CHAPTER 2

THE BIOLOGY OF TERMITES AND OTHER WOOD-DESTROYING PESTS

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Know the stages of insect growth and development.
- Understand why knowledge of insect growth and development is an important pest management consideration.
- Be able to identify the various types of termites and other wood-destroying insects and pests.
- Understand the biology of termites—i.e., their development, social order, distribution, and role in nature.
- Know the four categories of termites and how to distinguish between them.
- Know the various castes found among termites, their role in the colony, and how to distinguish one caste from another.
- Understand how termite colonies are formed, what environmental conditions a colony needs, and how the colony maintains these conditions.
- Understand the basics behind termite communication within the colony.
- Be able to identify the type of wood-destroying pest from the signs and symptoms on damaged wood.

THE BIOLOGY OF INSECTS AND THEIR RELATIVES

Living things are divided into the plant kingdom, the animal kingdom, and several smaller kingdoms of microscopic life. Insects are part of the largest group in the animal kingdom—the *phylum* Arthropoda. Arthropods include spiders, mites, ticks, millipedes, centipedes, crabs, shrimp, and insects.

The class Insecta is distinguished from the other arthropod classes by the three body regions—**head**, **thorax**, and **abdomen**. The head bears a single pair of antennae, the thorax bears three pairs of legs and usually wings, and the abdomen contains most of the digestive system and the reproductive organs.

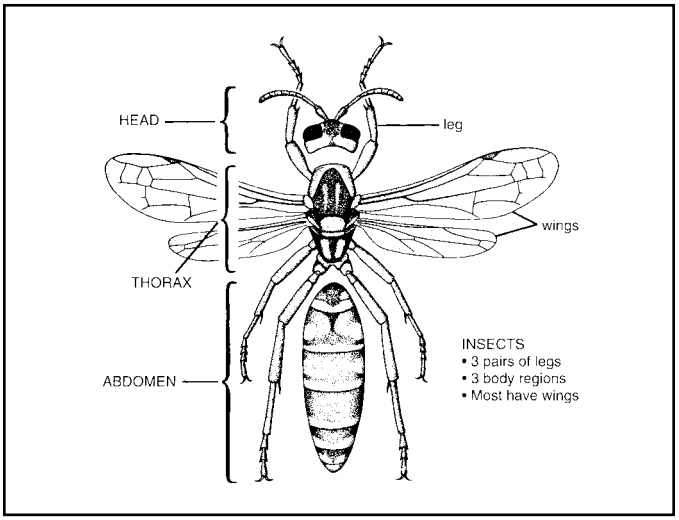

Figure 2.1. The three principal regions and parts of an insect's body, as shown on the paper wasp (Provonsha).

Other Divisions Used in Classification

Classes of arthropods—insects, for example—are divided into **orders**. These are distinct groups whose members look very much alike (e.g., the order of moths and butterflies, or the order of beetles).

Orders are subdivided into **families** made up of related **species**. Species of animals can be thought of as specific kinds of animals. Very closely related species are grouped together in a **genus**. Species or types of animals (and plants) are given scientific names that always consist of two words—the first word is the genus name (the first letter is always a capital); the second is the species name (always lower case). Both are written in italics or underlined (e.g., *Musca domestica*). Well known species also usually have non-scientific names, called "common names" (e.g., "housefly").

GROWTH AND DEVELOPMENT

Growth

The arthropod body is confined in its ***exoskeleton***. This outer covering can expand only a little at pliable or soft places. It does not grow continuously. Arthropods grow in stages. They form a new, soft exoskeleton under the old one, then shed—or ***molt***—the old one. The new skeleton is larger and allows the animal to grow. The new exoskeleton is white at first, but it hardens and darkens in a few hours. After the molting process, which usually takes place in hiding, the arthropod resumes its normal activities.

Development

Most arthropods hatch as tiny individuals and grow by molting, usually keeping the same appearance until they become adults. However, a spectacular and very important exception occurs in the class Insecta. The insect class is divided into groups according to the way insects change during their development. This change is called by the technical term ***metamorphosis***, which means "change in form." Three main types of metamorphosis have been identified.

Group 1. Simple Metamorphosis

This group, including the order of silverfish, makes no drastic change in form from juvenile to adult. They simply hatch and grow larger by molting periodically. Only a few orders are in this group.

Group 2. Gradual Metamorphosis

In this group (e.g., termites, cockroaches, crickets, grasshoppers, boxelder bugs, earwigs, etc.), individuals hatch from the egg only partially resembling the adults. The immatures, or ***nymphs***, do not have wings. Winged insects are always adults. Insects in 14 orders develop in this way. Some of these orders have many species and include many pests. Nymphs and adults are often found together and usually eat the same food.

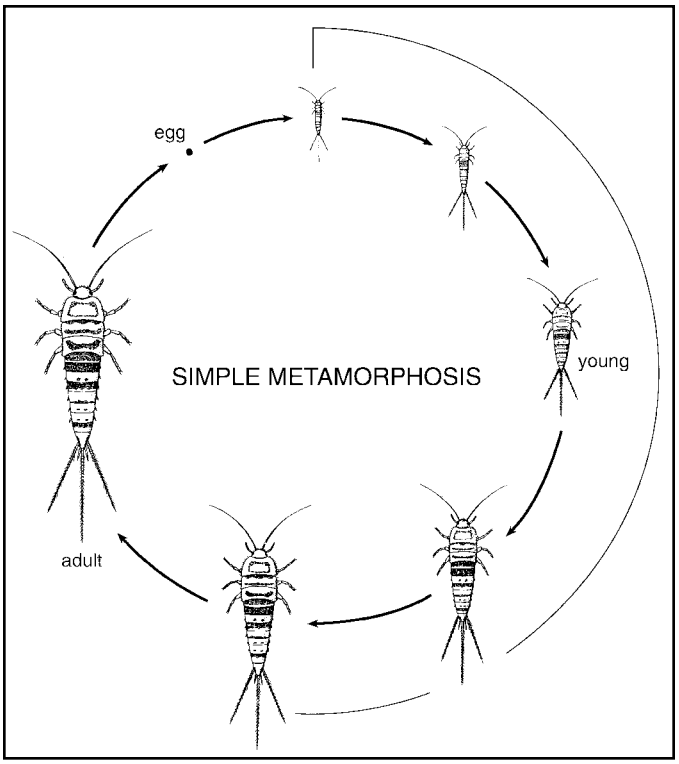

Figure 2.2. Development with simple metamorphosis (example: silverfish) (Provonsha).

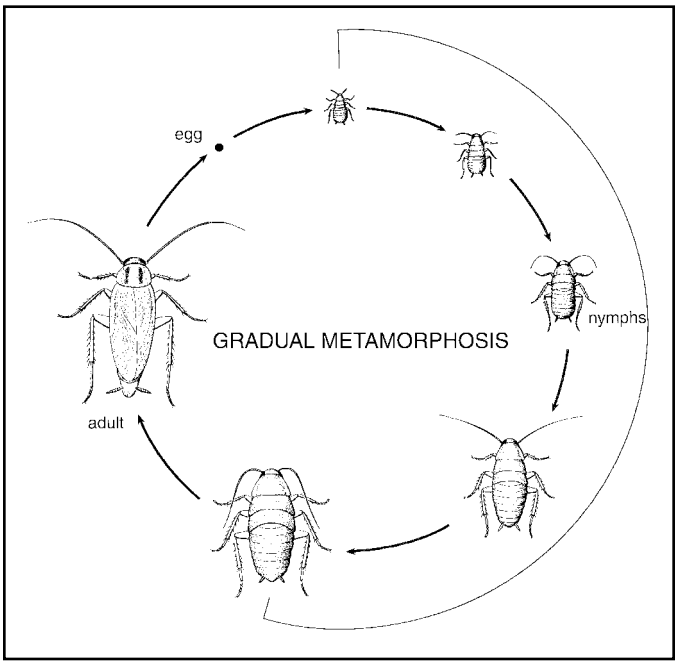

Figure 2.3. Development with gradual metamorphosis (example: cockroach) (Provonsha).

Group 3. Complete Metamorphosis

Insects that develop by complete metamorphosis make a complete change in appearance from juvenile to adult. These nine orders contain the majority of insect species. ***In fact, they number more than all of the other species in the entire animal kingdom!*** This major group

includes beetles, moths and butterflies, flies, fleas, and stinging insects (ants, bees, and wasps).

Insects with complete metamorphosis hatch from eggs as ***larvae*** (grubs, maggots, and caterpillars). The mission of the larval stage is to feed and grow. Larvae continue their development through a number of molts until they become mature; then, they change into ***pupae***. The purpose of the inactive pupal stage is one of change or body rearrangement resulting in a complete change into the adult stage. Reproduction occurs during the ***adult*** stage.

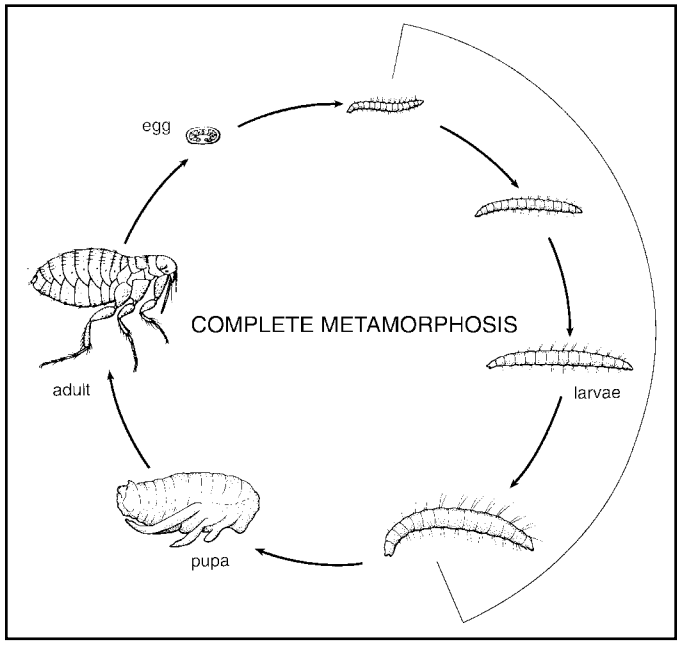

Figure 2.4. Development with complete metamorphosis (example: flea) (Provonsha).

Termites live in true social colonies with a division of labor among the various types of individuals. These different types, called ***castes***, usually consist of ***reproductives, soldiers***, and ***workers***. Castes vary considerably among the various species.

Termites develop via gradual metamorphosis from eggs laid by reproductives. Nymphs hatch from the eggs and undergo several molts through which individuals develop into one of the various castes. Termites found in the United States are generally grouped into three categories: **drywood, dampwood, and subterranean**.

TERMITE DISTRIBUTION

Several species of subterranean termites are found in the United States; they live in every state except Alaska (see Figure 2.5). The introduced Formosan subterranean (*Coptotermes formosanus*) is one of the most aggressive and economically important species of termites and has been found along the Gulf of Mexico and Atlantic coasts. Fortunately, it is not established in Michigan. This termite is found mainly in tropical regions but may be moved into more temperate areas through shipment of infested wood. Other subterranean termites of economic importance in the United States include the light southeastern subterranean termite (*Reticulitermes hageni*), the southeastern subterranean termite (*Reticulitermes virginicus*), the Pacific Coast subterranean termite (*Reticulitermes hesperus*), and the arid land subterranean termite (*Reticulitermes tibialis*). None of these termites have become established in Michigan.

The most common type of subterranean termite found in Michigan is the **eastern subterranean termite** (*Reticulitermes flavipes*). It is thought to be the most common and widely distributed termite in North America.

THE BIOLOGY OF TERMITES

The insect order **Isoptera** consists entirely of termites. There are more than 2,000 termite species living throughout the world, but only about 50 occur in the United States. In nature, termites are considered to be beneficial insects because they help to convert dead wood and other cellulose material to soil. Termites are considered pests, however, when they feed on wooden structures.

Termites harbor a specific kind of ***protozoan*** in their digestive tracts. These protozoans convert cellulose into substances that termites can digest. Without these symbiotic organisms, the termite could not digest the wood it consumes.

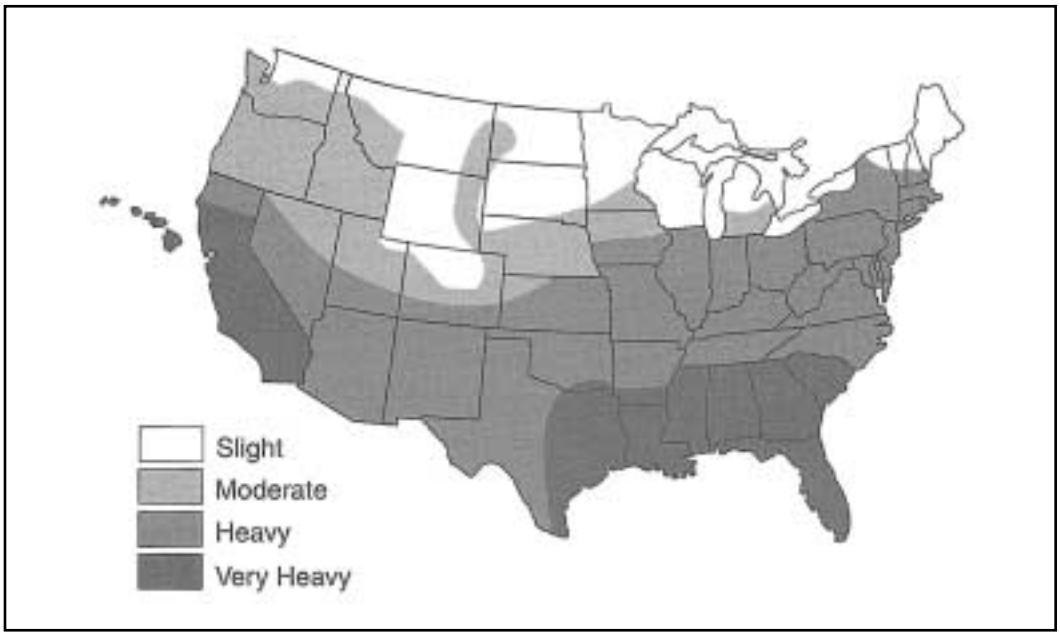

Figure 2.5. Geographic distribution of subterranean termites.

SUBTERRANEAN TERMITES

Subterranean termites nest in the soil, from which they obtain most of their moisture, and feed on any wood in contact with the soil. To reach wood that is separated from the soil, these termites must build a connecting mud tube or tunnel. Four castes can develop from the nymphs of subterranean termites: **workers, soldiers, winged (primary) reproductives**, and **supplementary reproductives** (see Figure 2.6).

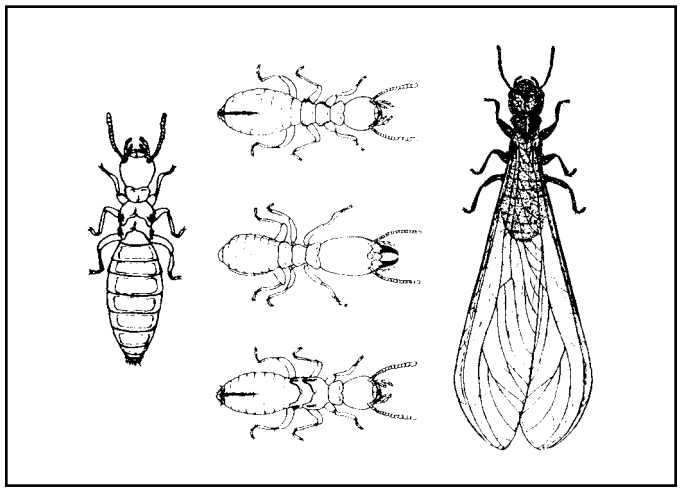

Figure 2.6. Representatives of the castes of the eastern subterranean termite, *Reticulitermes flavipes*. *Right:* The winged (alate) primary reproductive. These alate forms are the familiar swarmers that often give the first indication that a structure is infested. *Middle row, top:* The sexually undeveloped worker. The members of this caste are the individuals that do the actual damage. Note the complete lack of wing pads. *Middle row, center:* The soldier is greatly modified in head structure and serves a completely specialized function in the division of labor within the colony. It works solely in the defense of the colony and cannot feed itself. *Middle row, bottom:* A developing supplementary reproductive. Note the lengthened wing pads, which are usually the first indication of the development of these reproductives. *Left:* A functional supplementary reproductive. Female supplementary reproductives are thought to be the most important of the reproductive individuals in the subterranean termite colony.

Eastern Subterranean Termites

The colonies of eastern subterranean termites are located in the soil. Their food consists of wood or wood products and other dry plant material. They will also feed within the stems of some of the woody annual plants such as sunflower, dahlia, etc. They attack woody material in contact with the soil. They construct ***shelter tubes*** (often referred to as ***mud tubes***) over concrete and other inorganic material to reach wood that is not normally in contact with soil.

Primary reproductives of subterranean termites are the male and female ***swarmers*** or ***alates*** that started the original colony. This is the caste most often seen by homeowners. The winged adults are usually much darker than the other members of the colony. Their bodies are flattened and they have large eyes. All four wings are the same length and extend more than the length of the body beyond the tip of the abdomen. Both male and female reproductives leave the colony in great numbers (swarms), usually in the spring or fall. These swarms are often the first visible indication that termites are present. As a general rule, swarmers emerge on warm, sunny days when the humidity is high (e.g., often on days following rain showers). Primary reproductives are produced in mature colonies, 3 to 5 years old and older.

Figure 2.7. The queen subterranean termite is a primary reproductive who resides in the soil. Her only function is to lay eggs.

Figure 2.8. Winged primary reproductive swarmer.

Swarmer termites are often confused with flying or swarmer ants. Ants are often seen swarming in and around buildings, so it is important to be able to distinguish between the two so that appropriate control recommendations can be made. There are three ways to separate termites from ants. First, ants have a very thin waist between the thorax and the abdomen; termites are broad-waisted. Second, termite wings are all the same size and shape, whereas the forewings of the ant are larger, longer, and of a different shape than the hindwings. And third, termite antennae are straight; ant antennae are elbowed.

Supplementary reproductives (sometimes referred to as **secondary reproductives**) of both sexes are wingless or have only very short, non-functional wings. These reproductives are developed as needed and quickly replace a primary queen who is injured or dies. They usually develop in addition to the primary queen and

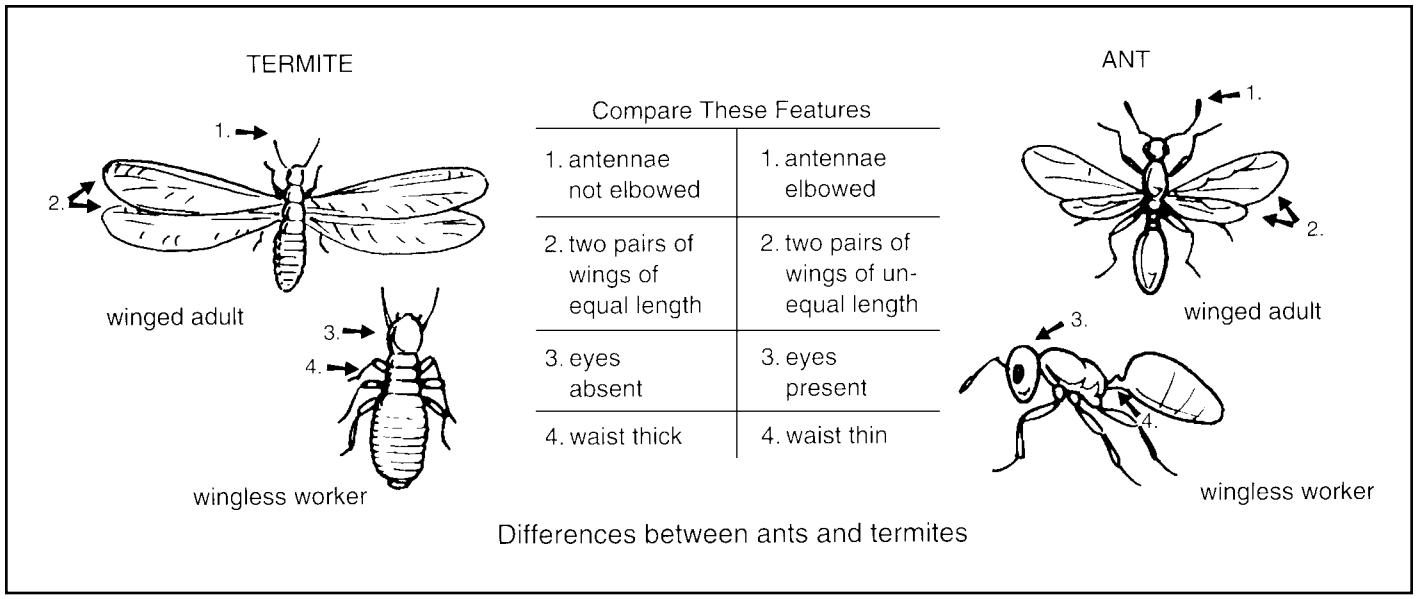

Figure 2.9. Comparison of termites and ants.

become the most important source of eggs in the colony. Supplementary reproductives, with a group of males and workers, may become isolated from the colony and establish a new colony, thus spreading the original infestation without having to swarm.

Workers are the most numerous individuals in a termite colony. They perform all 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. In the process of making nests and tunnels and ingesting food, they chew and eat wood, thus causing the destruction that makes termites economically important. Workers are creamy white, wingless, eyeless, and soft-bodied with chewing mouthparts. Workers are sometimes mistaken for "white ants." They mature within a few months and may live 2 to 3 years.

Workers maintain the shelter tubes and close any breaks in the surface of the wood they are infesting. Termites must maintain this closed system to have a certain level of humidity and to protect themselves from natural enemies. Occasionally a subterranean termite colony may find a source of moisture in the wood—from a leaking pipe or roof, for example—so contact with the soil is no longer necessary.

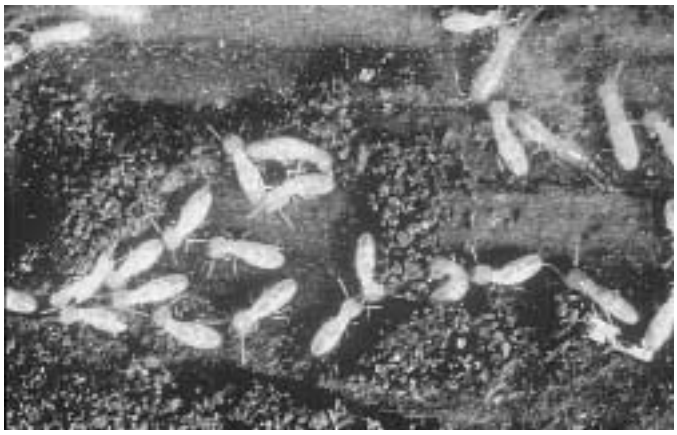

Figure 2.10. Subterranean termite workers in soil. The workers travel to wood, feed, and then bring back ingested wood to the colony.

Soldier termites serve specifically to protect the colony from its enemies. Their heads are large, quite hard and reddish-brown, and have much larger mandibles than are found in the other forms. When openings are made in termite structures, the soldiers gather with their large heads and strong mandibles facing outward and protect the colony from invaders, primarily ants. Like workers, they mature within a few months and may live 2 to 3 years.

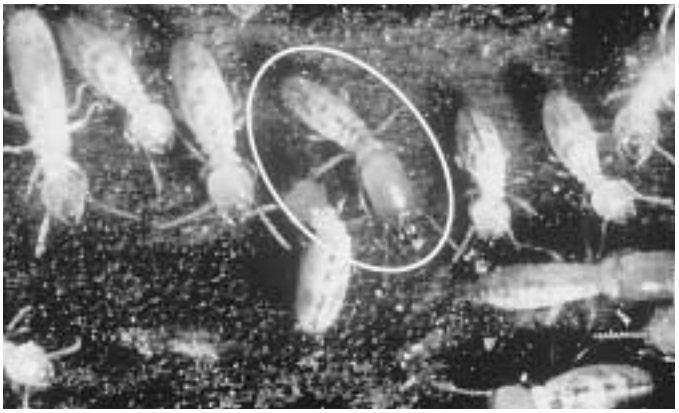

Figure 2.11. Subterrranean soldier termites have enlarged heads with large mandibles.

Colony Formation

A termite swarm is a dispersal flight that contains both male and female reproductives. As the termites fall to the ground after a short, fluttering flight, their wings break off. Males and females pair off and begin excavating a new nest. Subterranean termites usually burrow under trees or decaying wood, or in soil that is in contact with wood. They rarely use crevices in trees to initiate a colony. Many termites in a swarm never find a mate or a homesite. Others are eaten by predators such as birds.

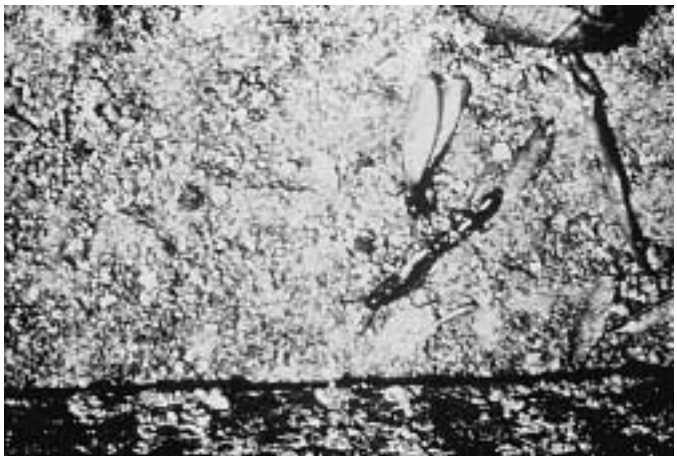

Figure 2.12. Swarmers with fallen wings ready to mate.

Once a pair finds a site and seals themselves in, they will mate and the female (queen) will begin egg laying. The first batch will be small, usually 6 to 12 eggs. Once these nymphs hatch, they begin to eat cellulose and enlarge the colony area. As the number of nymphs increases, the queen will lay increasingly larger numbers of eggs. Reproductive forms usually will not be produced in the first year. It usually takes 2 to 3 years for a newly established colony to begin doing serious damage to structural wood. As the colony grows, the secondary reproductives also begin to lay eggs to supplement those laid by the queen. There is not just one central nest containing one queen. Secondary reproductives may be found throughout the colony.

Another way colonies may be formed is by ***budding*** from a well established colony. Budding occurs when a number of individuals, including one or more secondary reproductives, leave the colony and start a new one.

Stone or concrete building foundations are temporary obstacles to termites. If a crack 1/32 inch wide develops in these foundations, termites can enter and move into the wood above unless there is some other barrier. Remember, if distances are short, termites can build shelter tubes across foundations to reach wood. So cracks in concrete, continuous openings in building blocks, utility openings, expansion joints, and wood below soil level offer the best and easiest access for termites.

The Termite and its Environment

Termites require specific environmental conditions to survive (see Figure 2.13). Most times, moist soil or other moist environments provide these conditions. Moisture is critical to termite survival because all castes except the swarmers are soft-bodied insects that lose water rapidly upon exposure to dry air. Thus, an available moisture source is critical to termites. This is why termites construct shelter tubes when they pass over exposed areas. Subterranean termites must maintain contact with the soil unless they have a constant aboveground source of moisture.

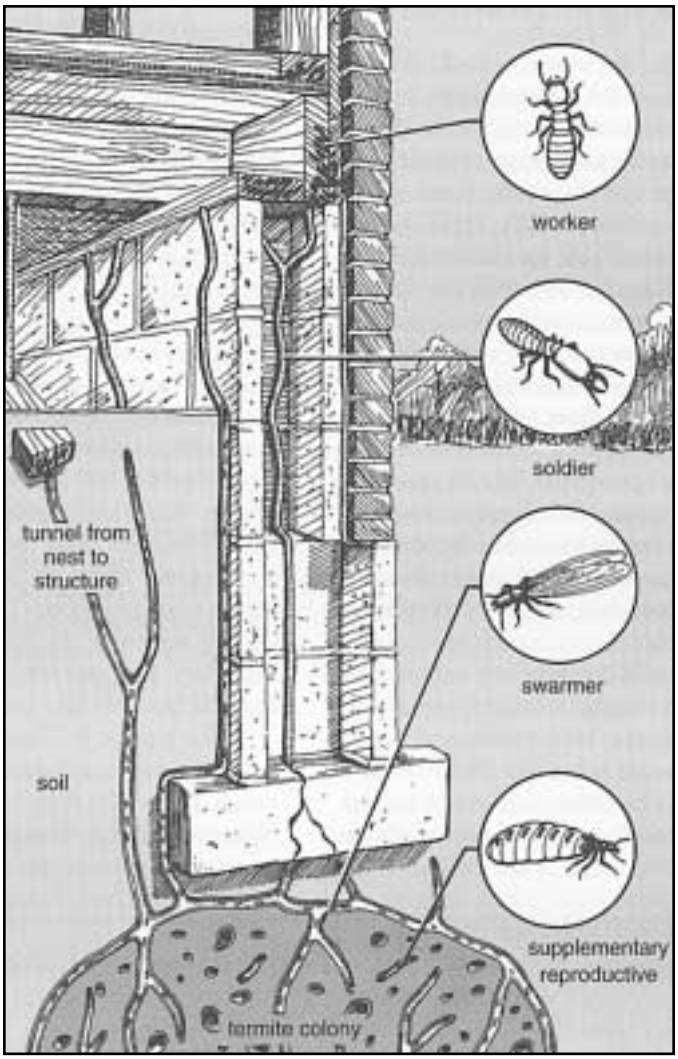

Figure 2.13. The environment of the subterranean termite.

On occasion, free-standing shelter tubes will be built straight down from the infested wood toward the ground if they are in a protected area, such as a crawl space under a house. This usually occurs after a colony has become well established and feeding has progressed some distance from the initial shelter tunnel. In this way, the colony can obtain the necessary moisture without having to travel great distances.

Figure 2.14. Free-standing shelter tubes.

The retention of moisture is not the only important factor associated with water 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 helps to promote the growth of the fungi.

The termite system is an extremely delicate and well-balanced system. Maintaining the proper levels of temperature and moisture is essential to the survival of the colony. The type of soil also has a great effect on the ability of subterranean termites to flourish. They generally prefer a sandy soil over a clay soil, though they will survive in many types of soil.

Communication in the Colony

Among social insects, communication is needed to maintain efficient social integration and division of labor. The most basic means of communication among termites is chemical (***pheromone***) communication. In fact, each colony develops its own characteristic odor. Any intruder, be it a termite from another colony, an ant, or any other natural enemy, is instantly recognized as foreign when it enters the colony. An alarm pheromone secreted by the colony triggers the soldier termites to attack and kill the intruder. The intruder is then walled off from the colony with fecal matter. If a hole in the termite workings occurs, it is immediately patched by the workers.

Sound is another means of communication. Termite soldiers and workers bang their heads rapidly on the surface of their mud tunnels or wood galleries when the colony is disturbed. The vibration of the surrounding surface is perceived by others in the colony and they, too, take up the banging activity. Like the alarm pheromones, this activity serves to mobilize the colony defenses.

One of the primary means of communication is ***trophallaxis***, which is 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. Termites exchange food from both the mouth and the hind gut. When termites shed their skin during moltings, they also lose their hind gut contents, including the protozoans they need for digesting wood. To get a new supply, they must feed from the hind gut of other colony members. The feeding of the queens and soldiers by the workers is also a form of trophallaxis.

Worker termites forage continuously for new sources of food. They also forage randomly in many locations throughout their foraging territory, looking for food. When a foraging termite worker finds a source of food, it recruits others to the food source by laying a chemical (pheromone) trail. The more foragers that find the food and return with it to the colony, the more intense the pheromone trail becomes. As the food source is depleted and the foragers no longer deposit the pheromone, the trail deteriorates and eventually is abandoned.

The proportion of the castes in the colony is also regulated chemically. For example, soldiers and reproductives produce chemicals that are distributed to other colony members by trophallaxis. The chemicals inhibit the production of additional soldiers and reproductives. Termites may react to a high level of soldier-produced chemical by killing some of the soldiers. Thus, the needs of the colony are met, and the proper balance of the various castes is maintained. In most subterranean termite colonies, nymphs can molt into workers, soldiers, or reproductives; workers can change into soldiers, nymphs, or supplementary reproductives; and nymphs that have begun developing wing buds may actually lose them with additional molts and return to the worker stage. All these changes are chemically regulated within the colony, depending on its needs.

OTHER TERMITES

Michigan's termite problem is basically caused by subterranean termites. The other groups of termites—drywood and dampwood—are found in the western United States and/or along the southern coastal areas from California to the Atlantic. Unlike subterranean termites, these other termites groups do not require contact with the soil for moisture. They are occasionally introduced into Michigan through furniture or other seasoned wood. A description of these other termite groups and control recommendations are given in case the pest control operator encounters them.

Drywood termites

Drywood termites differ from subterranean termites in three ways:

- Unlike subterranean termites, drywood termites bore directly into wood and make their nests in the wood rather than belowground.
- As drywood termites feed, they cut across the grain of wood, excavating large chambers that are connected by small tunnels.
- Drywood termites produce hard fecal pellets. These hard pellets have six distinct concave surfaces on the sides. These pellets are often pushed out of the colony through small holes in the wood.

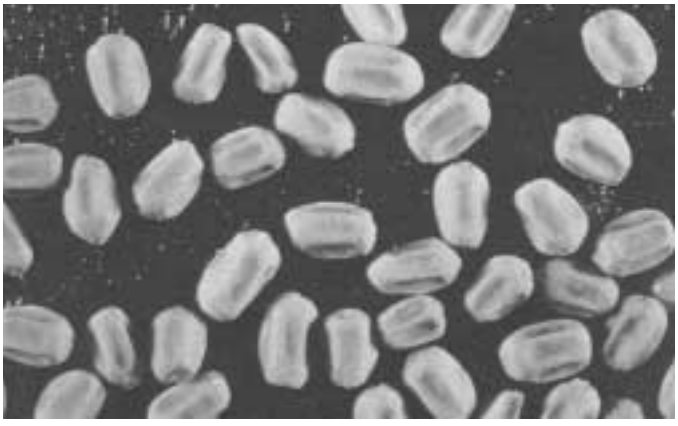

Figure 2.15. Drywood termite fecal pellets (approximate length 1/25 inch).

Powderpost termites are drywood termites that produce tiny fecal pellets resembling powder. The ejection of this material from the gallery is usually the first indication of the presence of powderpost termites. Powderpost termites are smaller than other drywood termites but excavate similar galleries and can be controlled by the same methods.

Drywood termites seldom infest buildings in Michigan. Furniture or other seasoned wood shipped from the western or southwestern parts of the United States may be infested with these termites.

Because drywood termites do not require any contact with the ground, treatment is quite different from that for subterranean termites. It consists of covering the structure (i.e., furniture or seasoned wood) with a tight tarpaulin or using a fumigation chamber and fumigating with a toxic gas. In minor infestations, a toxic liquid or dust may be introduced through holes drilled into the excavated chambers. Drywood termites may be killed by holding the infested furniture for 4 hours at 140 degrees F in a heat chamber. Exposing infested wood to 15 degrees F for 4 days will also kill these termites.

Dampwood Termites

Dampwood termites also do not require contact with the soil to obtain moisture, but they do require wood with a high water content. Dampwood termites excavate large galleries, as do drywood termites. But unlike drywood termites, they do not keep these galleries clean of their fecal pellets.

Species of dampwood termites are found along the Pacific Coast, in the southwestern United States, and along the Gulf Coast to Florida. Occasionally colonies may be carried to other parts of the United States, including Michigan, in shipments of lumber. However, dampwood termites are unable to become established in these areas.

Figure 2.16. Dampwood termites.

OTHER WOOD-DESTROYING INSECTS AND PESTS

Many other insects infest and seriously damage wood. Many of these, such as the various bark beetles and round- and flatheaded borers, are found alive most frequently in seasoned wood. The pest management professional is usually most concerned with those insects that damage seasoned lumber. These insects include representatives of the orders Hymenoptera (horntail or wood wasps, carpenter ants and bees) and Coleoptera (beetles). The members of these two orders develop by complete metamorophis, advancing from eggs to larvae, pupae, and adults.

The characteristics of the damage done to wood by these insects are generally sufficient evidence to identify the insects to their family, but positive identification to genus or species requires examination of the insect itself. Below is a brief description of the wood-destroying pests of primary interest to pest control operations in Michigan. A more thorough discussion of these pests, along with control recommendations, can be found in Chapter 6.

Powderpost Beetles

The term ***powderpost beetle***, used in the broad sense, applies to any of the wood-boring species of three closely related families (Lyctidae, Bostrichidae, and Anobiidae) within the superfamily Bostrichoidea. The common name is appropriate because the larvae of these beetles reduce timbers to a mass of very fine, powderlike material (see Fig. 2.17). The adults do very little actual damage to wood, serving primarily a reproductive function. There are certain differences in structure, behavior, and nutrition among these groups, and these differences have led to the separation of the families discussed in further detail in Chapter 6.

Longhorned Beetles

Longhorned beetles are large (1/2 to 3 inches long), conspicuous beetles with long, thin antennae that may be longer than their bodies. They usually lay their eggs on unseasoned, rough-sawn timbers or logs. The larvae, called roundheaded borers, feed in the wood, boring large, oval-shaped holes as they move through it. Infestation usually takes place before the timber is used in structures. The larvae of some species take more than one year to complete their development, so they may still be feeding in the wood after it becomes part of a structure. Damage is usually limited to pine sapwood and can be recognized by the ripples on the surface of the galleries.

The adult beetle will not lay eggs for reinfestation on this type of wood, so control is rarely called for. However, the exception to this is a species known as the **old house borer** (*Hylotrupes bajulus*) (see Fig. 2.18). Old house borers will attack timbers in a building, so they are the only longhorned beetles requiring control measures. The adult is about 3/4 inch long and grayish brown to black with two white patches on its wing covers.

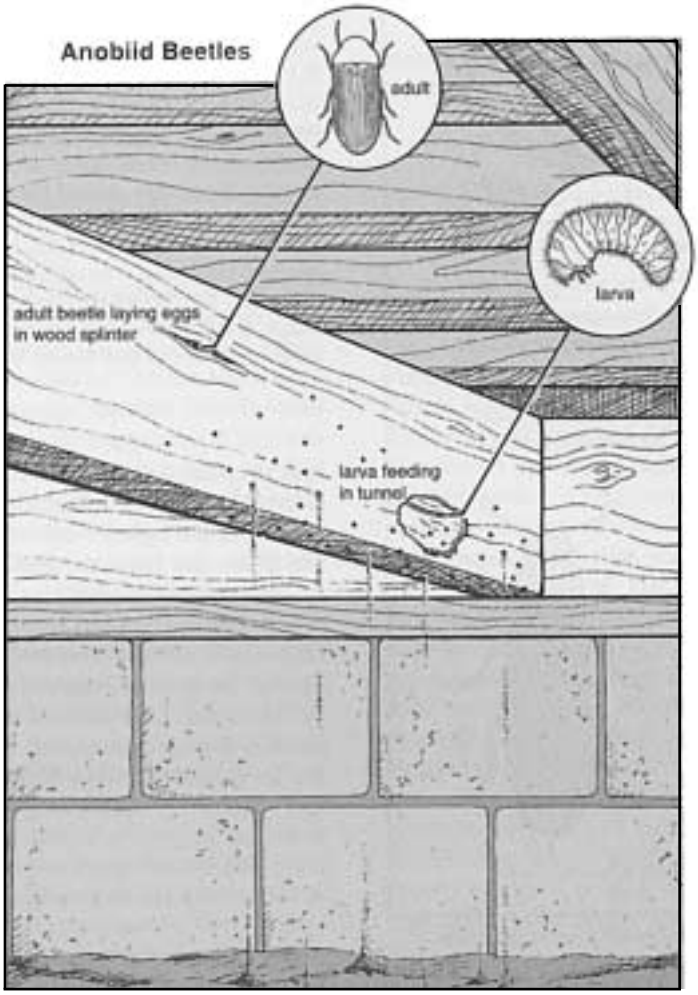

Figure 2.17. Powderpost beetles reduce timbers to a fine, powderlike material; hence their name. This illustration shows an adult and a larva from the Anobiidae family (Shuster and Provonsha).

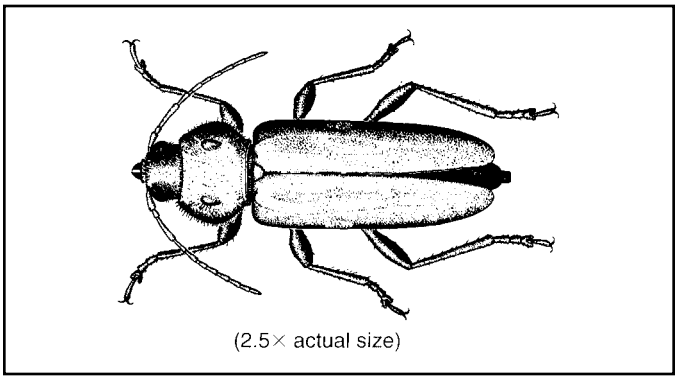

Figure 2.18. The old house borer, *Hylotrupes bajulus*, is one of the longhorned beetles of the family Cerambycidae (Provonsha).

Black Carpenter Ants

Ants of the genus *Camponotus* often nest in wood. There are probably many carpenter ant species in Michigan, but only one poses a major pest problem (the black carpenter ant (*Camponotus pennsylvanicus*). The black carpenter ant varies from 1/8 to 1/2 inch in length because of the presence in most colonies of both "major" and "minor" workers.

Carpenter ants may construct their nests in hollow trees, logs, posts, porch pillars, hollow doors, and other timbers used in homes. The ants do not consume the wood but simply hollow it out to form cavities for the nest. They are usually attracted to damp, decaying wood, but once the nest is started, they will also excavate sound wood as they enlarge the nest. It is often quite common to find them nesting in existing voids that require no excavation; occasionally they start in an existing void and enlarge it as their need dictates. The presence of carpenter ants suggests the potential for damage to wood.

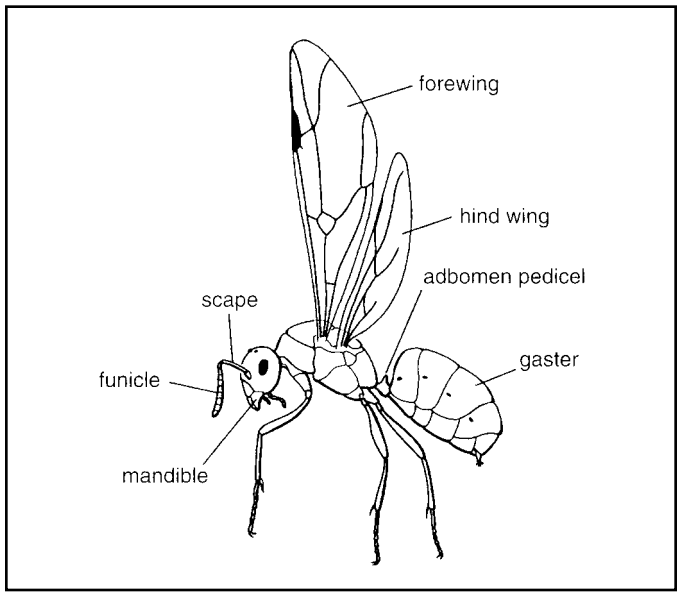

Figure 2.19. An illustration of an ant, showing body parts (Provonsha).

Carpenter Bees

The carpenter bee (*Xylocopa virginica*) resembles a bumblebee in that it is robust and black with some markings of yellow hair. The dorsal surface of the abdomen lacks the yellow hair markings of bumblebees and is mostly devoid of any hair.

These bees are considered pests of wood because they excavate tunnels in softwood as sites for producing their brood. Common nesting sites are posts, fence railings, porch support posts, wall siding, eaves, wooden shingles, windowsills, doors, wooden porch furniture, etc.

Wood-decay Fungi

Much of the structural damage attributed to subterranean termites may actually be the result of wood decay fungi. Favorable conditions for both pests are very similar. They both readily attack damp wood. Wood decay fungi occur only in wood with a moisture content greater than 20 percent. Most decay or rot fungi grow only on wood that is subject to wetting by contact with moist soil, rain, plumbing leaks, or condensation. Decay fungi take their food from the wood as they grow and reduce the strength of wood, often making it brown and crumbly or

white and stringy. Discoloration and powdery growth on wood should not be confused with decay. If the moisture content of the wood is not obvious, it must be measured with a ***moisture meter*** to accurately determine the need for treatment.

The use of fungicides alone will not stop wood decay once it has started, though it will slow its progress in some cases. The key to the complete control of wood decay is to eliminate the source of moisture, if possible, through proper drainage, breaking wood-soil contact, ventilation, the use of vapor barriers, and other good construction practices. A thorough discussion of wood-decaying fungi and methods for control can be found in Chapter 7.

KEY TO INSECT DAMAGE OF WOOD-DESTROYING PESTS

1. In processed wood, numerous small holes less than 3/8 inch in diameter. If the piece is split open, many frass-filled tunnels can be seen, most of them running with the grain. .....**Powderpost beetles**
   - Exit holes 1/16 to 1/8 inch in diameter. More advanced galleries running across the grain. Frass consists in part of distinct elongate or bun-shaped pellets. In hard- and softwoods. .....**Family Anobiidae**
   - Exit holes vary from 1/8 to 3/8 inch in diameter. Occasional tunnels go across the grain but mostly with the grain. Fine or coarse frass that tends to stick together; few if any pellets. In hardwoods such as ash, oak, and hickory; sometimes in softwoods .....**Family Bostrichidae**
   - Exit holes 1/32 to 1/16 inch in diameter in newer or poorly seasoned hardwood lumber. (Common in poorly seasoned lumber.) Frass in tunnels is loose and powdery and contains no pellets. .....**Family Lyctidae**
2. In either processed wood or rough timber, occasional holes, round or elliptical, 1/4 to 1/2 inch in diameter. Irregular and rather extensive tunnels in the sapwood with usually coarse, packed frass. .....**Longhorned beetles**
   - Usually heavy damage of this sort in finished wood. Often the only external evidence of damage is one or two oval exit holes .....**Old house borer**
3. In rough, bark-covered wood, small exit holes about 1/8 inch in diameter. Inner side of bark and surface of wood itself "engraved" with galleries (old damage; can't reinfest dried wood; no control required). .....**Bark beetle**
4. Pinholes and slender galleries in sapwood, frequently of southern yellow pine. The burrows and area around them stained dark by the action of fungi (old damage, can't reinfest dried wood; no control required). .....**Ambrosia beetle**
5. No openings (or very few and these are usually sealed over). Extensive galleries run lengthwise, usually in the springwood, and are packed with a hard, mastic-like frass. May infest many old cellulose objects near or in contact with the soil. .....**Subterranean termites**
6. Distinct round openings to outside of wood; when split open, it reveals very thorough excavation. Galleries contain considerable amounts of coarse, hard, sandlike frass, each pellet having rounded ends and six longitudinal depressions. No mastic-like frass or very fine powder. .....**Drywood termites**
7. Timbers with extensive galleries that are sandpaper smooth, often with rounded edges, and contain no frass. Coarse sawdust may be found near damage. .....**Carpenter ants**
8. Wood with 1/3- to 1/2-inch round holes on side, edge or end, leading into long tunnel (3 to 24 inches). If hole is on side of wood, tunnel turns at right angles and continues with the grain of the wood. .....**Carpenter bees**

Adapted from a release by Department of Entomology, Purdue University, West Lafayette, Ind.

SUMMARY

The class Insecta belongs to the phylum Arthropoda, which includes other non-insect classes (spiders, mites, centipedes, crabs, etc). Insects are distinguished from other arthropods in that they do not keep the same appearance as they grow. Instead, they undergo a ***metamorphosis*** or a change in body shape as they develop from one stage to another.

Termites belong to the insect order Isoptera and undergo gradual metamorphosis. There are several termite species in the United States, but only the eastern subterranean termite (*Reticulitermes flavipes*) is a significant termite pest in Michigan. Four castes develop among termites, with each caste having a specific role in the establishment, defense, reproduction, and maintenance of the colony. It is important that the pest management professional understand termite biology, behavior patterns, and environmental requirements so that the appropriate pest control technique can be applied.

Other wood-destroying pests of economic importance in Michigan include powderpost beetles, longhorned beetles, carpenter ants, carpenter bees, and decay fungi. The pest management professional must become familiar with the damage caused by these pests to properly identify them.

CHAPTER 2

Review Questions

Chapter 2: The Biology of Termites and 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. On which segment of an insect's body are the legs and often the wings attached?
   A. Thorax
   B. Head
   C. Abdomen
   D. Antennae

2. Termites develop by:
   A. Simple metamorphosis.
   B. Gradual metamorphosis.
   C. Complete metamorphosis.
   D. Parthenogenesis.

3. What are the stages of development for insects that undergo complete metamorphosis?
   A. Egg, nymph, adult
   B. Egg, larva, pupa, adult
   C. Egg, nymph, larva, adult
   D. Egg, larva, adult
   E. Egg, nymph, pupa, adult

4. Which is the most commonly found termite in Michigan?
   A. Dampwood termite
   B. Drywood termite
   C. Formosan subterranean termite
   D. Powderpost termite
   E. Eastern subterranean termite

5-16. Match the following to the appropriate description for each termite caste.

A. Primary reproductives
B. Supplementary reproductives
C. Workers
D. Soldiers

____ 5. The most numerous in the termite colony.
____ 6. Have functional wings.
____ 7. Started the original colony.
____ 8. Have large reddish brown heads.
____ 9. May have short, non-functional wings.
____ 10. Creamy white, wingless, eyeless, and soft-bodied.
____ 11. The most responsible for causing damage to wood in structures.
____ 12. Leave the colony in swarms usually in the spring or fall.
____ 13. Gather at openings to protect the colony.
____ 14 May establish a new colony without swarming.
____ 15. Usually become the most important source of eggs for the colony.
____ 16. The most responsible for making tunnels and repairs and for foraging, feeding, and grooming other castes.

17. The first batch of eggs laid by the queen in a new subterranean termite colony contains:
   A. 6 to12 eggs
   B. 50 to 75 eggs
   C. 100 to 150 eggs
   D. 200 to 300 eggs

18. How long before a newly established termite colony will seriously damage structural wood?
   A. 1 to 2 weeks
   B. 4 to 6 months
   C. 2 to 3 years
   D. 5 to 10 years

19. Termites are more prevalent in _____ soils.
   A. Clay
   B. Silty
   C. Sandy
   D. Gravel

20. Termites can enter structures through:

A. Cracks in concrete
B. Utility openings
C. Expansion joints
D. Wood below soil level
E. All of the above

21. Which is true about termite colony formation by budding?

A. Budding occurs when primary reproductives leave a newly formed colony in swarms to establish a new colony.
B. Budding occurs when termite workers and soldiers leave a well established colony in swarms to establish a new colony.
C. Budding occurs when a number of individuals, including some supplementary reproductives, leave a well established colony to start a new one.
D. Budding occurs when primary reproductives are isolated from a well established colony to start a new colony.

22. Subterranean termites cannot survive without:

A. Adequate moisture.
B. Clay soils.
C. Light.
D. Clean air.
E. All of the above.

23. Describe why the termite nest system must be "well balanced."

24. Which are means of communication within the termite colony?

A. Pheromone signals
B. Head banging
C. Trophallaxis
D. A & C
E. All of the above

25. How are chemical pheromones used within the termite colony?

A. To indicate the location of food sources.
B. To mobilize colony defenses.
C. To transfer new supplies of cellulose-digesting protozoans.
D. A&B
E. All of the above.

26. How is trophallaxis used within the termite colony?

A. To regulate the number of members of a particular caste within the colony.
B. To transfer new supplies of cellulose-digesting protozoans.
C. To mobilize colony defenses.
D. A&B
E. All of the above

27-30. Match the following to the appropriate description.

A. Drywood termite
B. Dampwood termite
C. Powderpost termite
D. Subterranean termite

27. _____ Make nests by boring into wood; fecal pellets have six distinct concave surfaces on sides.
28. _____ Require wood with a high moisture content but do not require contact with the soil.
29. _____ Usually require contact with the soil for moisture.
30. _____ Live in dry wood and produce tiny dust like fecal pellets.

31. Which would be a treatment for drywood termites?

A. Heat chamber for 4 hours at 140 degrees F.
B. Soil treatment with insecticides.
C. Expose termites to 15 degrees F for 4 days.
D. Install metal termite shield.
E. A & C

32-37. Match the following to the appropriate description.

A. Powderpost beetles
B. Longhorned beetles
C. Carpenter ants
D. Carpenter bees
E. Wood decay fungi

32. _____ Excavate tunnels in softwood; black with yellow hair.
33. _____ Occur only in wood having a moisture content greater than 20 percent.
34. _____ Construct nests in wood but do not consume it; live in colonies.
35. _____ Damage usually limited to pine soft wood; recognized by ripples on the surface of the galleries.
36. _____ Consist of three families; larvae (not adults) do most of the damage to wood.
37. _____ Larvae are called roundheaded borers and feed on wood, doing most of the damage.

38. The most common structural pest in the longhorned beetle family is the:

A. Bronze birch borer.
B. Old-house borer.
C. Cherry-shelf borer.
D. Powderpost beetle.

39. What is the best method for controlling wood decay fungi?

A. Use fungicides.
B. Eliminate moisture sources.
C. Eliminate insect
D. Fumigate