with a different active ingredient and/or formulation.

PATHOGEN—A disease-causing organism.

PERSONAL PROTECTIVE EQUIPMENT (PPE)—Devices and clothing intended to protect a person from exposure to pesticides. Includes such items as long-sleeved shirts, long trousers, coveralls, suitable hats, gloves, shoes, respirators, and other safety items as needed.

PEST MANAGEMENT—The reduction of pest populations to tolerable numbers by changing practices, making habitat or structural alterations, and carefully using pesticides to kill pests only when indicated.

PEST—An undesirable organism (plant, animal, bacterium, etc.); any organism that competes with people for food, feed, or fiber, causes structural damage, is a public health concern, reduces aesthetic qualities, or impedes industrial or recreational activities.

PESTICIDE—A chemical or other agent used to kill, repel, or otherwise control pests or to protect from a pest.

pH—A measure of the acidity/alkalinity of a liquid—acid below pH7; basic or alkaline above pH7 (up to 14).

PHEROMONE—A substance emitted by an animal to influence the behavior of other animals of the same species. Examples are sex pheromones (to attract mates) and aggregation pheromones (to keep members of the same species together in a group). Some pheromones are synthetically produced for use in insect traps.

PHOTODEGRADATION—Breakdown of chemicals by the action of light.

PHYSICAL CONTROL—Altering habitat or changing the infested physical structure—e.g., caulking holes, cracks, tightening around doors, windows, moisture reduction, ventilation, etc.

PHYTOTOXICITY—Injury to plants caused by a chemical or other agent.

PIER—A column of masonry or sometimes wood, usually rectangular in horizontal cross-section, used to support other structural members.

POISON CONTROL CENTER—A local agency, generally a hospital, that has current information on the proper first aid techniques and antidotes for poisoning emergencies. Centers are listed in telephone directories.

POPULATION—Individuals of the same species. The populations in an area make up a community. (See *ecosystem*.)

PRECIPITATE—A solid substance that forms in a liquid and settles to the bottom of a container; a material that no longer remains in suspension.

PREDATOR—An animal that attacks, kills, and feeds on other animals. Examples of predaceous animals are hawks, owls, snakes, many insects, etc.

PRONOTUM—The area just behind an insect's head (i.e., the upper plate of the *prothorax*).

PROPELLANT—The inert ingredient in pressurized products that forces the active ingredient from the container.

PROTHORAX—The first segment of an insect's *thorax*. One pair of legs is attached.

PROTOZOAN—A unicellular animal; termites are dependent on a specific type of protozoan to help them digest *cellulose*.

PUPA (plural, pupae)—The developmental (resting) stage of insects with complete metamorphosis during which major changes from the larval to the adult form occur.

RAFTER—One of a series of structural members of a roof designed to support roof loads. The rafters of a flat roof are sometimes called roof joists.

RATE OF APPLICATION—The amount of pesticide applied to a plant, animal, unit area, or surface; usually measured as per acre, per 1,000 square feet, per linear foot, or per cubic foot.

READY-TO-USE PESTICIDE—A pesticide that is applied directly from its original container consistent with label directions, such as an aerosol insecticide or rodent bait box, which does not require mixing or loading prior to application.

RE-ENTRY INTERVAL—The length of time following an application of a pesticide when entry into the treated area is restricted.

REGISTERED PESTICIDES—Pesticide products that have been registered by the Environmental Protection Agency for the uses listed on the label.

REPELLENT—A compound that keeps insects, rodents, birds, or other pests away from humans, plants, domestic animals, buildings, or other treated areas.

REPRODUCTIVES—The *caste* within the termite colony that is responsible for reproduction and for establishing new termite colonies. Subterranean termite colonies have both primary (winged males and females) and supplementary (wingless [or with short, non-functional wings] males and females) reproductives.

RESIDUAL PESTICIDE—A pesticide that continues to remain effective on a treated surface or area for an extended period following application.

RESIDUE—The pesticide active ingredient or its breakdown product(s) that remain in or on the target after treatment.

RESTRICTED-USE PESTICIDE—A pesticide that can be purchased and used only by certified applicators or persons under their direct supervision. A pesticide classified for restricted use under FIFRA, Section 3(d)(1)(C).

RHIZOMORPH—A thread- or rootlike fungal structure made up of *hyphae*.

RISK—A probability that a given pesticide will have an adverse effect on humans or the environment in a given situation.

RODDING—A method of applying termiticide. Long rods may be used to apply termiticide into the soil next to the foundation wall. Shorter rods are used to inject termiticide into the voids of walls and through concrete slabs.

RODENTICIDE—A pesticide used to control rodents.

RUNOFF—The movement of water and associated materials on the soil surface. Runoff usually proceeds to bodies of surface water.

SAPWOOD—A lighter colored ring of wood surrounding the ***heartwood*** of the tree that consists of cells that are actively conducting water and sap.

SEASONED—Lumber that has been chemically treated with wood preservatives and prepared for use. (See also ***unseasoned***.)

SHEATHING—The structural covering, usually wood boards or plywood, used over studs or rafters of a structure. Structural building board is normally used only as a wall sheathing.

SHELTER TUBES—Tubes constructed by subterranean termites to help them pass over exposed areas and reach new food sources (cellulose). Termites require a constant source of moisture and the shelter tubes enable this by providing a moist environment and allowing them to maintain contact with the soil. The tubes also serve to conceal the termites and protect them from natural enemies (ants). (Also referred to as ***mud tubes***.)

SIGNAL WORDS—Required word(s) that appear on every pesticide label to denote the relative toxicity of the product. Signal words are DANGER-POISON, DANGER, WARNING, and CAUTION.

SILL PLATE—A horizontal member anchored on top of a masonry wall.

SITE—Areas of pest infestation. Each site should be treated specifically or individually.

SOFFIT—The underside of an overhanging part or member (especially on the roof) of a building.

SOFTWOOD—Wood from evergreen trees such as pines, firs, and spruces.

SOLDIERS—Refers to the ***caste*** within a termite colony that is responsible for the defense of the colony.

SOLUTION—A mixture of one or more substances in another substance (usually a liquid) in which all the ingredients are completely dissolved. Example: sugar in water.

SOLVENT—A liquid that will dissolve another substance (solid, liquid, or gas) to form a solution.

SLAB-ON-GROUND—The type of foundation construction in buildings without basements or crawl spaces. The three basic types of slab-on-ground construction are ***floating slab***, ***monolithic slab***, and ***suspended slab*** (Figures 4.1-4.3).

SOUNDING—A method of detecting damaged wood by tapping on the wood and listening for a hollow sound, which indicates cavities that are non-visible from the surface.

SPACE SPRAY—A pesticide that is applied as a fine spray or mist to a confined area.

SPOT TREATMENT—Application of a pesticide to limited areas where pests are likely to be found. A method used to avoid contact of pesticides with food, utensils, or people.

SPRINGWOOD—The wood produced early in the season that is of lower density than wood produced later in the season.

STOMACH POISON—A pesticide that must be eaten by an animal to be effective; it will not kill on contact.

SUBFLOOR—Boards of plywood laid on joists, over which a finished floor is laid.

SUMP—A pit, well, or the like in which water or other liquid is collected.

SURFACE WATER—Water on the earth's surface: rivers, lakes, ponds, streams, etc. (See also ***groundwater***.)

SUSPENDED SLAB—A type of foundation construction in which the slab floor and the foundation wall are separate units, with the slab floor extending over the top of the foundation wall. The slab floor is concrete; the material used for the foundation wall may vary.

SUSPENSION—Pesticide mixtures consisting of fine particles dispersed or floating in a liquid, usually water or oil. Example: wettable powders in water.

SWARMERS—The winged primary ***reproductives*** (both male and female) of the termite colony. They leave the colony in swarms, usually in the spring or fall. These swarms are often the first visible indication that a termite infestation is present. (See also ***alates***.)

SWARMING—When winged termite primary reproductives leave the colony in great numbers to mate and start a new colony.

TARGET—The plants, animals, structures, areas, or pests at which the pesticide or other control method is directed.

TERMITE SHIELD—A shield, usually of non-corrodible metal, placed in or on a foundation wall, other mass of masonry, or around pipes to prevent the passage of termites.

THORAX—The middle part of an insect's body between the head and the abdomen. It is divided into three segments—the ***prothorax***, ***mesothorax***, and ***metathorax***. A pair of legs is attached to each thoracic region.

THRESHOLD—A level of pest density. The number of pests observed, trapped, counted, etc., that could be tolerated without an economic loss or aesthetic injury. Pest thresholds in structural pest management may be site-specific—for example, different numbers of cockroaches may be tolerated at different sites (e.g., hospitals and garbage rooms). A threshold may be set at zero (e.g., termites in a wooden structure, flies in an operatory).

TOLERABLE LEVELS OF PESTS—The presence of pests at certain levels is tolerable in many situations. Totally eliminating pests in certain areas is sometimes not achievable without major structural alterations, excessive control measures, unacceptable disruption, unacceptable cost, etc. Pest levels that depend on pest observations vary. The tolerable level in some situations will be zero (e.g., termites). Structural pest management programs usually have lower tolerable levels of pests than agricultural programs.

TOXIC—Poisonous to living organisms.

TOXICANT—A poisonous substance such as the active ingredient in a pesticide formulation.

TOXICITY—The ability of a pesticide to cause harmful, acute, delayed, or allergic effects. The degree or extent to which a chemical or substance is poisonous.

TOXIN—A naturally occurring poison produced by plants, animals, or microorganisms. Examples: the poison produced by the black widow spider, the venom produced by poisonous snakes, and the botulism toxin produced by a bacterium.

TRENCHING—A method for applying termiticide to soil. Soil is removed by digging a trench to within about 1 foot above the footing. As the soil is replaced, it is treated with termiticide.

TROPHALLAXIS—A form of communication within the termite colony that involves the mutual exchange of nutrients and the transfer of food between colony members. Trophallaxis permits the efficient use of nutrients within the colony, enhances recognition of colony members, distributes chemicals involved in caste regulation, and transfers cellulose-digesting protozoans.

UNSEASONED—Lumber that has not yet been chemically treated. (See also ***seasoned***.)

USE—The performance of pesticide-related activities requiring certification include application, mixing, loading, transport, storage, or handling after the manufacturer's seal is broken; care and maintenance of application and handling equipment; and disposal of pesticides and their containers in accordance with label requirements. Uses not needing certification are long-distance transport, long-term storage, and ultimate disposal.

VAPOR BARRIER—Material used to retard the movement of water vapor into walls or slabs and to prevent condensation in them. Also a covering used over dirt in crawl spaces. Common materials: polyethylene film, asphalt paper.

VAPOR PRESSURE—The property that causes a chemical to evaporate. The higher the vapor pressure, the more volatile the chemical and the easier it will evaporate.

VECTOR—A carrier, an animal (e.g., insect, nematode, mite) that can carry and transmit a pathogen from one host to another.

VERTEBRATE—Animal characterized by a segmented backbone or spinal column.

VIRUS—Ultramicroscopic parasites composed of proteins. Viruses can multiply only in living tissues and cause many animal and plant diseases.

VOLATILITY—The degree to which a substance changes from a liquid or solid state to a gas at ordinary temperatures when exposed to air.

WATER TABLE—The upper level of the water-saturated zone in the ground.

WETTABLE POWDER—A dry pesticide formulation in powder form that forms a suspension when added to water.

WORKERS—The sexually underdeveloped ***caste*** of the termite colony that is responsible for most of the work of the colony—foraging, feeding, and grooming of the other castes (including the queen), building and repairing the nest, and making the tunnels. They are the most numerous and destructive members of the colony.

ZONE LINES—A symptom of infestation in wood from white rot fungi—thin, dark lines form around the decayed areas.

For the further definition of terms, consult:

Pesticide Applicator Core Training Manual, E-2195, Michigan State University Extension.

The Federal Insecticide, Fungicide, and Rodenticide Act as amended. Public Law 92-516, October 21, 1972, as amended by Public Law 94-140, November 28, 1975, and Public Law 95-396, September 30, 1978.

Federal Register, November 7, 1990, Part II Environmental Protection Agency 40, CFR Part 171, Certification of Pesticide Applicator; Proposed Rule.

Region V Office of the EPA, Chicago, Ill.

Michigan Department of Agriculture State Plan for Commercial and Private Applicators.

Local, state, and national pest control associations.

APPENDIX C

WOOD-BORING INSECTS

Table 1. Characteristics of damage caused by common wood-boring insects

Insect Type	Shape and Size (inches) of Exit/Entry Hole	Wood Type	Age of Wood Attacked*	Appearance of Frass in Tunnels	Reinfests Structural Timber
Ambrosia beetles	Round, 1/50 to 1/8	Softwood and hardwood	New	None present	No
Lyctid beetles	Round, 1/32 to 1/16	Hardwood	New and old	Fine, flourlike, loosely packed	Yes
Bark beetles	Round, 1/16 to 3/32	Bark/ sapwood interface	New	Fine to coarse, bark-colored, tightly packed	No
Anobiid beetles	Round, 1/16 to 1/8	Softwood and hardwood	New and old	Fine powder and pellets, loosely packed; pellets may be absent and frass tightly packed in some hardwoods	Yes
Bostrichid beetles	Round, 3/32 to 9/32	Softwood and hardwood (bamboo)	New	Fine to coarse powder, tightly packed	Rarely
Horntail or wood wasp	Round, 1/6 to 1/4	Softwood	New	Coarse, tightly packed	No
Carpenter bee	Round, 1/2	Softwood	New and old	None present	Yes
Round-headed borer	Round-oval, 1/8 to 3/8	Softwood and hardwood	New	Coarse to fibrous, mostly absent	No
Flat-headed borer	Oval, 1/8 to 1/2	Softwood and hardwood	New	Sawdustlike, tightly packed	No
Old house borer	Oval, 1/4 to 3/8	Softwood	New and old	Very fine powder and tiny pellets, tightly packed	Yes
Round- or flat-headed borer, wood machined after attack	Flat oval, 1/2 or more; or irregular surface groove, 1/8 to 1/2	Softwood and hardwood	New	Absent or sawdustlike, coarse to fibrous; tightly packed	No

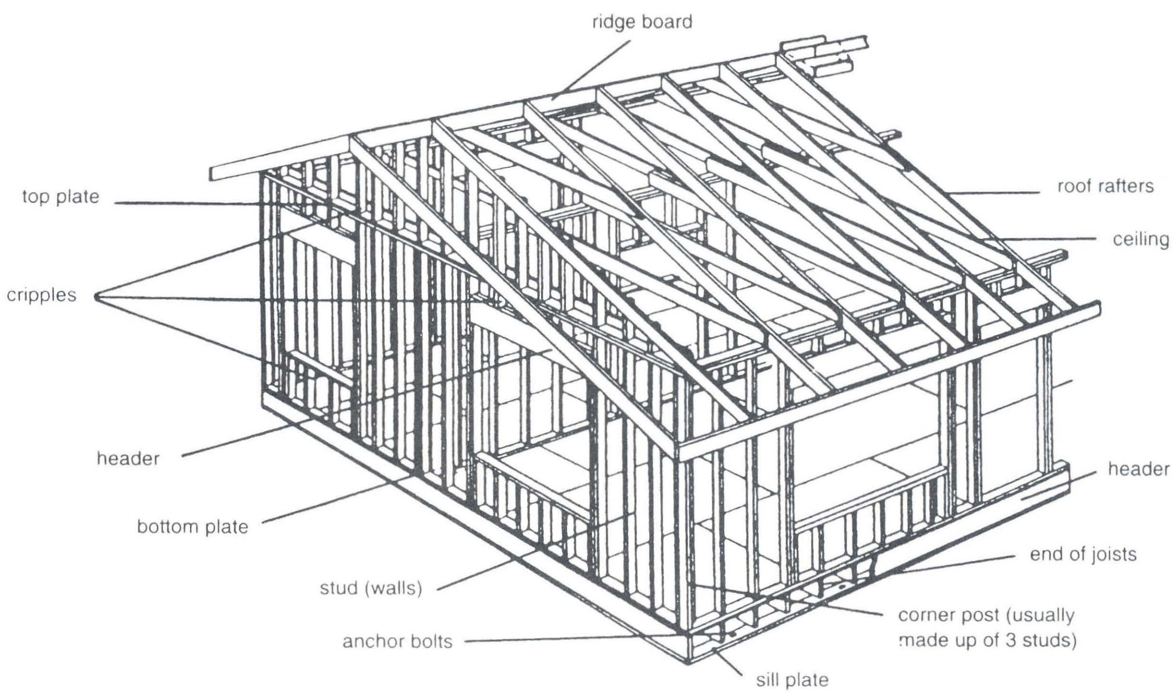
*New wood is defined as standing or freshly felled trees and unseasoned lumber. Old wood is seasoned or dried lumber.

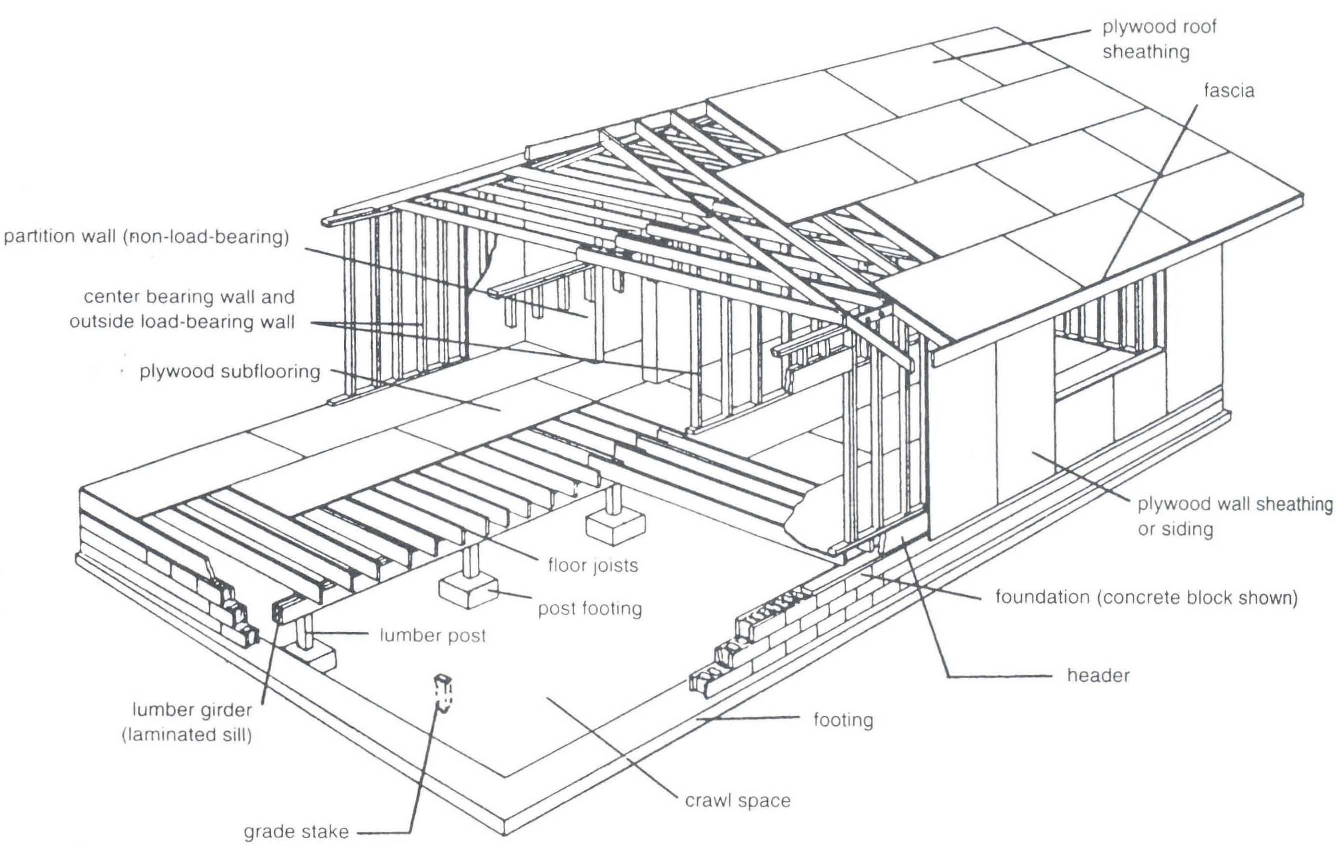
Source: M.P. Levy, *A Guide to the Inspection of Existing Homes for Wood-inhabiting Fungi and Insects*, U.S. Department of Housing and Urban Development, Washington, D.C., 1975.

APPENDIX D

STRUCTURAL AND HOUSING TERMS

Diagrams Identifying Structural Members





APPENDIX E

CONVENIENT CONVERSION FACTORS

Multiply	By	To Get
Acres	0.405	Hectares
Acres	4,047.0	Square Meters
Acres	4,840.0	Square Yards
Acres-feet	43,560.0	Square feet
Acre-feet	1,233.49	Cubic Meters
Acre-feet	43,560.0	Cubic Feet
Acre-feet	325,850.58	Gallons
Bushels	0.0461	Cubic yards
Bushels	1.2437	Cubic feet
Bushels	4.0	Pecks
Bushels	32.0	Quarts (dry)
Bushels	35.24	Liters
Bushels	64.0	Pints (dry)
Bushels	2,150.42	Cubic inches
Centimeters	0.3627	Inches
Centimeters	0.01	Meters
Centimeters	10.0	Millimeters
Cubic centimeters	0.0610	Cubic inches
Cubic centimeters	0.03381	Ounces (liquid)
Cubic centimeters	1.0	Milliliters of water
Cubic centimeters	1.0	Grams of water
Cubic feet	0.0283	Cubic meters
Cubic feet	0.0370	Cubic yards
Cubic feet	0.8040	Bushels
Cubic feet	7.4805	Gallons
Cubic feet	25.71	Quarts (dry)
Cubic feet	28.32	Liters
Cubic feet	29.92	Quarts (liquid)
Cubic feet	51.42	Pints (dry)
Cubic feet	59.84	Pints (liquid)
Cubic feet	62.4	Pounds of water
Cubic feet	1,728.0	Cubic inches
Cubic feet	28,317.0	Cubic centimeters
Cubic meters	1.308	Cubic yards
Cubic meters	35.31	Cubic feet
Cubic meters	264.2	Gallons
Cubic meters	1,000.0	Liters
Cubic meters	1,057.0	Quarts (liquid)
Cubic meters	2,113.0	Pints (liquid)
Cubic meters	61,023.0	Cubic inches
Cubic meters	1,000,000.0	Cubic centimeters
Cubic inches	0.000016	Cubic meters
Cubic inches	0.0005	Bushels
Cubic inches	0.0006	Cubic feet
Cubic inches	0.0019	Pecks (dry)

Multiply	By	To Get
Cubic inches	0.0037	Gallons (dry)
Cubic inches	0.0043	Gallons (liquid)
Cubic inches	0.0149	Quarts (dry)
Cubic inches	0.0164	Liters
Cubic inches	0.0173	Quarts (liquid)
Cubic inches	0.0298	Pints (dry)
Cubic inches	0.0346	Pints (liquid)
Cubic inches	0.0361	Pounds of water
Cubic inches	0.5540	Ounces (liquid)
Cubic inches	16.3872	Cubic centimeters
Cubic yards	0.7646	Cubic meters
Cubic yards	21.71	Bushels
Cubic yards	27.0	Cubic feet
Cubic yards	202.0	Gallons (liquid)
Cubic yards	807.9	Quarts (liquid)
Cubic yards	1,616.0	Pints (liquid)
Cubic yards	7,646.0	Liters
Cubic yards	46,656.0	Cubic inches
Cups	0.25	Quarts (liquid)
Cups	0.5	Pints (liquid)
Cups	8.0	Ounces (liquid)
Cups	16.0	Tablespoons
Cups	48.0	Teaspoons
Cups	236.5	Milliliters
Feet	0.3048	Meters
Feet	0.3333	Yards
Feet	12.0	Inches
Feet	30.48	Centimeters
Feet per minute	0.01136	Miles per hour
Feet per minute	0.01667	Feet per second
Feet per minute	0.01829	Kilometers per hour
Feet per minute	0.3048	Meters per minute
Feet per minute	0.3333	Yards per minute
Feet per minute	60.0	Feet per hour
Gallons	0.00378	Cubic meters
Gallons	0.1337	Cubic feet
Gallons	3.785	Liters
Gallons	4.0	Quarts (liquid)
Gallons	8.0	Pints (liquid)
Gallons	8.337	Pounds
Gallons	128.0	Ounces (liquid)
Gallons	231.0	Cubic inches (liquid)
Gallons	269.0	Cubic inches (dry)
Gallons	3,785.0	Cubic centimeters

Multiply	By	To Get
Gallons of water	0.0038	Cubic meters
Gallons of water	0.0049	Cubic yards
Gallons of water	0.1337	Cubic feet
Gallons of water	3.7853	Kilograms
Gallons of water	8.3453	Pounds of water
Gallons of water	3,785.3446	Grams
Grains	0.0648	Grams
Grams	0.001	Kilograms
Grams	0.0022	Pounds
Grams	0.0353	Ounces
Grams	15.53	Grains
Grams	1,000.0	Milligrams
Grams per liter	10.0	Percent
Grams per liter	1,000.0	Parts per million
Hectares	2.47	Acres
Hectares	10,000.0	Square meters
Hectares	11,954.8	Square yards
Hectares	107,593.2	Square feet
Inches	0.0254	Meters
Inches	0.02778	Yards
Inches	0.08333	Feet
Inches	2.54	Centimeters
Kilograms	0.0011	Tons
Kilograms	2.205	Pounds
Kilograms	35.28	Ounces
Kilograms	1,000.0	Grams
Kilometers	0.6214	Miles
Kilometers	1,000.0	Meters
Kilometers	1,093.611	Yards
Kilometers	3,280.833	Feet
Kilometers per hour	0.6214	Miles per hour
Kilometers per hour	16.6667	Meters per minute
Kilometers per hour	18.2268	Yards per minute
Kilometers per hour	54.6806	Feet per minute
Liters	0.001	Cubic meters
Liters	0.0353	Cubic feet
Liters	0.2642	Gallons (liquid)
Liters	1.0	Kilograms of water
Liters	1.057	Quarts (liquid)
Liters	2.113	Pints (liquid)
Liters	33.8143	Ounces
Liters	61.02	Cubic inches
Liters	1,000.0	Cubic centimeters
Liters	1,000.0	Grams of water
Meters	0.001	Kilometers
Meters	1.094	Yards
Meters	3.281	Feet
Meters	39.37	Inches
Meters	100.0	Centimeters
Meters	1,000.0	Millimeters

Multiply	By	To Get
Metric tons	1.1	Tons (U.S.)
Metric tons	1,000.0	Kilograms
Metric tons	2,204.6	Pounds
Metric tons	1,000,000.0	Grams
Miles	1.6093	Kilometers
Miles	1,609.3	Meters
Miles	1,760.0	Yards
Miles	5,280.0	Feet
Miles per hour	1.467	Feet per second
Miles per hour	1.6093	Kilometers/ hour
Miles per hour	26.8217	Meters per minute
Miles per hour	29.3333	Yards per minute
Miles per hour	88.0	Feet per minute
Miles per minute	26.82	Meters per second
Miles per minute	29.333	Yards per second
Miles per minute	88.0	Feet per second
Milliliters	0.00105	Quarts (liquid)
Milliliters	0.0021	Pints (liquid)
Milliliters	0.0042	Cups (liquid)
Milliliters	0.0338	Ounces (liquid)
Milliliters	0.0676	Tablespoons
Milliliters	0.2029	Teaspoons
Milliliters	1.0	Cubic centimeters of water
Milliliters	1.0	Grams of water
Ounces (liquid)	0.00781	Gallons
Ounces (liquid)	0.03125	Quarts (liquid)
Ounces (liquid)	0.0625	Pints (liquid)
Ounces (dry)	0.0625	Pounds
Ounces (liquid)	0.125	Cups (liquid)
Ounces (liquid)	1.805	Cubic inches
Ounces (liquid)	2.0	Tablespoons
Ounces (liquid)	6.0	Teaspoons
Ounces (dry)	28.3495	Grams
Ounces (liquid)	29.573	Milliliters
Ounces (dry)	437.5	Grains
Parts / million (PPM)	0.0001	Percent
Parts per million	0.001	Liters/cubic meter
Parts per million	0.001	Grams per liter
Parts per million	0.001	Milliliters per liter
Parts per million	0.013	Ounces per 100 gallons of water
Parts per million	0.0584	Grains per US gallon
Parts per million	0.3295	Gallons per acre-foot of water
Parts per million	1.0	Milligrams/ liter
Parts per million	1.0	Milligrams per kilogram
Parts per million	1.0	Milliliters per cubic meter

Multiply	By	To Get
Parts per million	2.7181	Pounds per acre-foot of water
Parts per million	8.345	Pounds per million gallons of water
Pecks	0.25	Bushels
Pecks	8.0	Quarts (dry)
Pecks	16.0	Pints (dry)
Pecks	537.605	Cubic inches
Percent (%)	1.33	Ounces (dry) per gallon of water
Percent	8.34	Pounds per 100 gallons of water
Percent	10.00	Grams per kilogram
Percent	10.00	Grams per liter
Percent	10,000.00	Parts per million
Pints (dry)	0.0156	Bushels
Pints (dry)	0.0625	Pecks
Pints (liquid)	0.125	Gallons
Pints (liquid)	0.4735	Liters
Pints (liquid)	0.5	Quarts (liquid)
Pints (dry)	0.5	Quarts (dry)
Pints (liquid)	2.0	Cups
Pints (liquid)	16.0	Ounces (liquid)
Pints (liquid)	28.875	Cubic inches (liquid)
Pints (dry)	33.6003	Cubic inches (dry)
Pounds	0.0005	Tons
Pounds	0.4535	Kilograms
Pounds	16.0	Ounces
Pounds	453.5924	Grams
Pounds	7,000.0	Grains
Pounds of water	0.0160	Cubic feet
Pounds of water	0.1198	Gallons
Pounds of water	0.4536	Liters
Pounds of water	27.693	Cubic inches
Quarts (liquid)	0.00094	Cubic meters
Quarts (liquid)	0.0012	Cubic yards
Quarts (dry)	0.03125	Bushels
Quarts (liquid)	0.0334	Cubic feet (liquid)
Quarts (dry)	0.0389	Cubic feet (dry)
Quarts (dry)	0.125	Pecks
Quarts (liquid)	0.25	Gallons (liquid)
Quarts (liquid)	0.9463	Liters
Quarts (liquid)	2.0	Pints (liquid)
Quarts (dry)	2.0	Pints (dry)
Quarts (liquid)	2.0868	Pounds of water
Quarts (liquid)	4.0	Cups
Quarts (liquid)	32.0	Ounces (liquid)
Quarts (liquid)	57.75	Cubic inches (liquid)
Quarts (dry)	67.20	Cubic inches (dry)

Multiply	By	To Get
Square feet	0.000009	Hectares
Square feet	0.000023	Acres
Square feet	0.0929	Square meters
Square feet	0.1111	Square yards
Square feet	144.0	Square inches
Square inches	0.00064	Square meters
Square inches	0.00077	Square yards
Square inches	0.00694	Square feet
Sq. kilometers	0.3861	Square miles
Sq. kilometers	100.0	Hectares
Sq. kilometers	247.104	Acres
Sq. kilometers	1,000,000.0	Square meters
Sq. kilometers	1,195,982.7	Square yards
Sq. kilometers	10,763,865.0	Square feet
Square meters	0.0001	Hectares
Square meters	1.308	Square yards
Square meters	10.765	Square yards
Square meters	1,549.9669	Square feet
Square miles	2.5899	Square kilometers
Square miles	258.99	Hectares
Square miles	640.0	Acres
Square miles	2,589,735.5	Square meters
Square miles	3,097,600.0	Square yards
Square miles	27,878,400.0	Square feet
Square yards	0.00008	Hectares
Square yards	0.00021	Acres
Square yards	0.8361	Square meters
Square yards	9.0	Square feet
Square yards	1,296.0	Square inches
Tablespoons	0.0625	Cups
Tablespoons	0.5	Ounces
Tablespoons	3.0	Teaspoons
Tablespoons	15.0	Milliliters
Teaspoons	0.0208	Cups
Teaspoons	0.1667	Ounces
Teaspoons	0.3333	Tablespoons
Teaspoons	5.0	Milliliters
Tons	0.907	Metric ton
Tons	907.1849	Kilograms
Tons	2,000.0	Pounds
Tons	32,000.0	Ounces
Yards	0.000568	Miles
Yards	0.9144	Meters
Yards	3.0	Feet
Yards	36.0	Inches

APPENDIX F

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Pest Control. P.O. Box 6215, Duluth, MN 55806-9915.

Pest Control Technology. P.O. Box 5817, Cleveland, OH 44101-9599.

Pest Management. National Pest Management Association, 8100 Oak St., Dunn Loring, VA 22027.

Trade Newsletter for Pest Control Technicians.

Techletter. Pinto and Associates, Inc., 29839 Oak Road, Mechanicsville, MD 20659-2201; phone (301) 884-3020.

APPENDIX G

TERMITES AND OTHER WOOD-DESTROYING PESTS

TERMITES

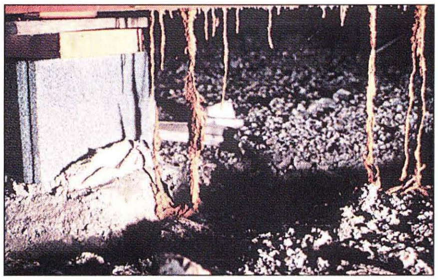
Queen subterranean termite

Primary reproductive swarmer subterranean termite

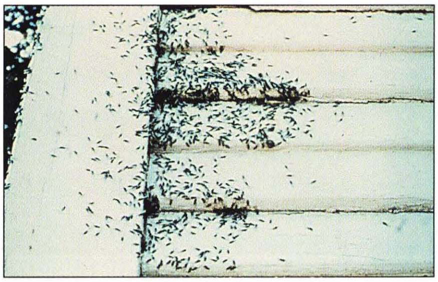
Subterranean termite workers

Subterranean soldier termites

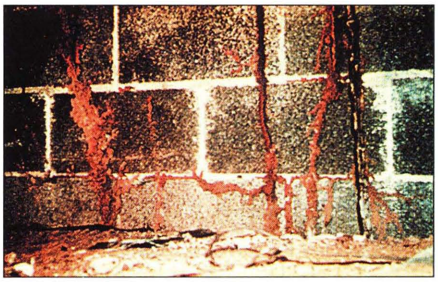
Swarmers with fallen wings



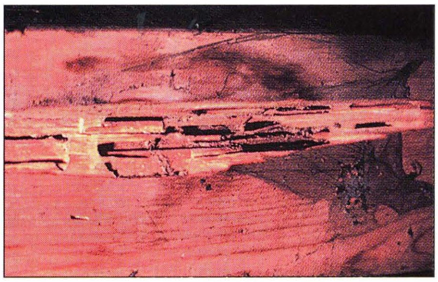
Free-standing shelter tubes



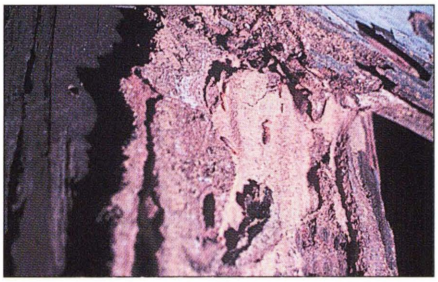
Subterranean termite swarmers on building



Shelter tubes on foundation wall



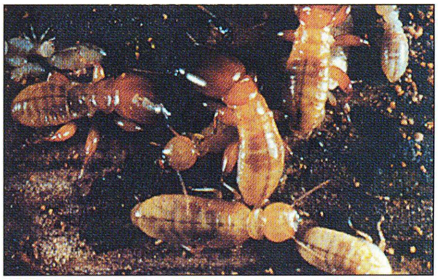
Subterranean termite damage to wood



Subterranean termite damage to wood

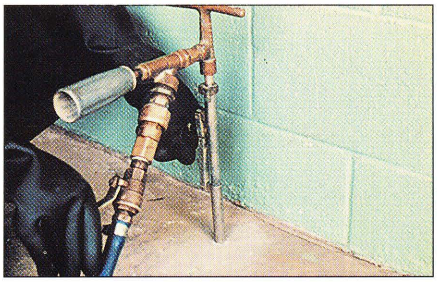
TERMITES

Drywood termite fecal pellets



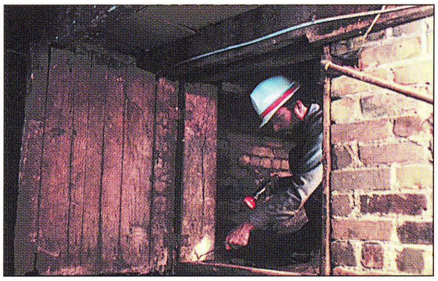
Dampwood termites

Long rodding exterior of house



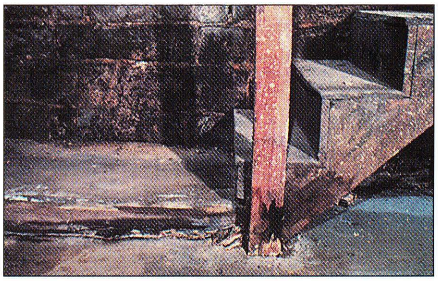
Sub-slab injecting

Drilling a slab

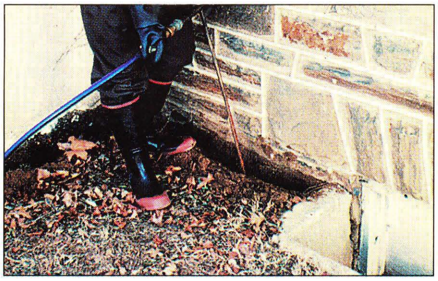


Inspecting a crawl space

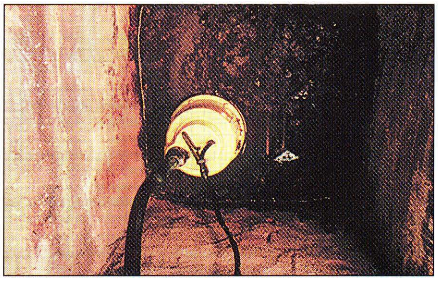
Probing wood



Basement form boards susceptible to termite attack



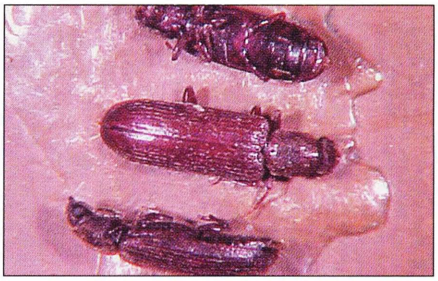
Rodding and trenching basement



Sump pump in basement

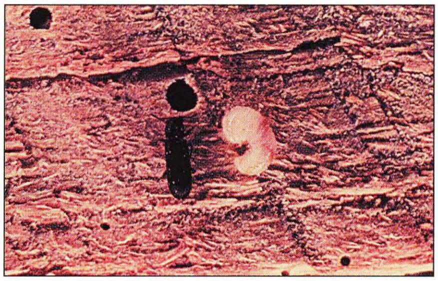
OTHER WOOD-DESTROYING INSECTS

Anobiid beetle damage

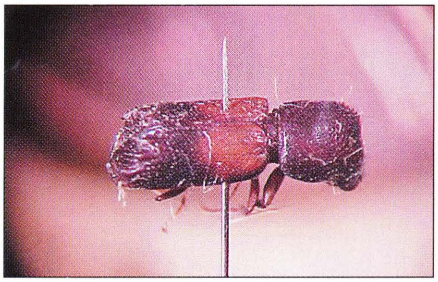


True powderpost beetle adults

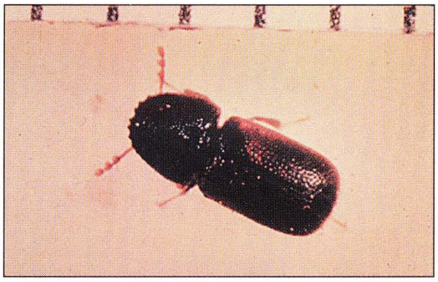
True powderpost beetle adult laying eggs



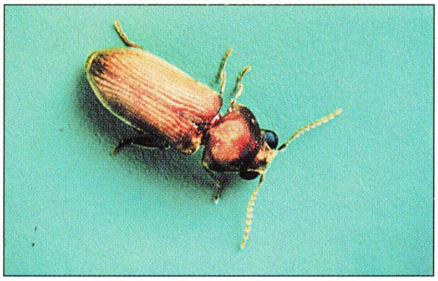
True powderpost beetle adult and larva



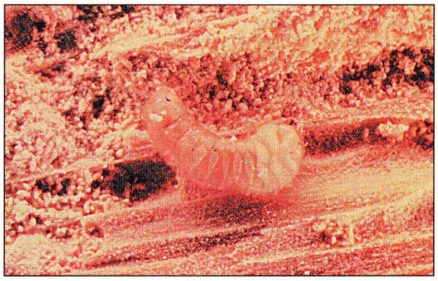
False powderpost beetle adult



False powderpost beetle adult

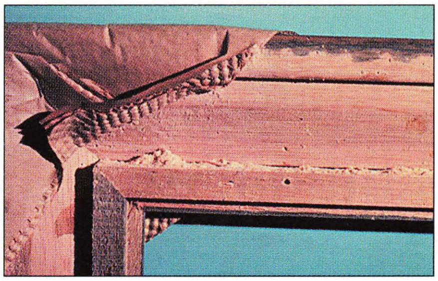


Anobiid beetle adult



Anobiid beetle larva

Eastern deathwatch beetle



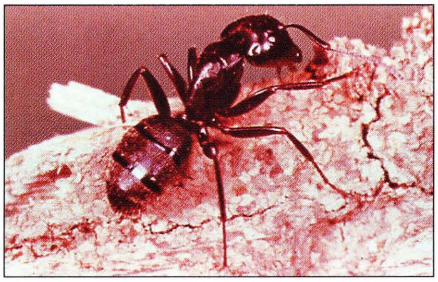
Lyctid beetle damage

OTHER WOOD-DESTROYING INSECTS

Wood-boring weevil

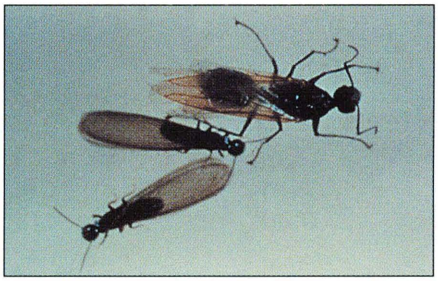
Old House borer adult

Old house borer damage

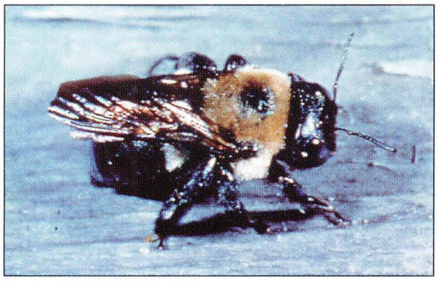


Carpenter Ant

Carpenter ant shavings



Ant vs. termite reproductives

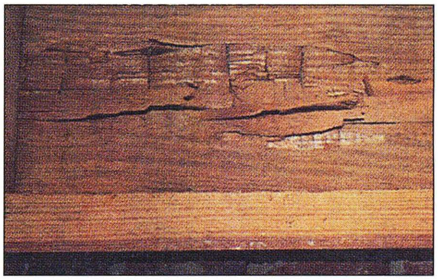


Carpenter bee

Carpenter bee damage

WOOD-DAMAGING FUNGI

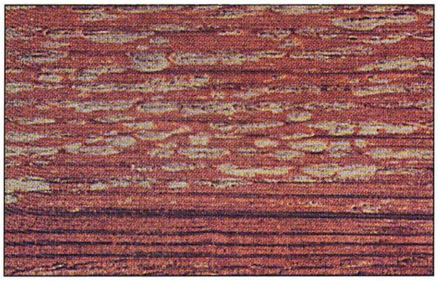
Brown rot



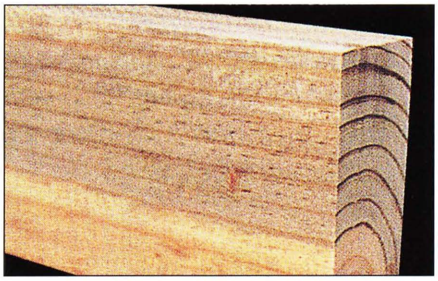
Wood damaged by *Poria*

Rhizomorphs of *Poria*

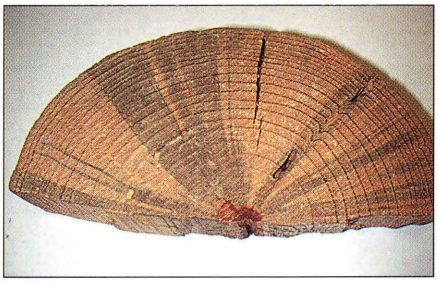
White rot



White pocket rot



Sapstain fungi



Blue stain fungi

Surface molds

Notes

PESTICIDE EMERGENCY INFORMATION

For any type of an emergency involving a pesticide, immediately contact the following emergency information centers for assistance.

Current as of August 2000

Human Pesticide Poisoning

MICHIGAN POISON CONTROL SYSTEM

From anywhere in Michigan, call

1-800-POISON 1

1-800-764-7661

Special Pesticide Emergencies

Animal Poisoning

Your veterinarian:

____
Phone No.

or

Animal Health Diagnostic Laboratory (Toxicology) Michigan State University:

(517) 355-0281

Pesticide Fire

Local fire department:

____
Phone No.

and

Fire Marshal Division, Michigan State Police:
M–F: 8–12, 1–5

(517) 322-1924

Traffic Accident

Local police department or sheriff's department:

____
Phone No.

and

Operations Division, Michigan State Police:

****(517) 336-6605***

*** Telephone Number Operated 24 Hours***

Environmental Pollution

Pollution Emergency Alerting System (PEAS), Michigan Department of Environmental Quality:

____
District MDEQ Office Phone No.

and

For environmental emergencies:

****1-800-292-4706***

also

****1-800-405-0101***

Michigan Department of Agriculture Spill Response

Pesticide Disposal Information

Michigan Department of Environmental Quality. Waste Management Division.

Monday– Friday: 8 a.m.–5 p.m.

(517) 373-2730

National Pesticide Telecommunications Network

Provides advice on recognizing and managing pesticide poisoning, toxicology, general pesticide information and emergency response assistance. Funded by EPA, based at Oregon State University

7 days a week; excluding holidays

6:30 a.m. – 4:30 p.m. Pacific Time Zone

1-800-858-7378

FAX: 1-541-737-0761

Revised by Carolyn J. Randall, *Pesticide Education Program, Michigan State University Extension*

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