

Chapter 10

BASIC ENTOMOLOGY



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Chapter 10

Basic Entomology

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I. Introduction

The animal kingdom contains many distinct groups called phyla. Each phylum is divided into a number of classes. The insects are in the class Insecta (or Hexapoda—“six feet”) within the phylum Arthropoda (jointed foot). The insect class is further divided into orders, families, genera, and finally, species.

Approximately 1 million species of insects have been identified to date. The greatest numbers of these species belong to the beetle, fly, and wasp-bee-ant groups. We generally associate insects with crop loss or disease transmission; however, insects fulfill a useful function in our environment.

Only a small percentage of insects are considered pests of humans and of their animals, crops, or fiber. However, this small number can cause serious crop losses, or transmit serious diseases to humans or animals.

Most insects appear to be beneficial or harmless. Many are predators, such as lady beetles, which live by feeding on pestiferous aphids. Others are parasitic, such as the wasps. Still others, such as honey bees, act as pollinators of crops and also provide us with honey. Many insects are responsible for the decomposition of plant and animal matter. A good example is the carpenter ant. Obviously, when it is attacking the timber of our home it is a pest, however, when it is in the forest mining the wood of old, fallen trees, it is part of nature's recycling program.

Size is quite variable throughout the insect world. The extremes include tiny wasps that are less than a milli-

meter long, and some of the larger long-horned beetles that are as much as 6 inches long.

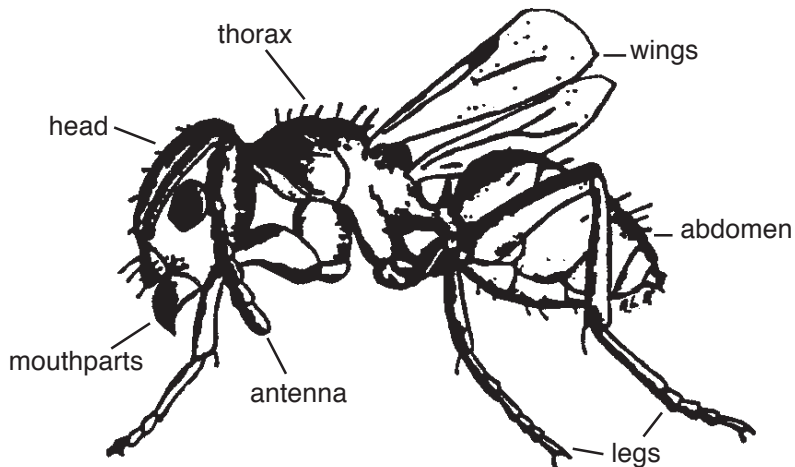
Except for a few common structural features, insects are also variable in appearance. Some have bizarre horns and spines, while others may resemble dead leaves. Some insects are quite attractive like the butterfly, but “beautiful” is hardly the word for a cockroach.

All of this makes insects a fascinating group to investigate, but it also makes the study of insects and their classification somewhat complex. It is important to learn the main differences among insects, so that we can distinguish one group from another. Then we can suggest adequate control procedures and give quality management suggestions.

II. Insect Anatomy

Insects are animals, however, unlike many animals, they have no backbones. They have an **outer** skeleton (**exoskeleton**) instead of the inner skeleton (**endoskeleton**) of most large animals. The following characteristics separate insects from other animals (Fig. 1).

Fig. 1. Parts of an insect.



- A. Insects have three body regions—Head, thorax, and abdomen.
- B. Many adult insects have wings, and insects are the only flying invertebrates.
- C. Adults possess three pairs of legs, all located on the thorax.

III. Insect Development

All insects change during growth by a process called metamorphosis (Fig. 2). Insect near-relatives such as spiders, mites, and centipedes also undergo metamorphosis.

The more highly developed insects make the most complete changes. Beetles, moths, butterflies, wasps, and ants all go through four stages. These are the egg, larva, pupa, and adult. The larva is usually the damaging stage, although adult feeding can be destructive.

Also, it is not unusual for the larval and adult stages of a species to feed on different hosts or different parts of the host. The pupa is a nonfeeding stage; in most cases it is also very inactive.

The lower forms or less-developed kinds of insects change only slightly during metamorphosis. True bugs, aphids, grasshoppers, termites, earwigs, stoneflies, etc., go through only three stages. These stages are the egg, nymph, and adult. Except for size, the nymph and adult closely resemble each other. The major difference is the lack of fully formed wings in the nymph. The nymph and adult generally feed on the same host or host parts.

IV. Insect Classification

There are several methods of separating or categorizing insects.

- A. The professional uses body parts for identification and observes differences in these parts through a microscope. He or she tracks down an insect's identity by using a written insect "key." The anatomy of an insect will place it into a specific insect group called an **order**. If you are around entomological ac-

tivities much, you will often hear the phrase "keying out." This simply means identifying the insect (see MS 109 in "Further Reading").

- B. Insects are also classified by the type of damage they cause. Some examples include "root maggot," "twig girdler," or "crown borer." Destructive insect activities help narrow down the multitude of possible identities and often make insect identification quicker and simpler.

- C. Some insects can be categorized as predators or parasites. Predators and parasites account for much of the reduction of pest insect populations in nature, and, for this reason, are also called beneficials (see PNW 343 in "Further Reading").

Beneficials can be useful, but they usually need some cultural encouragement. Their use requires careful crop management and a degree of tolerance for some crop loss.

1. Predators kill and feed on their prey; they are generally larger than their prey.
2. Parasites are usually smaller and often weaker than their prey; they gradually kill by injecting eggs that develop on, within, or near the insect over a period of time. They may sting and paralyze their prey in order to stock their nests with food for the developing larvae or eggs. The immature parasites will then consume the paralyzed insect at their leisure.

- D. Another form of categorization is by feeding mechanism or mouthpart. The broadest grouping is defined by chewing or sucking mouthparts (Fig. 3).

Fig. 2. Metamorphosis stages in insects.

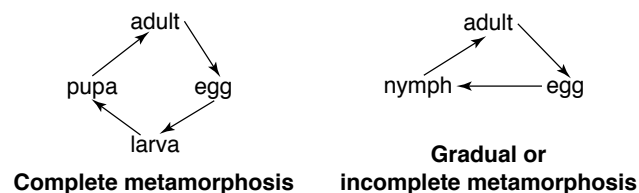
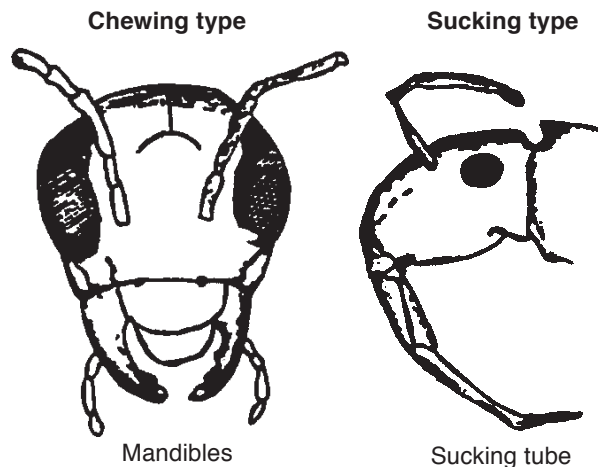


Fig. 3. Insect feeding mechanisms.



Although this manner of separation is somewhat helpful for identification, its greatest value is in determining if a certain kind of pesticide will work. For example, systemic insecticides “generally” do not work as well on chewing insects as on sucking insects. Proper identification is extremely important. If a beneficial insect or a nondamaging insect is improperly identified as a pest, a pesticide application will usually disrupt a natural control agent. The disruption of this beneficial’s activity may induce the need for the chemical. Chances are you may have made an application that did no more for you than cost you money.

Note: Do not make recommendations based on the verbal description of a pest by a client. Too many misidentifications are made this way, and wrong identification leads to ineffective control measures and unnecessary expense or problems. Insist on seeing the pest, or at least its damage, before you volunteer anything.

V. Major Orders of Insects

Major insect groupings under the class level are called orders. Some representatives that you will see are: beetles—Coleoptera; moths and

butterflies—Lepidoptera; flies—Diptera; bees, ants, wasps, hornets—Hymenoptera; true bugs, such as stink bugs—Hemiptera; aphids, scales, and leafhoppers—Homoptera; grasshoppers, crickets, and cockroaches—Orthoptera; termites—Isoptera; earwigs—Dermaptera. There are many other insect orders, but these are representatives of economic importance.

Separating groups of insects may be quite difficult unless you have closely studied examples of the various types. It is important to recognize the structural characteristics that distinguish one insect from another (see “Further Reading”). Use all of the characteristics listed in Table 1 to distinguish each order.

A. Beetles and Weevils—Coleoptera

Some of the typical beetles that you may see are long-horned beetles and flatheaded borers that bore into trees, logs, and lumber. These beetles are variable in color. Long-horned beetles usually have long antennae and are strong fliers. Lady beetles are about 1/4-inch long and are usually red or orange, generally with spots. Lady beetles are beneficial as larvae and adults, since they feed on aphids and other soft-bodied insect and mite pests. Some other common beetles are the pea weevil, an important pest of peas, and click beetles, whose larvae are known to some of you as wireworms.

Table 1. Major order of insects.

Name of order	Common examples	Wings/mouthparts
Coleoptera	Beetles, weevils	2 pairs wings or wingless; chewing
Lepidoptera	Moths, butterflies	2 pairs wings; chewing (larvae), sucking, or siphoning (adults)
Diptera	Mosquitoes, flies, and gnats	1 pair wings; chewing (larvae), piercing-sucking, or sponging (adults)
Hymenoptera	Wasps, bees, ants, and sawflies	2 pairs wings or wingless; chewing
Hemiptera	Bed bugs, stink bugs, and cinch bugs	2 pairs wings; piercing-sucking
Homoptera	Aphids, leafhoppers, scales, mealybugs	2 pairs wings or wingless; piercing-sucking
Orthoptera	Grasshoppers, crickets, and cockroaches	2 pairs wings or wingless; chewing
Isoptera	Termites	2 pairs wings or wingless; chewing
Dermaptera	Earwigs	2 pairs wings or wingless; chewing
Thysanura	Silverfish, firebrats	Wingless; chewing
Thysanoptera	Thrips	2 pairs wings or wingless; rasping-sucking
Collembola	Springtails	Wingless; chewing
Psocoptera	Barklice, booklice	2 pairs wings or wingless; chewing
Mallophaga	Chewing lice	Wingless; chewing
Anoplura	Sucking lice	2 pairs wings or wingless; piercing-sucking
Siphonaptera	Fleas	Wingless; chewing (larvae), piercing-sucking (adults)

1. Adults have a hardened, horny outer skeleton.
2. Adults have two pairs of wings; the outer pair is hardened, and the inner pair membranous.

Note: A few beetles are practically wingless, and some have only an outer hard pair of wings.

3. Beetles have chewing mouthparts.
4. Adults usually develop noticeable antennae.
5. Coleoptera larvae have a head capsule and three pairs of legs on the abdomen.

Note: Weevil larvae lack legs on the thorax.

6. Both beetles and weevils go through a complete metamorphosis as in Fig. 4.
7. Some authorities consider the beetles to be the largest group or order of insects in nature.

B. Moths and Butterflies—Lepidoptera

The moth and butterfly group has several damaging members. Cutworms damage many crops. For example, corn earworm larvae, which are greenish or tannish with some stripes and about 1 1/4-inch long when fully grown, cause severe damage to corn and attack a variety of vegetables.

Alfalfa, celery, and cabbage loopers have injurious larvae. They are often known as measuring worms because of their looping action, which gives the impression that they are measuring the plant on which they are feeding.

Another Lepidoteran is the codling moth, which does damage to apples. The peach twig borer is a severe pest of peaches, prunes, plums, and apricots.

1. Adults are soft-bodied with four well-developed, membranous wings covered with small scales.
2. Adult mouthparts consist of a coiled, sucking tube; adults feed on nectar and other liquids.
3. The larvae are caterpillars that are worm-like, and variable in color; they are voracious feeders.
4. The larvae have chewing mouthparts.
5. The larvae have true legs on the thorax and a variable number of prolegs on the abdomen.
6. Lepidopterans undergo complete metamorphosis as in Fig. 5.

C. Flies, Mosquitoes, Gnats, Midges—Diptera

Flies are an important group in terms of their medical effects on humans and animals. Some, such as bot flies, are parasites as immatures on mammals. Some flies, such as the face fly, disrupt or annoy livestock, causing the cows or other animals to stop feeding. Fly maggots or larvae are generally found in manure or other decaying matter.

The flies most commonly encountered are the housefly, the lesser house fly, and the face fly. The grayish adults infest homes, poultry houses, and livestock. The house fly has been suspected of mechanically transmitting such diseases as polio to food surfaces.

Fig. 4. Metamorphosis of a beetle.

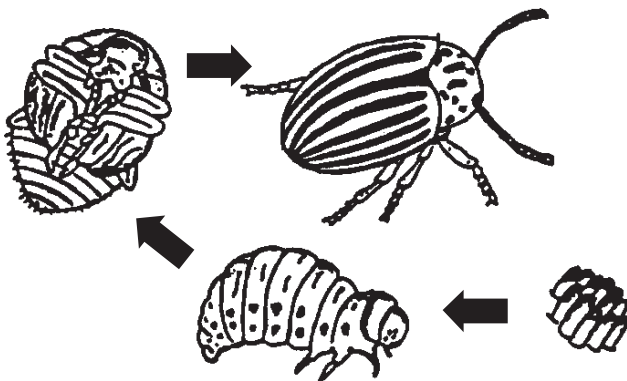
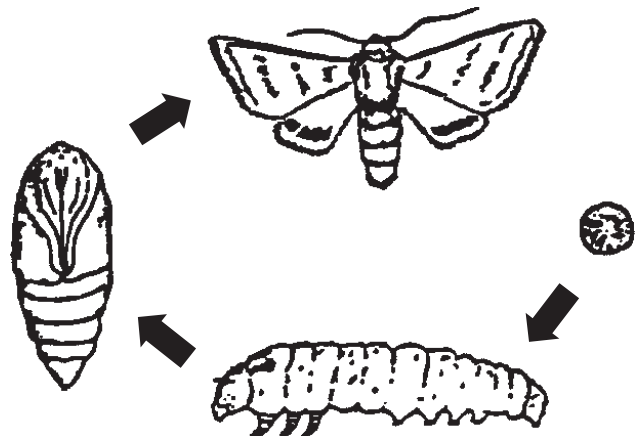


Fig. 5. Metamorphosis of a moth.



Commercial agricultural insect pests in this order include the cherry fruit fly, walnut husk fly, onion and cabbage maggot, and carrot rust fly. Others are often disease vectors, such as mosquitoes or deerflies. Vectors can transmit such diseases as malaria. Mosquitoes are small, slender, long-legged, frail flies. The larvae are elongate and live in water. The adult female is the injurious stage. She feeds by sucking human and live-stock blood by piercing the skin with her long stiletto-like mouthparts.

1. Adults have only one pair of wings and are rather soft-bodied and hairy.
2. Adults have sponging (house fly) or piercing (mosquito) mouthparts.
3. Diptera larvae may have mouth hooks or chewing mouthparts.
4. Most larvae are legless.
5. The larvae of advanced forms, such as the house fly and relatives, have no head capsule, possess mouth hooks, and are called maggots. Lower forms such as mosquito larvae and relatives have a head capsule.
6. Diptera undergo complete metamorphosis as in Fig. 6.

D. Bees, Wasps, Ants, Sawflies, etc. — Hymenoptera

This group is a large one. Many of its members are important pollinators of agricultural crops, such as the honeybee, leafcutter bee, and alkali bee. Some are important predators, parasites, and scavengers; others are injurious to humans and their crops.

1. Pear slug—The adult is black with yellow markings. The larva is small, slug-like, and feeds on leaves of pear, cherry, and plum.
2. Yellowjackets—The adults have black and yellow markings. They build nests in the ground, or papery structures on trees or under eaves. Their stings are painful and dangerous if you are allergic to them. Many species are beneficial predators.
3. Leafcutting bees—These are small- to medium-sized bees, variable in color. They are noted for their long tongues. One species is an excellent alfalfa pollinator. Leafcutters may defoliate some trees and shrubs.
4. Common ants—Several ants, such as the carpenter ants and the house ants (including the pavement ant and odorous house ant), are in this group. Many are beneficial predators or decomposers.
 - a. The adults have two pairs of membranous wings.
 - b. The adults generally have chewing mouthparts.
 - c. The adults are rather soft-bodied or have slightly hardened bodies.
 - d. The larvae have no legs (wasps, bees, ants) or have legs on the thorax and the abdomen (some sawflies).
5. Hymenoptera undergo complete metamorphosis as in Fig. 7.

E. True Bugs—Hemiptera

Conspire stink bug—A gray or brownish plant bug that is shield shaped. The stink bug feeds on many fruits and vegetables.

Fig. 6. Metamorphosis of a fly.

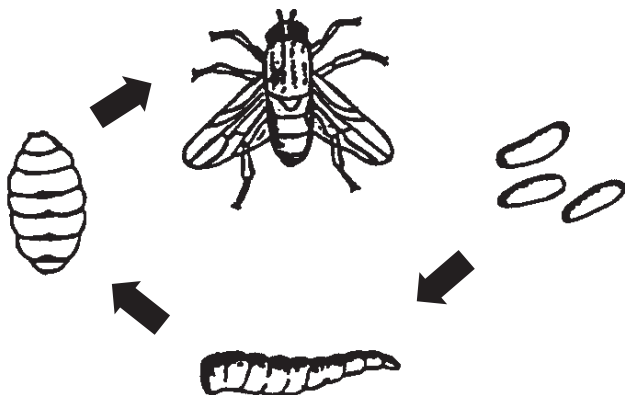
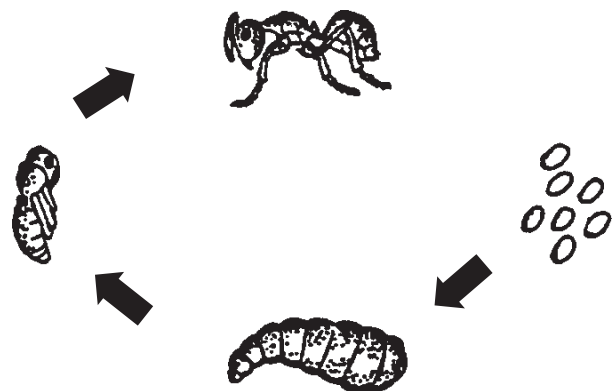


Fig. 7. Metamorphosis of an ant.



1. Boxelder bug—This bug is gray-brown to black with red lines on the under surface and on the lower portion of the outer wings. It feeds primarily on boxelder and can invade homes in early summer or fall.
2. Lygus bug—These bugs are greenish, or brownish black and occasionally yellowish or gray; they are rather slim plant bugs about 1/4-inch long. The head is blotched with black. They are probably the most injurious bugs of seed crops in the United States.
 - a. The adults have two pairs of wings; the second pair is membranous, the first pair is membranous and thickened on the basal half. The nymphs are not fully formed and are called “wing pads.”
 - b. Adults and nymphs usually resemble one another.
 - c. True bugs have piercing-sucking mouthparts.
 - d. Adults and nymphs both are damaging stages.
 - e. True bugs have a gradual metamorphosis (Fig. 8). The stages are egg, nymph, and adult.

F. Aphids, Scales, Leafhoppers, Cicadas—Homoptera

1. Aphid—There are many types, sizes, and shapes of aphids. The giant willow aphid is a large, black species. The pea aphid is a rather large, green species found on alfalfa, peas, clover, sweet clover, and other herbaceous legumes. It may also be pinkish in color. Several species of aphids attack vegetable and tree crops,

including the green peach aphid, which carries the leaf roll virus of potatoes and sugarbeets. The rose aphid, both green and brown forms, are found on many ornamentals. Apple aphids, and green, rosy, and woolly aphids all cause severe damage to apples.

2. Scales—Scale insects are usually quite small and are usually circular or football-shaped. During most of their life cycle, they are protected by a hardened scale covering. San Jose scale is a pest of many fruit trees and ornamentals. Oyster shell scale is a brown cornucopia-shaped scale (horn of plenty) found on ornamental trees and shrubs. Lecanium scale is a large, brown, hemispherical-shaped scale found on trees and woody plants of several types.
 - a. These insects are generally small and soft-bodied, though cicadas are larger and hard-bodied.
 - b. Members may be winged or wingless.
 - c. All stages have sucking mouthparts.
 - d. Many members are carriers of plant pathogens.
 - e. Homopterans have a gradual metamorphosis as the aphid in Fig. 9.

G. Grasshoppers, Crickets, Cockroaches, Camel Crickets—Orthoptera

Some examples of grasshoppers and their allies are migratory and two-striped grasshoppers and the red-legged grasshopper. These are damaging pests of crops and rangeland. The camel cricket, the Jerusalem cricket, and the German roach are also commonly encountered. Crickets also can damage crops. The German cockroach is a metropolitan pest.

1. Adults are moderate to large and are often rather hard-bodied.

Fig. 8. Metamorphosis of a bug.

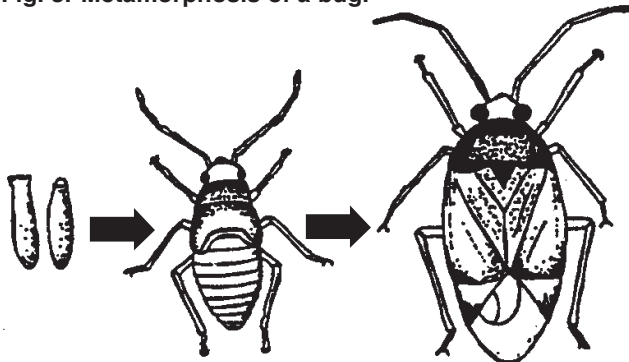


Fig. 9. Metamorphosis of an aphid.

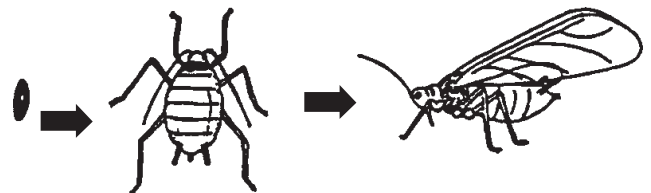
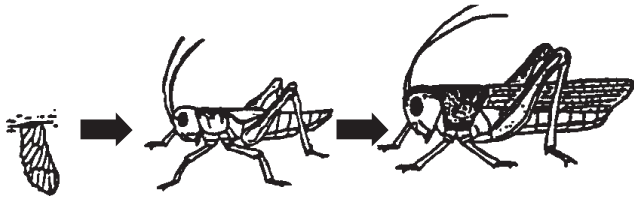


Fig. 10. Metamorphosis of a grasshopper.



2. Adults usually have two pairs of wings. The forewings are elongated, narrow, and leathery; the second pair of wings are membranous with an extensive folded area.
3. Adults and nymphs have chewing mouthparts and are damaging.
4. The hind legs of forms other than cockroaches and walking sticks are enlarged for jumping.
5. Immature stages are called nymphs and, except for being wingless, resemble adults.
6. Orthopterans have a simple metamorphosis as in Fig. 10.

H. Termites—Isoptera

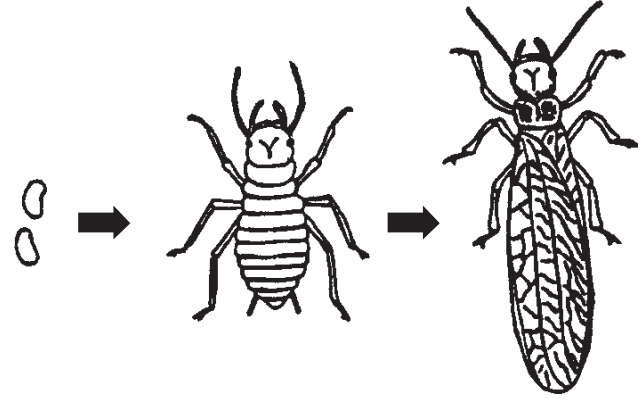
The injurious termites are generally placed in two groups: the dampwood and subterranean types. Both feed on wood and wood products. The dampwood types are usually not primary feeders on sound wood in buildings, while the subterranean types are found in large numbers in sound structures where they may do considerable damage if not detected early and controlled quickly. Colonies of the subterranean type must have a connection with soil to obtain moisture.

1. These are so-called “white ants.”
2. Termites are distinguished from true ants by their thick “waists” and their white or light brown color.
3. Termites have thin, straight antennae; ants have elbowed antennae.
4. Termites have chewing mouthparts.
5. They possess many forms or castes such as a worker, soldier, and queen.
6. Termites have a gradual metamorphosis as in Fig. 11.

I. Earwigs—Dermaptera

The European earwig is our only species of earwig. It is occasionally a pest of gardens,

Fig. 11. Metamorphosis of a termite.



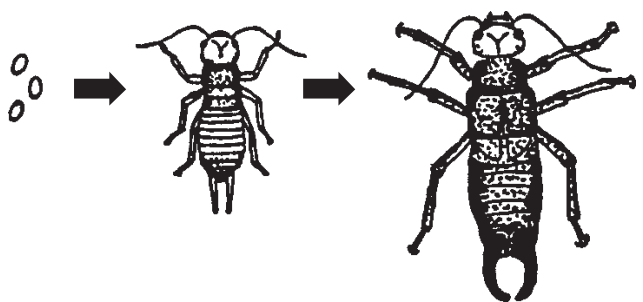
ornamentals, small trees, and houses throughout the state of Idaho, but it may also be beneficial since it often preys upon other insects.

1. Adults are moderately sized.
2. They have chewing mouthparts.
3. Earwigs are elongated, flattened and have strong, movable forceps on the rear end.
4. They have short, hardened outer wings and cover folded, membranous inner wings.
5. Earwigs have a gradual metamorphosis (Fig. 12).

J. Thrips—Thysanoptera

1. Thrips are small with sucking mouthparts that are assisted by a single mandible that aids in rasping the plant tissue.
2. Wings may be present or absent. If present, they are long and narrow and fringed with long hairs.
3. Many feed on ornamentals and some on vegetable crops such as peas and onions. Many are predators on other insects. A few species bite humans.
4. Thrips have a gradual metamorphosis.

Fig. 12. Metamorphosis of an earwig.



K. Silverfish and Firebrats—Thysanura

1. Group members have chewing mouthparts.
2. Thysanura is one of the few insect orders whose members do not possess wings.
3. These insects have bristles on the tip of the abdomen.
4. They are household pests and feed on such items as paste, paper, and crumbs.
5. They have a gradual metamorphosis.

L. Springtails—Collembolla

1. Springtails are minute insects with chewing or piercing mouthparts.
2. They possess an appendage on their ventral (under) side; it operates as a spring to aid the insect in quick escape.
3. These insects are abundant in moist areas, hence the reference to “moving piles of soot” in backyards during the wetter seasons.
4. They feed on decaying organic material primarily but will on occasion attack plants, particularly in greenhouses.
5. Springtails undergo a gradual metamorphosis.

M. Other Orders

Many other insect orders are of no real concern in the home garden. Some of the more common ones are stoneflies—Plecoptera; caddisflies—Trichoptera; dragonflies and damsel flies—Odonata; and mayflies—Ephemeroptera. These orders are all associated with aquatic habitats.

Some others you should be aware of include the nerve-winged insects—Neuroptera,

many of which are beneficial predators; book or bark lice—Psocoptera, basically scavengers, but with some species that are stored-products pests; animal lice and sucking lice—Anaplura; and chewing lice—Mallophaga.

VI. Other Insect-Like Creatures

Several noninsect pests may be found in the field and home and include those listed in Table 2.

A. Spider Mites, Spiders, Ticks, and Scorpions—Arachnida

1. Spider mites—These tiny, soft-bodied animals have two body regions, thick waists, four pairs of legs, and are without antennae. Common species include the following.
 - a. The two-spotted spider mite and its near relatives, the Pacific, Atlantic, and McDaniel spider mites. These mites have two spots on the back and have tail-end spots in some species. They may be clear, green, orange, or red. They are usually hard to observe without a hand lens.
 - b. European red mite: This mite is carmine red with white spines.
 - c. Brown mite and the clover mite: These mites are brownish or grayish, flat, and have very long front legs.
2. Spiders—Spiders resemble mites except that most are larger and the two body regions are more clearly distinct from one another (thin waist). Most spiders are beneficial predators. Common pest species include:

Table 2. Noninsect pests.

Class	Example	Description
Arachnida	Spiders, ticks, mites, scorpions	4 pairs legs; 2 body regions—cephalothorax and abdomen; no antennae; chewing or sucking mouthparts
Chilopoda	Centipedes	15 or more pairs of legs with only 1 pair of legs per body segment; 1 pair of antennae; 2 body regions—head and trunk; body flattened; chewing mouthparts; fast moving
Diplopoda	Millipedes	2 pairs of legs per apparent body segment; 1 pair of antennae; 2 body regions—head, trunk; body rounded; chewing mouthparts; slow moving
Crustacea	Sowbugs, pillbugs	1 pair of legs per body segment; 1 pair of antennae; 2 body regions—head and trunk; chewing mouthparts; roll into ball when disturbed
Symphyla	Symphylan, garden centipede	11 or 12 pairs of short legs; centipedelike animals

- a. Black widow spider: Shy and likes dank, dark places. This spider spins a characteristically messy web. It is normally a shiny black, moderately sized spider with a reddish or orange hour-glass marking on the underside of the abdomen. Males and immature females can have stripes of red, yellow, and black on the abdomen.
 - b. The hobo spider, sometimes called the aggressive house spider: Is a common light brown spider that is often found in basements. This spider has a painless bite, but sometimes the skin sloughs off in the bite area.
 - c. The brown recluse spider: A poisonous spider which, fortunately, does not occur in the Pacific Northwest, however, it is a potential threat. It is often confused with harmless wolf spiders and other hunting spiders. The brown recluse spider can be recognized easily by a distinct, brown “fiddle case” on a light brown or grayish background.
3. Ticks—Ticks resemble large mites and are important in agriculture and medicine. They are parasites of humans and animals.
- B. Millipedes—Diploda
- Millipedes are generally inoffensive creatures that feed on fungi and decaying plant material. At times, they can be fairly destructive to vegetables or other plants in greenhouses. They are elongate invertebrates with two visible body regions: a head and a body. They generally are rounded in cross section. With the exception of the first four or five segments, all of the body segments possess two pairs of legs. They are relatively slow moving.
- C. Centipedes—Chilopoda
- Centipedes strongly resemble millipedes. They are different in that they have longer antennae, are flattened in cross section, have only one pair of legs on each body segment, and move rapidly. They are beneficial because they prey on other arthropods.

D. Sowbugs and Pillbugs—Crustacea

Sowbugs are highly dependent on moisture, which accounts for their common association with damp habitats. Generally, they feed on decaying plant material, but they will attack young plants in greenhouses and gardens. They are oval with a hard convex outer shell made up of a number of plates.

E. Garden Centipede or Symphylan—Symphla

Members of this group resemble tiny centipedes. Generally, they are a pest of vegetables and found in damp soils rich in organic matter.

Further Reading

CDs, Booklets, and Pamphlets

University of Idaho Extension

- PNW 343 Beneficial Organisms Associated with Pacific Northwest Crops
- PNW 186 Cockroaches
- PNW 550 Encouraging Beneficial Insects in Your Garden
- CD 1 Identification Keys for Insect Pests in Pacific Northwest Field Crops (CD-ROM)
- MS 109 Keys to Damaging Stages of Insects Commonly Attacking Field Crops in the Pacific Northwest
- CIS 414 Spiders and Their Relatives