Chapter 17
IPM for Wood-Damaging Pests in Schools

Introduction

The job of maintaining a building includes detecting structural pest problems before they become severe. Early detection means less costly repairs. Although the discovery of wood-destroying insects often generates panic and premature decisions, these pests are slow to cause new damage and there is ample time to accurately identify the pest and decide on an appropriate IPM program. Some of the work can be done by school personnel and the rest contracted out to a professional, or the entire job can be contracted out to professionals.

This chapter will discuss wood-attacking fungi, termites, and wood-boring beetles.

Identification and Biology

WOOD-ATTACKING FUNGI

Fungi reproduce from seed-like spores present in the air and soil. Thread-like structures called hyphae grow from the spore and penetrate directly into wood. A mass of hyphae, called a mycelium, is frequently visible on the surface of the wood. A mycelium often takes the shape of a fan or a fluffy mat. Optimal growth occurs at temperatures between 50°F and 95°F on wood containing at least 20% moisture.

The three major groups of wood-attacking fungi are surface-staining fungi (molds and mildews), sap-staining fungi (wood-stains), and decay fungi (wood rots). Surface-staining and sap-staining fungi do not cause loss of structural strength and will not be discussed here; however, they are evidence of moisture problems needing correction. The third group, decay fungi, attack the cellulose and lignin in wood and cause structural weakness. They are hard to detect in their early stages; however, advanced stages are quite evident from the changes in the wood's appearance.

Brown Rot

- characterized by white mycelial mats
- causes wood to crack into small cubical pieces perpendicular to the wood grain
- wood rapidly loses its strength and eventually crumbles to powder
- changes the color of the wood to a distinctive brown

Dry Rot or Water-Conducting Rot

- relatively rare problem
- a special kind of brown rot most often found in new construction
- can disperse rapidly throughout wood, destroying large amounts in one to two years
- characterized by large, papery, white-yellow mycelial fans
- forms large tubes called rhizomorphs that are up to an inch in diameter and can conduct water to 25 feet
- rhizomorphs are dirty white to black, and grow out and away from the moisture source
- rhizomorphs allow the fungus to extend its growth into dry wood containing less than 20% moisture
- wood surface may appear sound but wavy, even while the interior is heavily decayed

White Rot

- makes wood look bleached
- affected wood feels spongy when probed and is stringy when broken
- no abnormal shrinkage
- strength of the wood gradually diminishes

Soft Rot

- seldom encountered in buildings, except where wood is in contact with constantly wet soil
- develops in marine habitats in wood that is too wet for other decay fungi
- attacks surfaces of wood and produces a gradual softening inward

Identification and Biology

TERMITES

Although there are a number of groups of termites in the United States (including subterranean, drywood, dampwood, and powderpost termites—see Table 17-1), they share some common characteristics. They are social insects and form colonies that contain several castes. These castes differ greatly in their form and function.

During the first six months of the development of a new colony, only 6 to 20 eggs are deposited by the queen.

The total number of eggs deposited by a queen varies depending on the termite species (drywood and dampwood queens lay only a few hundred eggs during their lifetimes, whereas subterranean queens can lay tens of thousands). Nymphs hatch in 6 to 12 weeks and are tended by the reproductives. As the nymphs increase in size and number, castes are formed. The worker caste maintains and feeds the colony, and in many species there is a soldier caste that defends the colony. The darkly pigmented, winged reproductive caste (kings and queens) serves only to reproduce and start new colonies. Reproductives "swarm" (fly away from their original colony) only at certain times of the year.

Subterranean Termites (Reticulitermes spp.)

Subterranean termites require different ecological conditions from drywood, dampwood, or powderpost termites. Knowing these differences is critical to their successful detection and management.

- Subterranean termites must be in regular contact with moisture, which in most cases means they must stay in contact with the soil.
- In rare cases, they live in the wood above the soil, getting their moisture from a leaky air-conditioner, regular condensation, or some other constant moisture source.
- They construct distinctive earthen tubes to bridge the distance between the soil and wood.
- The passageways protect them from predators and help prevent desiccation as they travel. These tubes are important visible clues to subterranean termite presence.
- Initially, subterranean termites tunnel into soft spring wood, but as the infestation grows, they remove more and more wood until most of it is gone.
- They reinforce their excavations with "carton," a mixture of wood fragments and fecal material held together by saliva.
- Subterranean termite galleries are coated with a carton-like substance which gives the interior of the galleries a more rough and uneven appearance than other termite galleries.
- Subterranean termites are found in every state, and are responsible for 95% of termite-related damage.

Recently, researchers have discovered distinct differences between northern and southern populations of R. flavipes, the eastern subterranean termite. The northern populations are commonly spread by infested firewood, lumber or possibly topsoil, resulting in a patchy distribution pattern similar to Formosan termites (described below). R. flavipes in northern areas is rarely seen swarming. As with Formosan termites, northern termites will feed on trees and free standing poles, and they have extremely large colonies that are comparable in size to Formosan termite colonies (up to 2 million individuals). Subterranean termites in the north build extensive shelter tubes on the outside of infested structures and trees.

This new information on northern termites has several implications for control and detection. More buildings must be considered at risk from a single detected infestation of northern termites because of their patchy distribution and large foraging area. Also, monitoring activities should extend to trees, poles, and fences to detect termite activity.

Formosan Subterranean Termite (Coptotermes formosanus)

The Formosan subterranean termite was first documented in the United States in 1965. This species is currently found in Hawaii, Texas, Louisiana, Mississippi, South Carolina, Alabama, Tennessee, Florida, and southern California, and is expected to continue aggressively expanding its range.

- The Formosan termite is considered a serious threat in subtropical areas of the United States because it is such an aggressive feeder and has extremely large colonies (2 million to 10 million individuals).
- These termites build nests underground, but they can also nest above ground inside structures.
- A single reproductive pair of C. formosanus can result in an extensive infestation within three to five years.
- These termites can chew through the insulation on electrical wire, causing shorts and even damaging 12,000 volt lines.
- They also attack more than 50 species of plants and trees. When trees are attacked and become riddled with tunnels, they lose their structural integrity and are easily blown over in storms.
- Infestations are difficult to locate and control. Chemical control of this insect has been largely unsuccessful.

Drywood Termites (Incisitermes spp.)

Drywood termites do not require much moisture. They can attack a structure at points far removed from the

Table 17-1. Distinguishing Major Termite Groups

Please find this table at end of chapter.

soil. Drywood termites have been the most costly to treat because, until recently, whole-house fumigation was the only treatment. These termites are found in California and the Gulf States.

- Drywood termites usually enter a building through a crack.
- They excavate numerous broad chambers connected by narrow passages.
- The inside of their tunnels is smooth and clean.
- They will tunnel in almost any direction through both spring and summer wood (note that carpenter ants excavate soft spring wood and leave the hard summer wood).
- Fecal pellets are often stored in old chambers, or the termites may drill small, round "kickholes" from the galleries to the outside for expulsion of fecal pellets.
- Piles of these sawdust-like pellets may be the only visible signs of drywood termites. The pellets have a distinctive elongated shape with rounded ends and

flat or concave sides separated by six ridges. To see this you will need a magnifying glass.

- Drywood termites cause less structural weakness than subterranean termites.

Powderpost Termites (Cryptotermes spp.)

The powderpost termites are tropical pests that can live in subtropical climates such as those found in Florida, Louisiana, southern California, and Hawaii. Although it is uncommon, they may occur elsewhere when brought in accidentally with infested goods imported from the tropics.

Dampwood Termites (Zootermopsis spp.)

Dampwood termites are found primarily in the western United States in wet, decaying wood, although they can extend their feeding activities into sound, dry wood.

- These termites are most often found in conjunction with fungal decay.
- In rotten wood their galleries are large and can run across the wood grain.
- In wood that is more sound, dampwood termites make narrower tunnels in the softer spring wood.
- The inside of their galleries has a velvety appearance and is sometimes partially or completely coated with fecal matter.
- An infestation of dampwood termites can usually be controlled by fixing any water leaks that caused the wood to decay and by replacing any rotten wood.

Identification and Biology

WOOD-BORING BEETLES

Although some wood-boring beetles can cause serious damage, there is always time to identify the type of beetle present before taking action. When dealing with wood-boring beetles, it is important to know whether or not they will reinfest a piece of wood. Some beetles cannot, and seeing their holes in wood means they have done their damage and left. See Table 17-2 for more information to help you identify some of the most important beetles.

Lyctid Powderpost Beetles

These are small (1/8-1/4 inch), slender beetles that vary from reddish brown to black. Lyctids attack only the sapwood (outer wood) of hardwoods, and are the most common and widespread of the beetles that reinfest wood in the United States and Canada.

Females lay an average of 20 to 50 eggs in exposed areas of partially seasoned lumber with a high starch content. The hatched larvae bore down the vessels of the wood making straight tunnels which then turn and become irregular. Most species complete their life cycle in 9 to 12 months but they can develop more quickly if the temperature and starch content of the wood are favorable. The larvae pupate near the surface of the wood, and the emerging adults drill a hole through the wood to get out.

You are unlikely to see adult beetles during an inspection, and the larvae are always inside the wood. There is no outside evidence of infestation on wood that has been attacked for only a short time; however, once adult beetles emerge, you will see their small exit holes in the wood. You may also see piles of the fine, flour-like frass (beetle excrement) that sifts from the holes.

Anobiid Beetles (sometimes called deathwatch or furniture beetles)

These beetles are small (1/8-1/4 inch), reddish brown to black, and elongate with a very rounded back. In general, beetles in the family Anobiidae are more frequently a problem in coastal areas, unheated dwellings, or wherever the humidity is high. Furniture kept in centrally-heated living spaces is usually too dry for them to infest.

Anobiids attack both hardwoods and softwoods, and will feed on either newly seasoned or older wood. Although they feed mainly on the sapwood, they can also damage heartwood that is close to the sapwood. In the wild, they live in dead tree limbs or in bark-free scars on the trunks.

The females lay their eggs in small cracks or crevices on the surface of the wood When the larvae hatch, they bore a short distance into the wood, then turn at a right angle and tunnel with the grain. Their tunnels get larger as the larvae grow, and eventually become so numerous that they intersect, and the wood becomes a mass of fragments. Tunnels are packed with fecal pellets from the larvae. It may take two to three years for larvae to complete their development.

Larvae usually pupate in the spring. The newly emerged adults bore holes straight out of the wood, and a large proportion of the females lay eggs in the same wood from which they emerged.

Table 17-2. Characteristics of Damage Caused by Common Wood-Boring Beetles

Please find this table at end of chapter.

[a] In hardwood, pellets may be absent and frass packed tightly.

Adapted from Moore 1995

Old House Borer (Hylotrupes bajulus)

These beetles are brownish black, slightly flattened, and about 5/8 to 1 inch long. The segment just behind the head is marked by a shiny ridge and two shiny knobs that suggest a face with two eyes. These beetles are very common along the Atlantic coast, particularly the mid-Atlantic states, but because they can be moved around in infested wood, they may become established in other parts of the country.

Despite being called the "old" house borer, this insect is also very common in new construction. This beetle attacks coniferous wood, such as pine, spruce, hemlock, and fir, but it will also feed on hardwoods. The female lays her eggs in cracks and crevices on the surface of wood, and the hatched larvae sometimes crawl around before finding a place through which they can bore into the wood. They remain near the surface, feeding on the sapwood and only gradually penetrating deeper as they grow. They do not feed on heartwood.

The larval period may be completed in two to three years, but it can take as long as 12 or 15 years in dry wood, such as that found in attics. Old house borer tunnels have a distinctive rippled appearance on the inside. Unless the moisture content is high, the tunneling proceeds slowly.

Although this beetle can reinfest wood, the likelihood of this happening in buildings that are occupied, heated, and well ventilated is small.

Detection and Monitoring

It is important to determine exactly which organisms are present and causing damage before deciding on treatment strategies. The actual damage caused by structural pests (except Formosan termites) occurs slowly over a period of months or years, so there is time to study the situation and make a decision. Correct identification of the pest is critical to determining appropriate management strategies. The diagnostic key in Table 17-3 will help you identify the pest that is causing the problem. Figure 17-1 illustrates some of the major differences between ants and termites, which are often confused with each other. Table 17-1 provides information to distinguish among the major termite groups. Note that in some cases more than one kind of wood-damaging pest may be present.

Table 17-2 describes the major groups of wood-boring beetles and the damage they cause. Wood-boring beetles can be distinguished from one another by the type of frass they produce and the size and shape of the holes they create. It is important to distinguish between those species of beetles that can reinfest wood, causing extensive damage, and those beetles whose damage is limited to one generation.

If you are uncertain about which pest is present, get a professional identification from the local Cooperative Extension Service or a pest control professional. The time and potential expense needed to correctly identify the pest will be compensated by the fact that you will be able to develop an effective management program for your school.

Regular Monitoring

Monitoring means looking for signs of damage to the wooden parts of the structure on a regular basis. Information gathered from these regular site inspections should be written down. Include a map of the site with notes about problem areas. Monitoring should show whether a pest problem is getting worse and requires treatment, and whether the treatment has been effective.

Monitoring for structural pests should be regarded as an ongoing responsibility, repeated every one to five years depending on the kind of problems in your area. Early detection of structural pest activity will result in considerably less expensive treatment later.

School Staff Responsibilities for Monitoring

All personnel responsible for maintaining wooden structures should be trained to identify the conditions

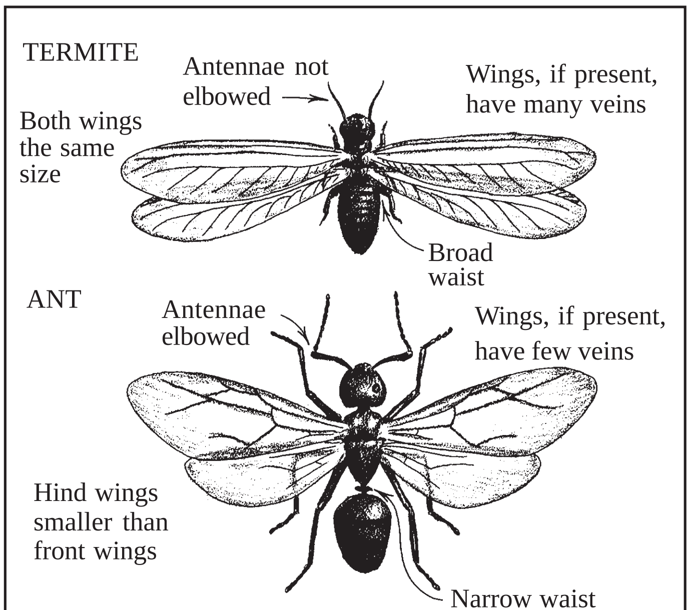


Figure 17-1. Differences Between Ants and Termites

Table 17-3. Diagnostic Key to Wood-Attacking Organisms Based on Symptoms

Please find this table at end of chapter.

that can lead to infestation by wood damaging pests (see the inspection checklist in Appendix I). Box 17-A provides a list of equipment needed for monitoring. If monitoring by school personnel indicates signs of termite or wood-boring beetle activity, a more thorough inspection should be made by a pest control professional. These staff members should also be trained to recognize obvious signs of damage, such as those listed under Symptoms in Table 17-3. Although major structural pest management decisions should be based on the recommendations of a trained inspector, having someone on the school district staff who is knowledgeable about structural pests and can supervise outside contractors can improve the quality of pest control and contain costs.

Using a Pest Control Service

When contracting for structural pest control services, the choice of a company should be based partially on their willingness to provide monitoring services for a fee separate and distinct from treatments. In some parts of the country it is still common for pest control professionals to offer free termite inspections with the expectation that the inspection cost will be covered by the fees for the treatments that follow. Because there is a potential conflict of interest in having the inspection and treatments performed by the same company, inspection services should be purchased separately. Separate payment increases the likelihood of an unbiased inspection, especially if the inspection and treatment companies are different.

You can use the checklist in Appendix I to confirm the thoroughness of an inspection performed by a professional. A compromise that can save money might involve school personnel checking the relatively accessible areas once or twice a year using this checklist, and hiring a professional (ideally with a termite detecting

Box 17-A. Tools and Safety Equipment for Monitoring Termites

- Flashlight with spare batteries and bulbs
- Screwdriver or ice pick for probing wood suspected of being infested
- Hammer or similar instrument for hitting wood and listening for indications of hollowness
- Ladder for inspecting roof trim and other off-ground areas
- Moisture meter with a range of at least 15% to 24% moisture
- Pencil, clipboard, graph paper, and measuring tape; with these, records can be made precisely on the floor plan or elevation of the building where moisture is evident or wood is damaged
- Tools for opening access entrances into crawl spaces
- Hacksaw blade for checking earth filled porches adjacent to crawl spaces; when inserted under the sill, the thin portion of the blade should not penetrate beyond the sill or headers
- Good-quality caulk, such as silicone seal, and a caulking gun to plug suspicious exterior cracks and crevices; silicone seal is also available in a thinner consistency that can be applied with a brush

dog [see below]) to check the harder-to-see places less frequently. Inspect both the inside and the outside of the buildings.

If a professional is hired to do the inspection, ask to see examples of sites which were found to have damaged wood. Discovering subterranean termite tubes or beetle damage is not necessarily evidence of an active infestation. Termite tubes or beetle exit holes or frass indicate only that termites or beetles were there at one time. In the case of beetles, the adults that made the exit holes may have been the last beetles that will ever emerge if they are from a species that does not reinfest wood. Treatment of inactive infestations would be an unnecessary expense. Ask for confirmation that living termites or beetles are present, as some companies do not make this confirmation normal practice.

Detection Techniques for Termites

There are several ways to identify termite activity. The observation of swarming reproductives is an indication of a current termite infestation in the area, but simply finding a pile of discarded wings can be misleading. Winged termites are attracted to light and so could come from other areas. If only swarming insects are seen, a distinction must be made between carpenter ants and termites (see Figure 17-1). If they are termites, monitoring will determine whether the infestation is from drywood, dampwood, or subterranean termites.

Sometimes you may be able to find "kickholes" made by drywood termites. These holes, 1/16 inch or smaller, are used by drywood termites to eject their sawdust-like fecal pellets from their galleries. These piles of fecal pellets are often the only visible sign of a drywood termite infestation. Wood-boring beetles also make holes in wood and, in some species, fine sawdust-like fecal pellets sift from the holes. Table 17-2 can be used to help identify the pest based on the kind of fecal pellets (frass) left and the kind of hole and tunnels produced by the pest.

The discovery of a mud tube extending from the soil up to the wood is an indication of probable subterranean termite infestation (these tubes are described above under Biology). If only one tube is located, monitoring for other tubes should begin immediately. Break open tubes to see if the termites are active or if the tubes are deserted; an active tube will be rebuilt within a few days. Finding soil in cracks and crevices can also be an indication of subterranean termites.

It isn't always possible to detect damaged wood by looking at the surface. An ice pick can help you probe the wood, and listening for sound differences while pounding on the wood surface can help you find the hollow areas (see Box 17-B).

For many years the only structural pest detection method available was visual observation by trained, experienced pest control inspectors. This method has been further improved by inspection tools such as detection dogs and moisture sensors.

Termite-Detecting Dogs

The use of termite-detecting dogs is a great advance in inspection methods. Like their bomb- and narcotics-detecting counterparts, these dogs, usually beagles, are specially trained to use their highly developed sense of smell to help their handlers to locate infestations of termites, wood-boring beetles, carpenter ants, and other live, wood-damaging insects. Inspectors use information from the dogs to enhance their own visual and physical inspections.

Termite inspections with dogs cost $50 to $100 more than inspections by humans alone, but the cost is usually justified by the increase in thoroughness of the inspection and the added precision in pinpointing sites of infestation. This added precision can lead to enormous savings by focusing treatment on the site of infestation rather than on the entire building.

Moisture Meters

A moisture meter will help determine whether or not the moisture content of the wood is high enough to support the growth of wood-inhabiting fungi, wood-boring beetles, or subterranean termites. The needles of the meter should be inserted along the grain of wood to give the most accurate readings. Temperature corrections should be applied to readings taken below 70°F and above 90°F (correction tables are supplied with meters). The meters should not be used in wood treated with water-borne wood preservatives or fire retardants.

Monitoring Techniques for Formosan Termites

Detection of subterranean Formosan termites (Coptotermes formosanus) requires considerable experience, and various techniques may not be equally effective in all areas where the termite has been found.

Box 17-C describes a monitoring trap used in areas like south Florida and Hawaii where aerial infestations of the Formosan subterranean termite in multilevel buildings are prevalent. Light traps are another tool for area-wide monitoring programs, but the cost of a light trap can be expensive. An alternative, developed in South Carolina, uses sticky traps attached to street lamp poles. Studies show that the greatest number of termites was caught 19 feet from the ground. Light traps should be used in the spring during the swarming season. Note that the month in which Formosan termites swarm varies with the area.

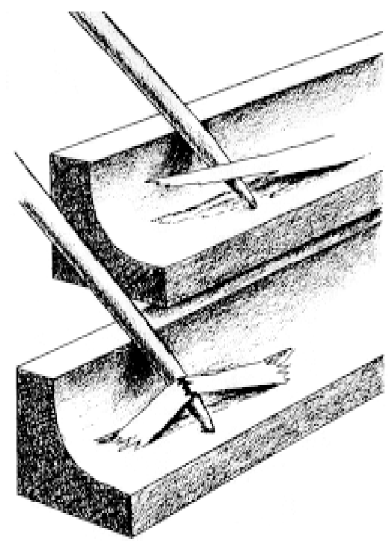
Monitoring for Beetle Infestations

When wood-boring beetle larvae mature into adults inside the wood, they bore exit holes to the surface to get out. Table 17-3 can help you determine what kind of insect created the holes you find. If it is a beetle, the information in Table 17-2 will help to identify the kind of beetle and whether or not it is capable of reinfesting. Consultation with a professional is also advised.

Box 17-B. The Pick Test

When monitoring your building, use an ice pick or screwdriver to probe wood you feel might be decayed based on its color or other changes you detect. Insert the pick about 1/4 inch into the wood and press sharply downward perpendicular to the grain. If the wood is sound, a long splinter will pull out of the wood along the grain (as shown in the figure below). If the wood is decayed, the splinter will be brittle and break into short pieces across the grain, especially at the point where the pick enters the wood and acts as a lever. You can also detect decayed wood by its lack of resistance relative to sound wood.

Mudsills (wood installed on footings) can be pick-tested without producing excessive visual or structural damage, since they are not visible from outside the crawl space. Sometimes wood treated with a preservative on the surface is decayed inside. The pick test can help reveal these hidden pockets of decay.



Discovering beetle damage is not necessarily evidence of an active infestation. Signs that the infestation is still active include fresh frass the color of new-sawn wood and live larvae or adults in the wood. Where you suspect an infestation of the kind of beetles that do not emerge for several years (such as old house borers), you can confirm their presence by listening for the chewing sounds they make inside the wood. To amplify the sounds, use a doctor's stethoscope or the cardboard tube from a roll of paper towels. You can also place a cloth or piece of paper underneath the suspicious area for a week or two to monitor for the fresh debris and frass that are indications of activity for some beetles.

Management Options

Habitat Modification (All Wood-Damaging Pests)

No structural pest control program is complete unless the conditions that favor the survival of the pest are modified. Moisture in or on wood is the single most important predisposing condition for wood damage and structural failure.

Reduce the moisture level of the wood

The investment in installing, fixing, or relocating gutters, siding, roofing, vents, drains, downspouts, and vapor barriers will pay for itself in long-term protection against termites, wood-boring beetles, and fungi. Leaking pipes, drains, sinks, showers, or toilets should be repaired. For wood-boring beetles and fungi, often the only control measures necessary are fixing leaks, installing vapor barriers, and using central heating to dry out wood and keep it dry. The most common wood-boring beetles cannot establish themselves in wood with a moisture content below 15%, and the old house borer probably needs more than 10% moisture. Wood must contain at least 20% moisture before it will support the growth of fungi. Few species of fungi can extend their growth into dry wood, and these fungi are relatively rare.

Ensure proper drainage under buildings

If the soil under buildings is constantly wet or becomes wet after it rains, this problem should be corrected. Equip downspouts with plastic extensions to direct water away from foundations. Grade the soil around the building to slope gently away from the structure. Installation of a vapor barrier under the building will correct many situations, but more serious moisture accumulations need other measures. Coat foundations walls with rubberized asphalt membranes to reduce moisture under the building. Extreme cases may require the installation of a sump pump or French drains. French drains are lengths of perforated pipe placed under the soil below the outside foundation footings to catch and drain water away from the building.

Improve irrigation or landscape practices to decrease water collection near buildings

Remember that water that falls on the sides of buildings from sprinklers can cause as many problems as natural rainfall.

Eliminate direct contact between wood and soil

Ideally, wood should be at least 8 inches above the soil to prevent direct access by subterranean termites and to prevent wood from absorbing excessive moisture. Wood in contact with the soil must be replaced with concrete. If wood is too close to the soil, remove some of the soil and grade it so that it slopes away from the building.

Replace damaged wood with treated wood

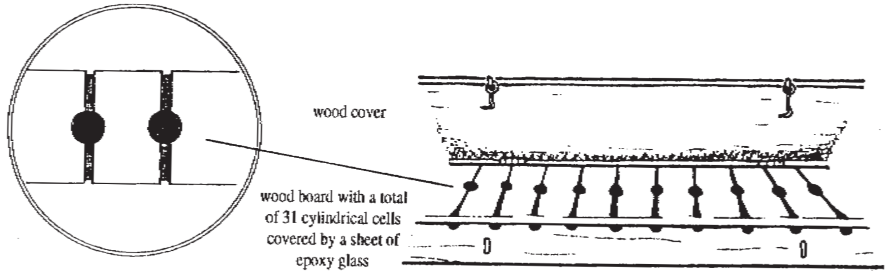
When wood must be replaced, especially wood in vulnerable areas, it can be treated with borates (see discussion below under Chemical Controls) to protect it

Box 17-C. Aerial Monitoring for Formosan Termites

Research shows that aerial infestations of the Formosan termite alates (winged termites) can be monitored using a pine board (3.8 x 8.5 x 120 cm) with 31 cylindrical cells (13 x 10 mm) drilled 37.5 mm. apart (Su et al. 1989).

Saw a groove (3.5 mm wide x 5 mm deep) through the center of each cell across the width of the board. Attach a wood cover (1.0 x 8.5 x 120 cm) to the board by two metal hinges and fasten it with two hook-and-eyelet closures. When covered, the grooves provide alates with pathways leading to each cell. Before fastening, sandwich a plate of clear epoxy glass (2.5 x 8.5 x 120 cm) between the board and the cover. When the cover is lifted for observation, the epoxy glass prevents escape of alates. Soak in water for 24 hours before use. Monitor the traps weekly.

Alates trapped on rooftops of multi-story buildings originated either from aerial colonies in nearby buildings or ground colonies. The trap cells can also detect termites, Cryptotermes spp., Incisitermes spp., and Reticulitermes spp. Catching alates means the area is infested. Develop a management prevention program before the next swarming season.



from termites and fungal decay. Whenever wood will be exposed to the weather, it is important to paint a water repellent on the bare wood before it is stained or painted. Depending on the product, water sealed wood must dry for a few days to over a month before being painted. Studies show that wood treated in this manner resists weathering and decay many years longer than wood that is only painted or stained.

Replace moisture-prone wood with aluminum, concrete, or vinyl

Sometimes it is more cost-effective to eliminate wood altogether from the most vulnerable areas of the building.

Remove tree stumps and wood debris

Decaying stumps, construction debris, and wood scraps near or under the building can be a source of termite infestation. Remove all wood debris and stumps within 10 feet of foundations. To kill stumps, make a new cut horizontally across the top and a number of cuts vertically into the stump. Immediately rub handfuls of soil into the vertical cuts and cover the stump with a tarp to block out all light. Leave for several months until the stump has decomposed. Never bury wood pieces; they can become termite nesting areas. Small pieces of wood debris containing live termites can be soaked in soapy water to kill the insects. Wood debris containing live termites should be taken to a landfill or other area where the natural decomposing abilities of termites are useful.

Store wood piles properly

Firewood or lumber piles should be constructed so that no wood rests directly on the ground. Use cinder blocks or concrete as a base on which to pile lumber or firewood and inspect the pile periodically. Large piles should be as far from the building as is practical; smaller amounts of wood can be moved closer to the building as they are needed, but do not store logs inside or in a place where they can touch the building or a wooden deck.

Plant trees away from buildings

Because trees and shrubs used in landscaping are often planted when young, a common mistake is to site them too close to a structure. Roots, branches and eventually decaying stumps provide avenues for termite, carpenter ant, and wood-boring beetle infestations. Trees and large shrubs may also provide roof rats, squirrels, and other animals nesting places and access to the upper portions of the building. Leaves clog gutters and can lead to water damage.

Screen vents

Drywood termites also enter buildings through ventilation openings, especially in the attic. Screen vents with window screen instead of the hardware cloth that is commonly used and has much larger openings. Note that window screen may impede the flow of air through the vents, and the number or size of vents may need to be increased.

Maintain buildings in good repair

The most effective indirect strategy for controlling structural pests is keeping buildings in good repair. Keep the skin of the structure sealed using paint, putty, and caulk. Drywood termites often enter buildings through cracks in eaves or in siding near the roof. Repair cracked foundations by injecting cracks with various materials (patching compounds). Cracks should be chiseled out to a 1/2 inch depth and 3/4 inch width before patching. Injectable bonding materials have some elasticity to resist cracking, whereas cement mixes are likely to crack if soil heaving or settlement is causing ongoing foundation movement.

Inspect lumber

Lumber and other wood items should be carefully examined for wood-boring beetle damage, such as small holes, sawdust, or fine wood fragments, before using or storing. Wooden furniture should be examined carefully for current beetle infestations before placement in the building.

Use kiln-dried or air-dried lumber

Although close visual inspection of wood is essential, it is not a guarantee against beetle infestation. Some infestations can go undiscovered for years before damage is seen. Kiln-dried or air-dried lumber should be used in all construction projects.

Physical Controls

For termites, heavily damaged wood should be replaced with sound wood. Wherever possible, use lumber treated with wood preservatives such as borates (see Chemical Controls below). Dispose of wood as described above under removing tree stumps and wood debris.

For wood-boring beetles, simply removing and replacing infested wood should be the first treatment option you consider. Carefully inspect wood in contact with the pieces that are removed to see if there is further infestation. In some situations this may not be practical because of inaccessibility of the wood or prohibitive labor costs. If any wood has been damaged to the point of structural weakness, it must be replaced or reinforced no matter what treatment is used.

Breaking open termite shelter tubes (Subterranean Termites)

The highly visible earthen tubes of subterranean termites can be broken open easily, or scraped off with a trowel or other instrument and disposed of as described above for wood debris. Once the tubes are opened, natural enemies such as ants can more easily enter the colony and kill the termites. Seal any cracks in the foundation, flooring, or wall that the termite tubes led to, then check back a week or two later. If the tubes have not been rebuilt, the termites are no longer reaching wood at that location; however, it is possible that they will construct new tunnels in inaccessible areas. This is the reason thorough inspections and regular monitoring are essential.

Sand barriers (Subterranean Termites)

Sand barriers composed of grains of sand in a specific size range can be used to prevent subterranean termites from gaining access to a building. UCLA entomologist Dr. Walter Ebeling was the first to show that termites cannot tunnel through a layer of moist or dry sand consisting of particles ranging from 10 to 16 mesh (2.0 mm to 1.2 mm). The range of particle sizes is important because the termites are unable to put their jaws around the larger particles, and the smaller particles pack the spaces in between the larger ones so the termites can't push their heads through. Commercial sand sold for use in sandblasting operations generally contains the required particles sizes; however, confirm with the supplier the mesh sizes in a specific batch of sand before purchasing it for use in termite barriers.

Sand barriers can be used as a remedial treatment under buildings with perimeter foundations and piers or as a preventive treatment under slab foundations before the slab is poured. Sand can also be used around and under fence posts, around underground electrical cables and water and gas lines, beneath and around structural foundation blocks and telephone and electrical poles, inside hollow-tile cells, and as backfill against structural retaining walls. If sand barriers are installed along exterior walls or around fence posts, the sand must be capped with concrete or other material to prevent the sand from blowing or washing away. Around the exterior of a building this can be quite expensive.

Proper installation of the sand barrier is critical to its effectiveness. It is important to carefully smooth the soil before installing the barrier. For perimeter foundations sand is piled to a height of 3 inches next to the foundation or concrete piers, and tapered off over a horizontal distance of 20 inches. A 4-in layer of sand is necessary under a slab. Sand barriers around perimeter foundations must be monitored regularly in order to detect weaknesses that termites can exploit.

At present, Live Oak Structural in Berkeley, CA is the only company in the continental U.S. commercially installing sand barriers.

Heat (Drywood Termites, Powderpost and Wood-Boring Beetles)

Special equipment composed of a heating unit, blowers, and ducts carries heat to the locations in the structure where the pests are causing damage. In several years of field tests in various parts of the United States, heat treatments have killed insects inside wood without damaging the building or furnishings, although certain sensitive articles and appliances must be removed as a precaution.

An entire structure can be treated with heat but pest control operators generally confine the heat to areas of identified infestations. Temporary containment walls are built inside the building to help focus and contain the heat. Temperature control is critical to success. The inside air is usually heated to around 160°F to attain temperatures on the outside of exposed wood surfaces of 145°F to 150°F. These temperature allow the inside of the wood to rise to 120°F—a temperature known to kill termites. Large fans are used to mix the heated air, so that the interior of the wood remains at 120°F for 35 minutes.

Since large scale heat treatments are expensive, it is important to have a thorough inspection that can pinpoint infestations. The technique is called Thermal Pest Eradication™, and is marketed by Isothermics, Inc. in Orange, CA. They can supply names of contractors who supply heat fumigation services in your area.

Electricity (Drywood Termites)

A tool called the Electrogun™ can be used to kill drywood termites. The gun shoots pulses of electricity into the wood at low energy (90 watts), high voltage

(90,000 volts), and high frequency (100 kHz), killing the insects in their galleries. This tool is safe for the operator and emits no microwaves, X-rays, or ultraviolet rays. In most cases it does not require any special preparation of the structure, nor relocation or inconvenience to the client. There are drawbacks to the Electrogun which include the necessity of the wood being accessible and the limitations of the device that allow its use on only about 60 to 70% of existing structures. Although it will not damage wires, wirewound motors, refrigerators, or washing machines, computers and other electronic equipment must be unplugged and moved three feet away from walls.

Etex, Ltd. in Las Vegas, NV manufacturers the Electrogun and can identify operators in your area who are trained to use the tool. Operators must learn how to use it properly, and training is provided by the distributors.

Microwaves (Drywood Termites)

Microwave irradiation is commercially available in some areas for spot treatment of drywood termites. This method relies on the high water content of termites which makes them heat up faster than the surrounding wood when they are exposed to microwaves. If the internal temperature of the termite is elevated sufficiently, the insect will die just as it does during heat treatment.

Extreme cold (Drywood Termites)

Extreme cold in the form of liquid nitrogen can be used to kill drywood termites. It is applied commercially as "The Blizzard System" by Tallon Pest Control (Union City, CA) in parts of California and Nevada and can be used only in wall voids.

The pest control operator must know the approximate extent of the termite infestation in order to inject liquid nitrogen into the proper areas, but the material can reach areas of buildings not accessible to other treatment methods. For example, infestations embedded too deeply in wood to be accessible to chemical "drill and treat" methods, or wall voids containing metal lath which interferes with the Electrogun can be treated with liquid nitrogen.

Biological Controls

The fungus Metarhizium anisopliae has recently been formulated into a microbial pesticide that is effective against a number of termites including subterranean termites such as Reticulitermes spp., Heterotermes spp., and Coptotermes formosanus (the Formosan termite), drywood termites such as Incisitermes spp. and Kalotermes spp., dampwood termites such as Zootermopsis spp., and powderpost termites such as Cryptotermes spp. (This same fungus is used in cockroach bait stations.) The fungus is extremely infectious among termites and is spread in the termite colony by direct contact, grooming, and trophallaxis (the exchange of alimentary fluids). It causes death within 8 to 11 days.

The fungus is currently formulated as a dust or wettable powder that must be applied where termites will come into contact with it. This means it can only be sprayed into active termite galleries. Initial studies indicate that only 5% of the termites have to encounter the fungus directly to kill the entire colony, although this number will probably vary depending on the termite species and the environmental conditions. Since it cannot grow at temperatures greater than 95°F, the fungus does not infect humans or other mammals.

Chemical Controls

If non-chemical methods alone prove insufficient to solve the problem, then integrating a pesticide into your management program may be warranted. For information on the hazards of various pesticides and on how to select an appropriate pesticide for your situation, consult Appendix G for a list of resources.

Pesticides must be used in accordance with their EPA-approved label directions. Applicators must be certified to apply pesticides and should always wear protective gear during applications. All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Do not apply these materials when buildings are occupied, and never apply them where they might wash into the sanitary sewer or into outside storm drains.

Always post durable signs where pesticides have been used in attics and crawl spaces so that future inspectors and repair technicians can identify and avoid the materials if necessary.

If insecticides are used, spot treatment is recommended to reduce human exposure. Spot treatment in this case refers to the application of the insecticide to only those areas where structural pests have been detected or areas that are not accessible for monitoring. Standard practice is to apply long-lasting pesticides in all areas where structural pests might conceivably become established. With a good monitoring program in place, it should not be necessary to use broad-scale applications of insecticides. If insecticides are used, they are most effective when combined with physical controls such as habitat modifications, wood replacement, heat treatments, and electrical treatments.

Borate-based wood treatments (Subterranean and Drywood Termites, and Wood-Attacking Fungi)

Borates are fungicides and slow-acting insecticides. They are not repellent to insects (termites will construct tubes over borate-treated wood), but do act as anti-feedants, which means that pests prefer not to feed on wood treated with borates. When insects feed on wood treated with borate or, in the case of wood-boring beetles, chew emergence holes through treated wood, the borate acts as a stomach poison to kill the insects over a number of days. As fungicides, borates act by inhibiting the growth of wood-attacking fungi.

Borates are used both in the pre-treatment of lumber for the construction industry and in remedial treatment of lumber in existing buildings. Pre-treated lumber can be used to replace existing lumber to prevent reinfestation in areas of potential termite activity or in areas vulnerable to rot. Crawl spaces and attics can be treated by a professional using a borate fogger, by spraying or painting liquid solutions directly on the wood, or by pressure injecting the solution into the wood. A larger amount must be used in a fogger to get the same coverage as painting or spraying on the solution. Borates can be effective as an insecticide to eliminate small termite and wood-boring beetle infestations.

Since borates are water soluble they cannot be used to treat exterior wood unless a finish (paint or stain) or sealant is subsequently applied to the wood. Since borates can move easily through the soil and leach away from the area of application, they should not be used in close proximity to lakes, streams, ponds, or areas where there is standing water. High concentrations of borates are toxic to plants, so treatments of the perimeter of buildings can result in inadvertent poisoning of plants and shrubs near the building.

Desiccating dusts such as diatomaceous earth and silica gel (Drywood Termites and Wood-Boring Beetles)

Desiccating dusts can help in preventing future infestations of drywood termites and wood-boring beetles. They are particularly useful in confined spaces such as attics and wall voids where they can remain effective for the life of the building. Desiccating dusts alone are effective and safe. They act primarily as physical, not chemical, agents but are commonly combined with pyrethrins.

Desiccating dusts act by absorbing the oily or waxy outer layer that coats the body of an insect. Water inside an insect is contained by this waterproof coating, and loss of the coating causes the insect to die from dehydration.

Diatomaceous earth has been used against termites as a repellent, but the use of silica gel for termite control is more common. Diatomaceous earth can be easier to handle because it is composed of larger particles than the silica gel. It is important to note that the product described here is not the glassified diatomaceous earth used for swimming pool filters, but rather "amorphous" diatomaceous earth.

These dusts are effectively used during construction to prevent infestations of drywood termites, but can also be blown into attics and wall voids as a remedial treatment. They can be applied over a small or large area. Examples of sites where desiccating dusts are useful are areas where condensation or poor drainage cannot be corrected, where wood cannot be moved far enough above the soil level, or where physical access for monitoring is limited, such as wall voids, crawl spaces, and attics.

If dusts are applied on a large scale, it is best to use special (but readily available) pressurized application equipment. Whenever dusts are applied, use a dustmask and goggles to avoid breathing the material and getting it in the eyes.

Synthetic pyrethroids (Subterranean and Drywood Termites)

Synthetic pyrethroids are coming into wider use as termiticides. Studies have shown that cypermethrin, fenvalerate, and permethrin are more toxic and more repellent to eastern subterranean termites than is chlorpyrifos (Su et al. 1990). Cypermethrin is by far the most toxic, and although permethrin is somewhat less toxic to termites than cypermethrin, it is capable of repelling them at the lowest concentrations. Note, however, that pyrethroids cannot repel termites at a distance because of their low vapor pressure (their vapors do not move far into the soil); termites must come into direct contact with the treated soil to be repelled.

Using insecticides as termite barriers in the soil relies on uniform distribution in the soil; however, in some cases soil characteristics may prevent this and barriers will fail.

Termiticides can also be applied as a foam to more effectively coat hard-to-reach surfaces. This can be particularly useful when treating a slab where the underlying soil has subsided or washed away. Injections of liquid pesticide may not coat all vulnerable surfaces, especially the underside of the slab. Because the foam fills the void, it leaves a residue on all surfaces.

Termite baits (Subterranean Termites)

The termite baiting strategy involves two steps: attracting termites and then exposing them to a slow-acting toxicant. The toxicant must be slow-acting so that termites have time to go back to the nest to spread the toxicant among their nest mates through food sharing and through mutual grooming. Since termites habitually wall off members of the community and/or galleries when they sense a problem with their food supply, the toxicant must work slowly enough that it goes undetected until a good portion of the colony has been exposed.

Baiting can eliminate a termite colony over a number of months (conventional chemical barrier treatments only try to prevent termites from entering a structure), but elimination may not be practical or necessary. Adequate control can probably be achieved by reducing the colony enough that no termites are seen in structures and no PCO call-backs are necessary (Ballard 1995).

Safety of Baits

Much smaller amounts of active ingredient are used in baits than are used in chemical barrier treatments so there is less of a risk of contamination by the poison. Most of the toxicants that are used in termite baits have low acute toxicity, and the concentrations in which they are used are generally low. Manufacturers are designing bait stations to be self-contained and tamper-resistant to protect children and animals from accidental exposure.

When to Bait

Because termite activity is seasonal, baiting is more effective at certain times of the year than other times. The best time to bait the eastern subterranean termite (R. flavipes) is in the late spring and early summer. The western subterranean termite (R. hesperus) can probably be baited year around, but the best results will be obtained in June, July, and August.

Two Types of Baiting Strategies

There are two general types of food baiting that can be used: perimeter baiting or interceptive baiting. If the whereabouts of the termites are unknown, perimeter baiting is used. Wooden stakes, bait blocks, or plastic monitoring stations are set around the perimeter of a structure either in a continuous circle or in a grid pattern. Perimeter baiting relies on the certainty that termites foraging at random will eventually discover the bait. Once termites have been located, either by perimeter baiting or by finding shelter tubes or active galleries, interceptive baiting can be used. Here, actively foraging termites are intercepted with a toxic bait. Interceptive baiting of structures has the disadvantage that quite often termite damage has already been done, and even though the colony is eliminated, the wood may have to be replaced.

Three Bait Toxicants

At this writing, only three toxicants are being used commercially for baiting termites.

Sulfluramid. Sulfluramid is currently registered as an above-ground bait toxicant and cannot yet be used below ground. The tamper-resistant bait stations contain a food bait treated with sulfluramid. Sulfluramid acts by biochemically blocking the termite's ability to respire causing death by suffocation. Only tiny amounts of sulfluramid are necessary. Currently, sulfluramid bait stations are only being produced by FMC Corporation under the product name First Line®.

For inside infestations, the mud shelter tubes need to be located and broken into at the leading edge where a bait station is then attached with tamper-resistant screws. For outside infestations, bait stations can be placed near fenceposts, in wooden mulches, and in other areas where termite infestation is likely.

Hexaflumuron. Hexaflumuron is currently registered as a below-ground bait toxicant. It is a chitin-synthesis inhibitor that stops termite development by preventing the insects from producing chitin, the substance that makes up their exoskeleton or "skin." Termites must produce a new exoskeleton each time they molt (grow) which is every 1-2 months; therefore, a toxicant that interferes with molting could kill an expanding termite colony over a period of 3 months.

Currently, hexaflumuron is being manufactured into termite bait stations only by DowElanco. The bait stations are being marketed as one part of a 3-step process (the Sentricon® System) that involves detection, elimination, and continued monitoring. The stations, which are perforated plastic cylinders, are buried in the ground every 10 to 20 feet around the perimeter of the building. The cylinders are first filled with wooden monitoring blocks, but when the termites are found, the blocks are replaced by bait tubes. Once termites are no longer feeding on the bait, monitoring with wooden blocks continues in order to detect any new invasions.

Hydramethylnon. Hydramethylnon is registered for underground use in termite bait stations, but it is also used in fire ant and cockroach bait stations. This toxicant works as an insect stomach poison. At this writing, hydramethylnon is formulated into a toxic termite bait only by Cyanamid for use in their patented bait stations (called the Subterfuge™ Termite Bait System). The bait stations are placed in the ground at least every 20 feet. If there is a known infestation, they are placed every 10 feet, and if termites are found entering a building, two or three bait stations are placed around the entry point. The stations can be opened to replenish bait without removing them from the ground so that termite feeding tunnels are not disturbed and the termites are less likely to abandon the station. After termites have stopped feeding on the bait, the stations can be left in the ground to monitor for new infestations.

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Table 17-1. Distinguishing Major Termite Groups

Termite Group	Distribution	Habitat	Behavior	Appearance
Subterranean termite *(Reticuliterrnes* spp.)	throughout the United States	ground-dwelling in moist sites	builds earthen tubes; does not form fecal pellets; eastern species swarm in April or May, western species usually swarm on warm, sunny days after the first autumn rain	workers and soldiers ¼ inch long; winged reproductives ½ inch long
Formosan termite *(Coptotermes formosanus)*	along Gulf and southern Atlantic coasts, Florida, Hawaii, southern California	structural lumber, living plants; can penetrate non-cellulosic materials, such as soft metals, asphalt, cracked concrete, and plastic	builds earthen tubes; swarms on warm, sultry evenings especially after rain	soldiers have an oval head with prominent horn-like gland; winged forms pale yellow-brown, similar to drywood termites, with wings about ½ inch long
Drywood termite (Incisitermes spp.)	southern and coastal areas	dry sites including outdoor furniture, firewood and sometimes woody plants (e.g., English walnut, grape, rose, citrus, eucalyptus)	forms oval, six-sided fecal pellets resembling poppy seeds; sometimes expels pellets in sawdust-like piles from 'kick-hole' exits in galleries; swarms during the day from July to October depending on the climate	larger than subterraneans but smaller than dampwoods; winged forms and soldiers up to ½ inch long
Dampwood termite (*Zootermopsis* spp.)	western United States and from British Columbia to lower California	damp, decaying wood, old tree stumps, rotting logs, pieces of buried timber and damp decaying structural lumber	produces large, oval fecal pellets similar to drywood, but flat or concave sides not so prominent; forms only reproductives and soldiers, noworkers; swarming peaks in late summer and early fall at dusk	largest termite in the United States; winged forms 1 inch long, with wings twice the length of the body
Powderpost termite (*Crptotermes* spp.)	southern and subtropical areas; occasional invader elsewhere	dry wood, furniture, woodwork, wood floors	forms small fecal pellets	small; soldiers have strongly concave brown or black heads; winged forms 7/16 inch long

Table 17-2. Characteristics of Damage Caused by Common Wood-Boring Beetles

	WOOD ATTACKED		RECOGNIZING DAMAGE			
TYPE OF BORER	**Part and type**	**Condition**	**Exit Holes**	**Galleries (tunnels)**	**Frass**	**Reinfest?**
Anobiid powderpost beetles	Sapwood of hardwoods and softwoods; rarely in heartwood	Seasoned	Circular, 1/16 to 1/8 inch diameter	Circular, up to 1/8 inch diameter; numerous; random	Fine powder with elongatepellets conspicuous; loosely packed in isolated clumps of different sizes; tends to stick together[a]	Yes
Bostrichid powderpost beetles	Sapwood or hardwoods primarily; minor in softwoods	Seasoning and newly seasoned	Circular, 3/32 to 9/32 inch diameter	Circular, 1/16 to 3/8inch diameter; numerous; random	Fine to coarse powder; tightly packed, tends to stick together	Rarely
Lyctid powderpost beetles	Sapwood of ring- and diffuse-porous hardwoods only	Newly seasoned with high starch content	Circular, 1/32 to 1/16 inch diameter	Circular, 1/16 inch diameter; numerous; random	Fine, flour-like, loose in tunnels	Yes
Round-headed borers (general)	Sapwood of softwoods and hardwoods; some in heartwood	Unseasoned, logs and lumber	Oval to circular 1/8 to 3/8 inch long diameter	Oval, up to ½ inch long diameter, size varies with species	Coarse to fibrous; may be mostly absent	No
Old house borer	Sapwood of softwoods, primarily pine	Seasoning to seasoned	Oval, 1/4 to 3/8 inch long diameter	Oval, up to 3/8 inch long diameter; numerous in outer sapwood, ripple marks on walls	Very fine powder and tiny pellets; tightly packed in tunnels	Yes
Flat oak borer	Sapwood and heartwood of hardwoods, primarily oak	Seasoning and newly seasoned	Slightly oval; 1/16 to 1/12 inch	Oval, up to 1/12 inch long diameter	Fine granules	No
Flat-headed borers	Sapwood and heartwood of softwoods and hardwoods	Seasoning	Oval, 1/18 to ½ inch long diameter	Flat oval, up to 3/8 inch long diameter; winding	Sawdust-like, may contain light and dark portions if under bark; tightly packed	No
Bark beetles	Inner bark and surface of sapwood only	Unseasoned, under bark only	Circular, 1/16 to 3/32 inch diameter	Circular, up to 3/32 inch diameter; random	Coarse to fine powder, bark-colored, tightly packed in some tunnels	No
Ambrosia beetles	Sapwood and heartwood of hardwoods and softwoods	Unseasoned, logs lumber	Circular, 1/50 to 1/8 inch diameter	Circular, same diameter as holes; across grain, walls stained	None present	No
Wood-boring weevils	Sapwood and heartwood of hardwoods and softwoods	Slightly damp, decayed	Raggedly round or elongate, 1/16 to 1/12 inch diameter	Circular, up to 1/16 inch diameter	Very fine powder and very tiny pellets, tightly packed	Yes

[a] In hardwood, pellets may be absent and frass packed tightly.

Adapted from Moore 1995

Table 17-3. Diagnostic Key to Wood-Attacking Organisms Based on Symptoms

Fungi: Wood damaged and discolored with shrinkage and/or loss of structural strength. Colored stains or dusty coating on underside of floor, on walls, or on ceilings.

Specific Symptoms	Probable Cause
Blue stain visible in sapwood.	Blue stain fungus.
Fan-shaped white fungal mat with large 1 inch wide dirty white, brown or black threadlike strands (mycelia)	Poria fungus, or 'dry rot'.
Soft decayed wood with mycelia and checking (cracking) at right angles to the grain of the wood, particularly on floor or perimeter joists. Wood looks brown and crumbles to a powder when touched.	Brown rot.
White mycelial mass covered with irregular specks or pocks.	Fomes fungi.

Insects: Holes, tunnels, galleries or chambers on or beneath the surface of the wood.

Specific Symptoms	Probable Cause
Holes greater than 1/2 inch in diameter.	Carpenter bees.
Holes less than 1/2 inch in diameter	Wood boring beetles.
Galleries or chambers found in wood. The wood surface is easily penetrated with a screwdriver or ice pick.	Termites.
Surface earthen tubes or tunnels running from soil to wood	Subterranean termites
Swarming winged insects at base of fence post, foundation or indoors, or a collection of wings but no insect specimens.	Ants or termites (refer to Fig. 17-1 to distinguish). Use Table 17-1 to distinguish termites.
Large bumble bee-like insects flying around exterior near the eaves of the house. Some enter large holes. Damage mostly confined to siding or outer boards.	Carpenter bees.
Sawdust or tiny wood scraps on floor	Carpenter ants or drywood termites (see Fig. 17-1)