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University of Kentucky
College of Agriculture,
Food and Environment
Cooperative Extension Service

Insects

Kentucky Master Gardener Manual Chapter 8

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In this chapter:

Insects, spiders, mites, etc. are among the oldest and most numerous animals on Earth. Some species, like the house fly, occur in every county of the state, while others live in very specific areas, such as a western Kentucky wetland or an eastern Kentucky mountain meadow.

A few species get most of the attention because they eat our plants, annoy pets or other animals, or are simply a nuisance in our homes or on our land. But the vast majority of insects are either beneficial or harmless, and all of them have an important role in the environment. Some insects pollinate fruits and vegetables, and others are vital to the food chain as herbivores, predators of other insects, or recyclers. They provide food for birds and fish, and a few produce important useful natural products such as honey, wax, and silk.

Like it or not, insects have a major impact on our lives, health, and environment. Learning more about them can increase your enjoyment of nature and help you to manage problem species more effectively.

Identification

The animal kingdom is divided into phyla (plural for phylum). Insects are in the phylum Arthropoda (which also includes spiders and crayfish). This phylum contains more than 75% of the known species belonging to the animal kingdom.

Classes

Arthropoda is divided into classes based on characteristics such as number of body segments, antennae, body regions, and legs (Table 1). Insects in Arthropoda should be familiar to you, but they have differences you may not have noticed before now. Once you know what to look for, it's easy to put a particular insect into its proper class within this phyum.

Table 1. Classes of the Phylum Arthropoda

Class	Examples	Antennae	Number of Body Segments/ Regions	Pairs of Walking Legs	Role
Crustacea	Crayfish, pillbugs, sowbugs	2 pairs	2	5	Mostly scavengers and recyclers
Chilopoda	Centipedes	1 pair	Multiple	1 pair/ segment	Predators
Diplopoda	Millipedes	1 pair	Many	2 pairs/ segment	Recyclers
Arachnida	Spiders, mites, ticks, daddy longlegs	None	2	4	Spiders: predators, ticks: parasites, mites: various.
Insecta	Insects	1 pair	3	3	Varies with groups

Classes in Arthropoda and a brief description about each follow:

Crustacea—Crayfish, lobsters, and crabs are the biggest and best-known members of this class. Most live in the water and breathe by gills or through the exoskeleton. Pillbugs and sowbugs live on land but must stay in humid areas to survive.

Chilopoda—Centipedes (commonly known as "hundred leggers") have one pair of relatively long legs attached to each flat body segment. These fast-moving predators use a pair of fangs (modified legs) on the segment behind the head to bite and paralyze their prey. They are common in mulch and leaf litter.

Diplopoda—Millipedes, or "thousand leggers," have two pairs of short legs attached to each round body segment. They generally feed on decaying organic matter, helping to break it down into smaller pieces. Occasionally, they feed on plant roots or leaves in contact with the soil.

Arachnida—is a large class that includes many different types of organisms, from mites to daddy longlegs. All have four pairs of walking legs and two body regions: the head and thorax are one region and the abdomen is the other. These two regions are clear in spiders. Mites, ticks, and daddy longlegs, however, look as if they have only one region, and a scorpion, because of its segmented tail, appears to have more than two.

Insecta (Hexapoda)—usually have three body regions, three pairs of legs, and a single pair of antennae. With a million species in this class, their individual appearance and environmental role vary greatly.

Orders

Classes are divided into orders. About 25 orders of insects are listed, depending upon the resource you use. See Table 2 for the more important orders.

In addition to having a similar set of characteristics, all members of an order have the same type of life cycle or development. Anyone can learn to identify insects. Being able to recognize the common orders and key pests of the plants in your landscape will be useful and add a new dimension to your outdoor experiences.

Just being able to recognize the order tells you a lot about the basic biology of the insect and may be enough to answer your questions about it. It can allow you to take action against damaging pests and avoid unnecessary treatments against incidental plant visitors or beneficial insects.

The main characteristics used to recognize adults are type of mouthparts and number and type of wings. Different features are used to recognize the immature stages, which may look very different from the adults. Many of the order names end in "ptera" because the wings can provide distinct characteristics.

Table 2. Common Orders of Insects

Order	Common Name	Metamorphosis	Mouthparts	Wings
Collembola	Springtails	None	Chewing	None
Thysanura	Silverfish	None	Chewing	None
Orthoptera	Crickets, grasshoppers	Gradual	Chewing	2 pairs
Mantodea	Praying mantids	Gradual	Chewing	2 pairs
Blattaria	Cockroaches	Gradual	Chewing	2 pairs
Isoptera	Termites	Gradual	Chewing	2 pairs or none
Dermaptera	Earwigs	Gradual	Chewing	2 pairs
Thysanoptera	Thrips	Gradual/complete	Rasping-sucking	2 pairs
Hemiptera	True bugs	Gradual	Piercing-sucking	2 pairs
Homoptera	Aphids, scale	Gradual	Piercing-sucking	2 pairs
Neuroptera	Lacewings, antlions	Complete	Chewing	2 pairs
Coleoptera	Beetles, weevils	Complete	Chewing	2 pairs
Lepidoptera	Butterflies, moths	Complete	Chewing / siphoning	2 pairs
Diptera	Flies	Complete	Chewing / piercing-sucking	1 pair
Siphonaptera	Fleas	Complete	Chewing / piercing-sucking	None
Hymenoptera	Bees, wasps, ants, sawflies	Complete	Chewing	2 pairs or none

Figure 1. Thysanoptera

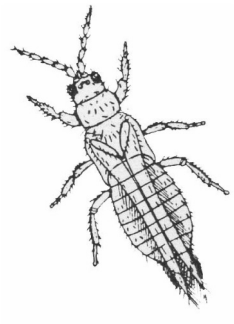
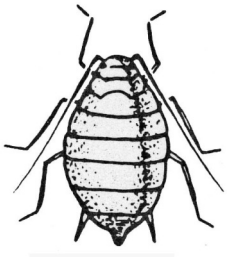


Figure 2. Homoptera



Following is information on some of the more common and important insect orders:

Orthoptera (crickets, grasshoppers, katydids, etc.)—Orthoptera are medium to large-sized insects with gradual metamorphosis and chewing mouthparts. Most adults have two pairs of wings. The front wings are narrow and leathery; the triangular hind wings are membranous and fold like a fan underneath the first pair. The antennae are visible and may be very long.

Grasshoppers are general feeders that can eat the foliage of many plants.

Mantodea (praying mantids—Mantids are generalist predators that capture and eat all kinds of insects. The two front legs are specialized for grabbing prey. These insects have keen vision and a neck that allows the head to rotate 180 degrees, making them good ambush hunters. Camouflage coloration allows mantids to blend in with the background as they sit on twigs and stems watching for movement and waiting to grab prey. Kentucky has three species—the European, Carolina, and Chinese mantids.

Blattaria (cockroaches)—The flat body and long antennae of the cockroach are among the features that make this insect widely recognized. Woods cockroaches live under the loose bark of fallen trees and in leaf litter or mulch. They may become accidental invaders during the summer but cannot become established in the home.

Dermaptera (earwigs)—The pair of large pinchers at the end of the abdomen make earwigs easy to recognize. Earwigs are primarily scavengers but may feed to some extent on plants. They will live under rocks or wood placed on the ground.

Thysanoptera (thrips)—These insects are tiny (1/15 inch long) and slender, with two pairs of narrow, fringed wings (or none) (Figure 1.) Thrips are rarely seen, but the damage from their rasping-sucking mouthparts can disfigure flowers and foliage. Thrips usually feed on or in developing leaf or flower buds, where they tear at the tissue with a sharp mouthpart and feed on the sap that wells up. Injured tissue often is speckled with white or silver, and some species' damage causes puckered leaves. Some thrips are important carriers of plant viruses, such impatiens necrotic spot virus. A few species are predators.

Hemiptera (true bugs: stink bugs, plant bugs, lace bugs, etc.)—True bugs have long, piercing-sucking mouthparts attached at the front of the head. The base of the front pair of wings is thick and leathery; the tip is thin and membranous. The wings lie flat over the back, and the membranous portion of the front wings overlap. Wingless nymphs' mouthparts place them in this order.

Many true bugs feed on plant sap. Often, there are no visible symptoms of their damage, but some leave tiny white spots where they have fed, and some species' salivary secretions may cause large spots or distorted tissue. Several hemipterans are predators.

Homoptera (aphids, leafhoppers, scales, cicadas, whiteflies)—The Homoptera have short, piercing-sucking mouthparts attached to the back of the head near the base of the first pair of legs (Figure 2). Their wings are membranous, but unlike insects in the Hemiptera, their front pair is not thickened at the base. Also, the two pairs are held roof-like over the body; they do not lie flat. All members of this order feed on plant sap.

Aphids are this order's most common troublemakers. Aphid numbers increase rapidly, and large colonies of them can be found on tender terminal foliage, especially in the spring. Some species produce large amounts of a sticky, sugar-rich waste called "honeydew." When honeydew accumulates, black, sooty mold fungus will grow on it. Some aphids and leafhoppers can carry pathogens that cause plant diseases.

Scales are among the most destructive pests of shade trees and ornamental plants in the home landscape. These small, cryptic insects, often covered by a waxy secretion, remove large amounts of plant sap, potentially stunting growth or even causing death of shoots and branches. Infestations are easy to overlook until significant damage has occurred.

Figure 3. Diptera

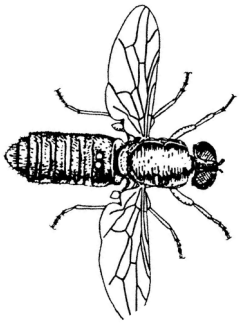


Figure 4. Hymenoptera

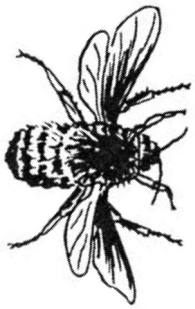
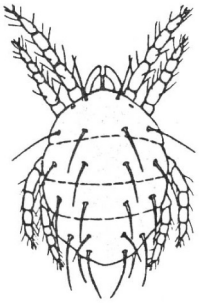


Figure 5. Acarina



Neuroptera (lacewings, antlions, dobsonflies)—These insects have two pairs of long wings that are crisscrossed with many fine veins and held rooflike over their backs. Common species in home landscapes and gardens are predators; adults and larvae feed on many soft-bodied insects such as aphids. The green lacewing is the most common species.

Coleoptera (beetles)—This is the largest order, containing about one-third of all known insect species. Hard front wings are the defining feature of most beetles. They protect the hind pair of flying wings that are folded efficiently beneath them when the beetle is at rest. Look for a line down the middle of the back where the hard wings come together. Some beetles, such as lightning bugs or firelies, soldier beetles, and blister beetles, have soft, flexible front wings.

Many of the basic larval forms can be found in this order, including white grubs, wireworms, and legless grubs. In terms of feeding habits, this species includes leaf feeders, leafminers, borers, predators, and scavengers.

Lepidoptera (moths, butterflies)—This is the second largest insect order. Many of the larvae (caterpillars) are leaf feeders, some are borers, and a few are leafminers. Butterflies and moths have coiled, siphoning mouthparts and two pairs of wings covered with scales. The brightly colored, day-flying butterflies, which fly mostly in the day, have long, thin antennae with a knob on the end. Drab-colored moths, which typically fly at night, have feathery or spindle-shaped antennae.

Diptera (flies, mosquitoes, gnats)—Diptera literally means two wings, which is the defining trait of this order (Figure 3). The front wing is usually clear with some distinct veins, while the hind pair is modified into a small balancing structure that resembles a golf tee. Fly antennae may be short or long and of various shapes; the eyes usually are large. The mouthparts of insects in this diverse order are modified in various ways to feed on liquids. The adults of some species live only a few days and don't feed.

Insects by the numbers:

- 200 million insects for each person on Earth
- 1 million+ species worldwide
- 2,000 new species found each year
- 100,000+ species in North America
- 16,000+ species in Kentucky
- ? species in your backyard

The larvae are legless; most live in a moist habitat or water but a few are terrestrial. Examples are maggots and mosquito wrigglers. Some species are important parasites of caterpillars and beetle larvae, and a few species are gall makers.

Hymenoptera (bees, wasps, sawflies, ants)—Hymenoptera have some type of chewing mouthparts and two pairs of wings (reproductive forms) or none (workers). When wings exist, the front pair is longer than the hind pair. The antennae are usually well developed and often long (Figure 4).

Many Hymenoptera lead solitary lives; others are organized into highly socialized colonies. Honey bees display the highest degree of social organization among insects in this order.

Some Hymenoptera are beneficial pollinators, as they visit flowers while collecting pollen. About 50% of the species are predators and parasites of other insects. Sawfly larvae, which resemble caterpillars, feed on leaves. Several species of small wasps produce galls on plants.

Acarina (mites)—Plant-feeding mites are small, round-bodied arthropods with eight pairs of legs that use needlelike mouthparts to pierce plant cells and remove sap (Figure 5). The empty cells appear on leaves as very small white-to-yellow specks. The amount of spotting increases as mite numbers build. Heavy infestations may cause brown leaves or needles and premature leaf drop. Foliage infested by spider mites becomes covered with distinctive fine silk webbing.

Families, Genera, Species

Each order consists of several families. Family members usually share distinct features that set them apart from other members of their order. In the animal kingdom, family names end with "idae." Aphidae (aphids), Muscidae (house flies), and Blattidae (cockroaches) are examples of families of insects.

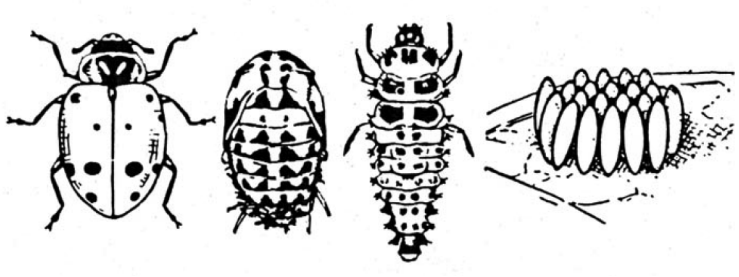
Families are divided into Genera that contain individual Species. The genus and species form the two-word scientific name that is unique. The housefly, *Musca domestica*, serves here as an example of classification:

Phylum ..... Arthropoda
Class ..... Insecta (Hexapoda)
Order ..... Diptera
Family ..... Muscidae
Genus ..... *Musca*
Species ..... *domestica*
Common Name ..... housefly

Common Names

Multiple common names can cause some confusion, which can be compounded by local or regional names. For example, the locust plagues of the Bible were caused by what many people call grasshoppers. In other areas, the word "locust" is used for the cicada. This insect (grasshopper/ locust/ cicada) also may be called a "jarfly." Dragonflies and damselflies may be called "snake doctors" because they have been seen resting on the head of a basking water snake.

Figure 6. Life cycle of the lady beetle.



While most people won't talk about the *Popillia japonica* feeding damage on their roses, the scientific name leaves no doubt about the identity of the insect causing the damage (Japanese beetle). Pinpointed identification is one of the benefits of scientific names.

Most common names of insects refer to large groups, such as families or orders, rather than individual species. The term beetle refers to the order Coleoptera, which includes about 30% of all insect species. However, "fly" and "bug" may be used for insects in more than one order. When the "bug" of an insect's name is written separately—stink bug or lace bug, for example—the insect belongs to the order Hemiptera, the true bugs. However, lightningbugs and ladybugs are beetles (Coleoptera), so their names are written as one word. The life cycle of the lady beetle, also called the ladybug, is shown in Figure 6. Many people recognize the adult stage, but other stages are also present on a plant. Both adults and larvae eat aphids and other plant pests.

Biology and Development

Insect Form and Function

Insects are considered to be the most successful group of animals on Earth because they are found almost everywhere—from deserts to snow fields—and because so many species exist.

Their success is due to the following:

- small size and the need for limited resources
- short life cycles and high reproductive rate
- wings, which allow them to migrate
- metamorphosis

The classification of an insect from order to species is based on structures of the body, which also give clues about what the insect does. For example, predators have large eyes and grasping legs; herbivores (plant feeders) are rounded with short legs.

Recognition of structural modifications of various insects will help you determine the role of the insects found on or around your plants.

For example, the basic insect body plan can be as simple as that of the familiar grasshopper, but it can also be as finely engineered as the specialized honeybee. This insect has mouthparts that can both sip nectar from a flower's depths and carefully craft wax to seal the brood cell of a bee larva before it pupates. It also has a stinger at the end of the arms on its abdomen that enables it to defend the hive from intruders. A basketlike structure on each hind leg allows it to accumulate pollen to take back to the hive.

Body Regions

The body of an insect is divided into the head for feeding, the senses, and the brain; the thorax with its legs and wings for movement; and the abdomen for digestion and housing of reproductive structures. Sometimes the divisions are not obvious, especially between the thorax and abdomen.

Head

The head is formed from the fusion of several segments. It has the antennae, which function much like a nose to detect chemical scents in the air or on surfaces. These scents may help insects locate food or mates. Insects with long or large antennae rely heavily on chemicals or touch, while those with large compound eyes rely on sight.

The head also has the mouthparts. They are very important in insect identification and determining whether the insect feeds by chewing solids or by sucking up liquids. Recognizing mouthparts can be difficult until you are able to look for the segment palps that chewing insects use to taste and handle food (Figure 7).

While chewing and sucking are the basic functions of mouthparts, some insects use mouthparts for rasping-sucking (for example, thrips) and chewing-lapping (such as bees).

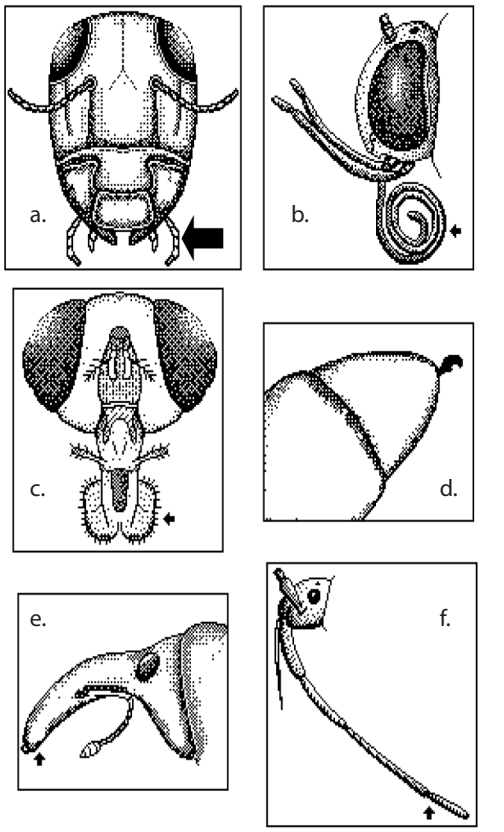


Figure 7. Examples of insect mouthparts.
a. Basic "no frills" chewing mouthparts of a grasshopper. The arrow points to the palps, structures seen on most insects that chew.
b. Coiled, siphoning mouthpart of a butterfly or moth, which is used for drinking nectar from flowers.
c. Arrow points to **s**ponging mouthparts of a fly, used to blot up liquids.
d. Mouthhooks of a maggot, used to pull the legless larvae across its food and tear away at it.
e. The arrow points to chewing mouthparts of the weevil, called a "snout beetle" because of the prolonged head. It's tricky to recognize because no palps are present. The hard beetle-like front wings are the key to identification.
f. The piercing-sucking mouthparts of a stink bug are used to feed on plant sap. (see arrow).

Thorax

The thorax is made up of three segments that are fused to form a box to support legs and wings and the internal muscles that move them. A pair of legs is attached to each segment. Generally, the wings are attached to the second and third segments (flies have wings only the second segment). Only the adult stage of an insect has wings.

Insect legs often are modified for very specific uses. They are almost always present on adult or mature insects and are generally also present in the immature stages, although they may look very different at each stage. In addition to enabling the insect to walk and jump, legs can be flat like shovel blades for digging, hinged and spiny for grasping, or long and thin for running. The legs of bees are fitted for carrying loads of pollen. This great variation in size and form can be useful in identification.

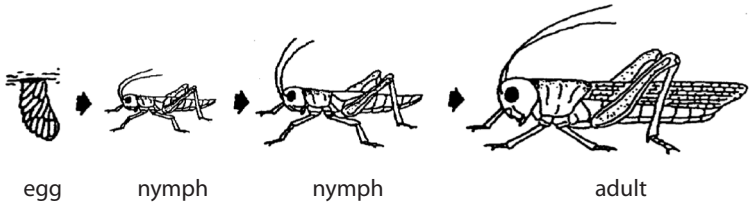
Wing characteristics are also very important in recognizing insect orders. For example, the front wings of beetles are usually very hard and serve as protective covering for the thin, flexible, hind wings when they are not being used. The wings of butterflies and moths are covered with fine scales.

Wings are also modified for different uses, and their shape, or even their vein pattern, can be used in identifying the insect. The clear wings of flies and wasps are designed for fast or nimble flight, while the flat wings of many cricket species are important in producing the sound used to find mates.

Abdomen

The abdomen is made up eight or more segments, but they may be covered by the wings or may be indistinct. Some insects have a pair of appendages at the tip of the abdomen. These appendages may be short, as in grasshoppers, termites, and cockroaches; extremely long, as in mayflies; or curved, as in earwigs. There may be an egg-laying device or stinger on the end of the female's abdomen.

Figure 8. Stages of gradual metamorphosis.



Growth and Metamorphosis

Because their skeleton is on the outside, insects can't increase gradually in size. They feed for a period of time, then molt or shed their external skeleton and begin to feed again. Hormones regulate the molting process. Depending on the species, insects may molt four to six or more times as they develop. Only insects in the most primitive orders grow and molt after becoming adults. Most insects don't grow after they reach the adult stage, so little beetles don't become big beetles and tiny gnats don't turn into large flies.

Insects are cold-blooded, so their activities are regulated by temperature. An insect goes through its life cycle more rapidly at 85° F than it would at 70° F.

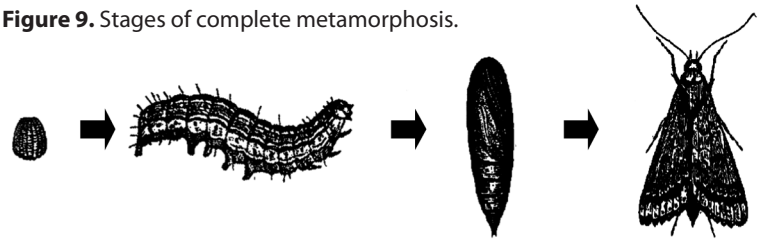
Metamorphosis, or change in form during development, is one of the distinctive features of insects. This ability to change has allowed insects to specialize and fill a wide variety of roles in the environment. While most insects begin life as eggs, there are four different paths, or type of metamorphosis, that will allow an insect to reach the adult stage. The types of metamorphosis, with the number of stages in each, are as follows:

- None - 3 (egg, nymph, adult)
- Gradual - 3
- Incomplete - 3
- Complete - 4 (egg, larva, pupa, adult)

Most insects have either gradual or complete metamorphosis. No metamorphosis occurs in the most primitive insects—springtails and silverfish, for example. The only change that takes place in these insects is an increase in size as the insect develops.

Gradual metamorphosis—This is a type of development in which the immature stage (nymph) is a smaller version of the adult (Figure 8). In addition to being smaller, the nymph does not have wings and is not sexually mature. External wing buds can be seen on late-stage nymphs. Nymphs have the same type of mouthparts as the adult, feed on the same food, and have the same general behavior. Except for wing characteristics, the basic features of the order can be used to identify nymphs and adults, at least as to order.

Figure 9. Stages of complete metamorphosis.



Incomplete metamorphosis—This development type is unique, occurring in three orders of aquatic insects: dragonflies and damselflies (Odonata), mayflies (Ephemeroptera), and stoneflies (Plecoptera). The immature stage is like a nymph but is called a naiad. It lives in the water, for which it has the necessary adaptations, including gills and a streamlined body. The adults are flying terrestrial insects, so they have some major structural differences, but the changes are accomplished without a pupal stage.

Complete metamorphosis—About 75% of all insects have this type of development. For these insects, the specialized feeding stage, called a larva, is very different from the adult stage, which may not feed at all (Figure 9). For example, caterpillars chew their food, while moths and butterflies have siphoning mouthparts to feed on nectar.

Several basic larval forms are specialized. Soft-bodied, legless maggots are ideal for crawling through moist organic matter, while the caterpillar is just right for hanging onto leaves while eating vast quantities of foliage. Recognizing the basic larval types is enough to give you an idea of what they do (Figure 10).

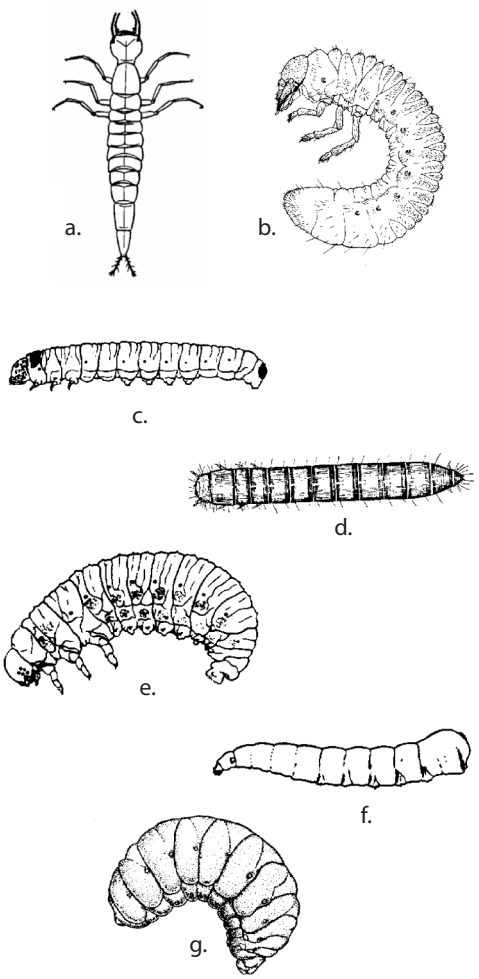


Figure 10. Basic larval types.

a. Predator (some beetles, lacewings). Characteristics include a streamlined body with hard exoskeleton, long thin legs, and big, often sharp, jaws at the front of the head.

b. White grub. This type has a distinct yellow-brown head with large jaws and a soft, white, curved body with distinct legs. This type is usually a root feeder, but some larvae of this type live in decaying organic matter. Japanese beetles and green June beetles have this larval type.

c. Caterpillar. This type has a distinct head; a long, cylindrical body with three pairs of segmented legs; and two to five pairs of fleshy legs along the abdomen. This is the larval stage of butterflies and moths. Many caterpillars are striped or brightly colored, but caterpillar larvae that bore in plants are usually white or cream-colored. Sawflies are similar but have fleshy legs on all abdominal segments.

d. Wireworm. This larval type has a round, cylindrical body that is hard and yellow or brown. It has three pairs of short, segmented legs behind the head but no fleshy legs on the abdomen. These larvae may live in the soil and feed on seeds or plant roots; some live in decaying logs. Some beetles have this form.

e. Leaf beetles. This type is similar to caterpillars but has no fleshy legs on the abdomen. Many leaf beetles feed on leaves and are camouflaged by color and markings. Some have white, thinner bodies and live in the soil, where they feed on plant roots.

f. Maggots. This type is headless, legless, soft-bodied, and white or cream-colored. They are the larvae of flies.

g. Legless grubs with distinct heads. Many feed in plants or seeds. Bees and wasps have this type of larva.

The transition between the larva and the adult is accomplished as an inactive pupa. Wings develop while the insect is a pupa and expand when the adult emerges. The main tasks for adults are dispersal and reproduction.

Winter Survival

Winters in temperate areas such as Kentucky are a problem for insects. There is a long period with cold, sometimes freezing, temperatures and no food.

Diapause, a dormant period for the insect, provides a means of surviving this inhospitable time. Diapause can occur during any life stage, and varies with the species. The gradually shortening daylight of late summer and early fall cues insects to get ready to enter diapause. Their to-do list includes eating a lot to store up fat reserves, producing an antifreeze-like substance in the blood, and finding a sheltered place to settle down.

Diapause alone cannot guarantee survival in harsh conditions. Winter weather plays an important role, too, but it impacts some species more than others. Those species that spend the winter under surface leaf litter or relatively exposed places can be killed by extended periods or freezing temperatures. In contrast, the Japanese beetle passes the winter in the grub stage down in the soil, where it is protected from extremes at the surface. Sanitation, burying, or removing dead plants in the fall can reduce infestations of some insects by eliminating their overwintering sites or the insulation provided by surface residues.

A few insects are migrants, arriving in Kentucky in early summer and leaving in the fall. The Monarch butterfly is the most familiar example. Many of these orange and black butterflies can be seeing flying slowly but steadily to the southwest as they head to specific wintering sites in the mountains of Mexico.

How Insects Injure Plants

In many cases, plant injury is the first indication of an infestation. Knowing the types of injury caused by various kinds of insect mouthparts can be a clue to the identity of the pest causing the damage and can also help determine appropriate control measures if needed. The time of year when the injury occurs and the species of plants being attacked also can be used in identification.

Following is a summary of injury types, which are illustrated in Figure 11:

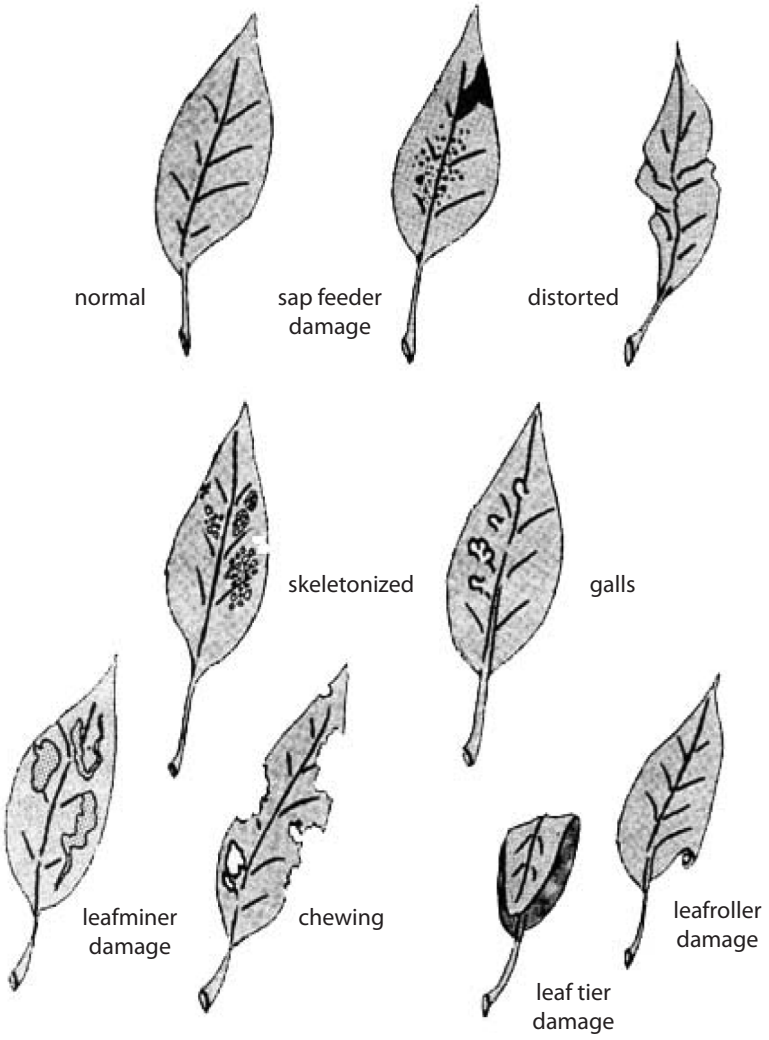
Chewers—Chewing insects make holes in leaves, which in some cases are distinctive. Examples include the small, rounded holes of flea beetles and the skeleton-like holes of Japanese beetles. Some insects chew rounded holes in the middle of leaves, while others feed from the edges of the leaves toward the midrib. These "signatures" can change, however. Newly hatched caterpillars may only feed partway through the leaf, leaving a skeleton-like effect, while the larger stages chew completely through the leaf.

Because of limited mobility, caterpillars must remain near their feeding site, so they often leave large accumulations of dark particles of insect waste (frass). In contrast, beetles and katydids move around, leaving damage far behind as they forage over many plants. With a little practice, it usually is possible to see the difference between fresh damage and injury that has begun to dry or form a callus.

Sap Feeders—Noticing or recognizing damage by sap feeders is a challenge. Distinct symptoms (such as wilting, leaf yellowing, or distortion) or a buildup of honeydew or sooty mold are caused by some insects. Many, however, don't provide clues unless they have fed at the site for a long time in large numbers.

Frequently sap feeders (and mites) feed on the tender tip tissue or on the underside of leaves or needles. It takes careful, regular inspections of these areas to catch problems early.

Figure 11. Types of insect injury to plants.



Borers and Leafminers—The larval stages of several species of beetles and moths tunnel inside plant stems, trunks, branches, twigs, or roots. Their activities disrupt water and nutrient flow; cause structural weakness; or allow entry for rots, pathogens, or other insects. Some attack specific plant species, while others are generalists. Examples include bark beetles, roundheaded and flatheaded borers, and some moth caterpillars. There are no "rescue" treatments for their injury, so controls are based on growing healthy plants and using preventive treatments applied as egglaying begins.

Leafminers are very specialized larval stages of species of moths, beetles, and flies. They tunnel inside the leaf tissue as they feed on internal cells. The cavities they leave may be blotches, lobes, or narrow, winding passageways that gradually widen. One of the most familiar examples is holly leafminer. As with borers, a preventive strategy is needed because of the protection given to the larva by the plant.

Gall Makers—Galls are irregular plant growths that can occur most anywhere on a plant. They may be caused by insects, mite, fungi, bacteria, or nematodes. Insects are responsible for most galls, and about 80% are produced by tiny wasps. However, aphids, maggots, and mites can be culprits, too. Over half of the known gall species occur on oaks. Thirty percent are associated with the daisy, rose, and willow families. Galls are unusual and striking, but some gardeners consider them unsightly.

Galls usually are initiated about the time of bud break by chemicals injected into the leaf during egglaying or by the insect or mite as it develops. Galls provide food and protection for the inhabitant but other than early leaf drop, rarely affect tree health.

See Figure 10 for generalized examples of these injury types. You can get help with pest identification and management recommendations from your county extension office.

Disease Carriers—More than 200 aphid species can carry more than 170 plant viruses. Planthoppers and more than 40 species of leafhoppers can carry pathogens, as can a few species of thrips, beetles, and mites.

Insects have the following roles as disease carriers:

- Carrying of pathogens on or in their bodies from an infected plant to a healthy susceptible plant and injecting it as they feed
- Creating a wound on the plant through which a pathogen can enter. For example, disease in the soil or on plant tissue may enter at feeding wounds. In this case, the insect plays a very indirect role.
- Protection of plant pathogens with their bodies, with some pathogens even developing or multiplying within the arthropod

Management of diseases carried by arthropods often is based on sanitation—removing infected plants that can serve as a source of the disease and avoiding the use of susceptible varieties. Usually, insecticide applications do not protect the plant adequately from arthropod-borne diseases.

Reducing Insect Problems in the Landscape

Following are a few keys to reducing problems with insect pests in the landscape

- Healthy, vigorously growing plants often are able to tolerate some feeding damage by insects. Sound cultural practices, including fertilizing and watering as needed, will allow many plants to compensate for light-to-moderate feeding damage.
- Select insect-resistant varieties if possible. For example, selecting plants that are not acceptable food for Japanese beetles will eliminate an annual battle with these hungry, persistent pests.
- Establish a diverse landscape with a variety of native or well-adapted species. This practice will foster a setting in which there are small numbers of many different kinds of insects instead of large numbers of just a few species. Insect problems are generally less severe in a balanced environment.
- Be willing to accept light-to-moderate levels of feeding damage or infestation. This tolerance will give a chance for natural enemies, such as lady beetles, to provide a degree of natural control and may reduce the need for insecticide applications.
- Choose a succession of flowering plants to provide the nectar and pollen that many beneficial insects need. This practice will increase the impact of natural control.
- Use selective insecticides as much as possible when pest outbreaks occur. This practice will minimize adverse effects on natural enemies and reduce the chance of problems with other pest species. For example, "Bt" insecticides only kill caterpillars; they will not kill insect predators and parasites that attack other pests.

UK Web Resources

Entomology for Master Gardeners
http://www.pest.ca.uky.edu/EXT/Master_gardener/entbasics/introduction/introduction.shtml

Entomology Fact Sheets
http://www.ca.uky.edu/entomology/dept/entfacts.asp

Kentucky Pest News
https://kentuckypestnews.wordpress.com/

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