ENT-68

Cooperative Extension Service

Insects

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In this chapter:

Insects are the most biodiverse group of animals on earth. Amazingly, there are about one million total species of insects known currently, with the possibility of tens of millions more left to discover. When you include spiders, mites, scorpions, millipedes, centipedes, and other relatives, it's astounding to see the diversity of this group and how dominant they are across the planet. Not only are there many different species, but you can encounter these organisms almost anywhere on earth, from the bottom of the ocean to your own living room.

Insects and their relatives have a complicated relationship with humans. While most have no impact on human lives one way or the other, some can have negative impacts on us, while others are viewed as beneficial organisms. Insects that cause problems are collectively known as pests; only about one to three percent of the total population of insects would be considered true pests. Beneficial insects may provide goods or services that humans value. Honey bees for example, provide pollination services, helping farmers to produce things like apples, as well as goods like honey and beeswax. The vast majority of insects though are simply wild animals trying to survive.

As Master Gardeners, you will receive many inquiries about insects, particularly those that are plant pests. This could involve insect identification and making pest control recommendations. In order to successfully identify pests and provide help, it will be helpful to understand some of the basic natural history, anatomy, and biology of insects and their relatives.

Identifying Insects

Scientists have created a classification system for organisms that divides them into various groupings. These groupings are part of a tiered system, which can be best visualized as a pyramid. The base of the pyramid is the most generalized way of talking about a specific organism, currently this level is called "domain". The top of the pyramid is the most specific way of talking about a specific organism; currently this level is called "species" (Figure 7.1). In between these levels there are also (in order of increasing specificity) kingdom, phylum, class, order, family, and genus. When talking about insects and their relatives, we will be referring to them by their phylum name, Arthropoda, or more simply, the arthropods. This group represents almost 80 percent of animal life on the planet.

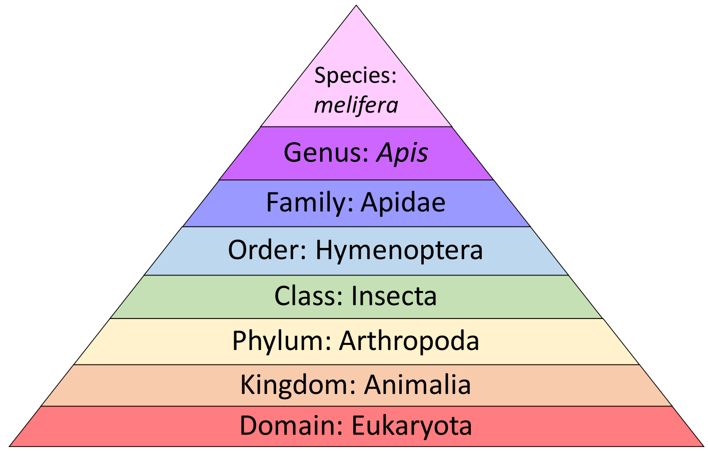


Figure 7.1. A pyramid showing the increasing specificity of terms referring to a European honey bee.

Arthropods

Representatives of the arthropods can look radically different from one another—think of comparing a monarch butterfly to a lobster. However, despite their differences, there are some traits that all arthropods share.

- All arthropods have jointed appendages. The name "arthropod" translates as "jointed foot."
- Arthropods all display bilateral symmetry. If a line is drawn down the middle of their bodies, the two sides should be a mirror image of each other.
- All arthropods have segmented bodies. Importantly, the different classes of arthropod are often separated by the number of segments their bodies have.
- Across the phylum, all representatives have an exoskeleton, a waxy outside layer that protects them, rather than having an internal skeleton like humans do.

Classes

There are multiple classes of arthropods that can be separated by certain physical traits, such as the number of body segments, number of legs or antennae, and the presence of other specialized anatomy.

Crustacea (Crabs, Lobsters, Shrimp, Crayfish, Isopods)

Members of this class have two pairs of antennae, two body segments, and five to seven pairs of walking legs (Figure 7.2). As a group, they tend to be found in bodies of water. Pillbugs and sowbugs (a.k.a. rolly pollies) are terrestrial, though they live in damp environments.

Figure 7.2. Crustacea.

Chilopoda (Centipedes)

Centipedes have one pair of antennae and one pair of legs per body segment (Figure 7.3). They tend to have a flattened profile and are predaceous. To subdue prey, they have a pair of venomous fangs. Contrary to what their name implies, they don't typically have one hundred legs.

Figure 7.3. Chilopoda.

Diplopoda (Millipedes)

Millipedes have one pair of antennae and two pairs of legs per body segment (Figure 7.4). They tend to have a tubular profile and are decomposers. Like their cousins, the centipedes, their name is a bit of a misnomer. It translates to "thousand feet" but most species have nowhere near that many legs.

Figure 7.4. Diplopoda.

Arachnida (Spiders, Ticks, Mites, Scorpions)

A very diverse class, containing predators, herbivores, parasites, and decomposers. All representatives have two body segments, four pairs of legs, and specialized mouthparts known as chelicera (Figure 7.5).

Figure 7.5. Arachnida.

Insecta (Beetles, Butterflies, Dragonflies)

While members of this class vary wildly in shape, size, color, and environmental role, they all share some traits. Insects have three body sections, three pairs of legs, and one pair of antennae (Figure 7.6).

Figure 7.6. Insecta.

Orders

After classes, organisms will be classified in an order. For the sake of this chapter, we'll focus on orders of insects to help you identify them in the future. Order level identification is often the level needed to help with pest problems. Not all orders are prevalent in Kentucky; some others can be found nearly anytime and anywhere.

There are about 30 orders of insects. This number fluctuates with new discoveries; entomologists may create new orders or fold one order into another, based on new genetic information. Previously, orders were compiled based solely on physical characteristics, but with the advent of genetic analysis, great shifts have occurred in our understanding of what is truly related to one another in the world of insects. Generally speaking, all members of an order will share certain physical characteristics and will develop in similar ways (Figures 7.7–7.18).

Anatomically, the most important traits that separate insect orders are the types of mouthparts, types of legs, and number of wings. Different orders will also progress through different types of metamorphosis as they mature. For more information on these anatomical and biological differences, see the second half of this chapter.

Figure 7.7. Odonata.

Figure 7.8. Orthoptera.

Odonata

Dragonflies and Damselflies

Odonata means "toothed," referring to the toothed parts of their mouths.

Big Eyes and Skinny

Odonates tend to have long, thin abdomens; heads that are mostly covered with compound eyes; and vein-filled wings.

Incomplete Metamorphosis

Odonates hatch from their eggs and develop through nymphal stages, gradually developing underwater.

Orthoptera

Grasshoppers, Crickets, and Katydids

Orthoptera means "straight wing," and these insects bear folded wings that form a straight line down the back.

Jumping and Singing

Most orthopterans have a hind pair of jumping legs and use songs to communicate.

Incomplete Metamorphosis

Orthopterans hatch from their eggs and develop through nymphal stages, gradually growing and developing wings.

Figure 7.9. Mantodea.

Mantodea

Praying Mantises

Mantodea means "prophet." There are three mantis species in Kentucky.

Predatory Attributes

Mantises have raptorial front legs and triangular heads with large eyes, both aiding in catching prey (usually other insects).

Incomplete Metamorphosis

Mantises hatch from their eggs and develop through nymphal stages, gradually growing and developing wings.

Figure 7.10. Blattodea.

Blattodea

Cockroaches and Termites

Blattodea means "cockroach." Termites were added to this order after recent genetic research.

Basic Legs and Antennae

Cockroaches and termites have simple walking legs. Cockroaches tend to be flattened, with a protected head. Termites are pale in color and live in colonies.

Incomplete Metamorphosis

Roaches and termites hatch from their eggs and develop through nymphal stages.

Figure 7.11. Dermaptera.

Dermaptera

Earwigs

Dermaptera means "skin wing," referring to the skin-like front-wing covers of earwigs.

Cerci and Ear-Shaped Wings

Earwigs are most recognized by the pincerlike cerci on their rear. When unfolded, their wings are ear shaped.

Incomplete Metamorphosis

Earwig mothers tend to their eggs over the winter. When they hatch, earwig nymphs will emerge.

Figure 7.12. Thysanoptera.

Thysanoptera

Thrips

Thysanoptera means "fringe wing," referring to the hairy-looking fringe on thrips' wings.

Slender with Hairy Wings

Thrips are small and pencil shaped, with fringed wings and asymmetrical mouthparts.

Strange Metamorphosis

Thrips are sometimes considered to have development that is both complete and incomplete metamorphosis.

Figure 7.13. Hemiptera.

Hemiptera

Aphids, Cicadas, Stink Bugs, Assassin Bugs, and More

Hemiptera means "half wing." Some hemipterans have half-leathery and half-membranous wings.

Piercing–Sucking Mouthparts

All hemipterans have needle-like mouthparts that can be used to siphon their food.

Incomplete Metamorphosis

Hemipterans hatch from their eggs and develop through nymphal stages, gradually growing and developing wings.

Figure 7.14. Neuroptera.

Neuroptera

Lacewings and Antlions

Neuroptera means "nerve wing," referring to the many veins in the wings of this group.

Slender with Vein-Filled Wings

Adults look vaguely like dragonflies but with long antennae, and their wings have many veins in them.

Complete Metamorphosis

Neuropterans are larvae when immature, looking considerably different from their adult form.

Figure 7.15. Coleoptera.

Coleoptera

Beetles

Coleoptera means "sheath wing," referring to the hardened top wing that protects the soft underwing.

Tough Wing Covers

Beetles have tough wing covers called elytra, along with chewing mouthparts and two pairs of wings.

Complete Metamorphosis

Beetles hatch from their eggs as larvae, sometimes referred to as grubs. They will pupate before reaching adulthood.

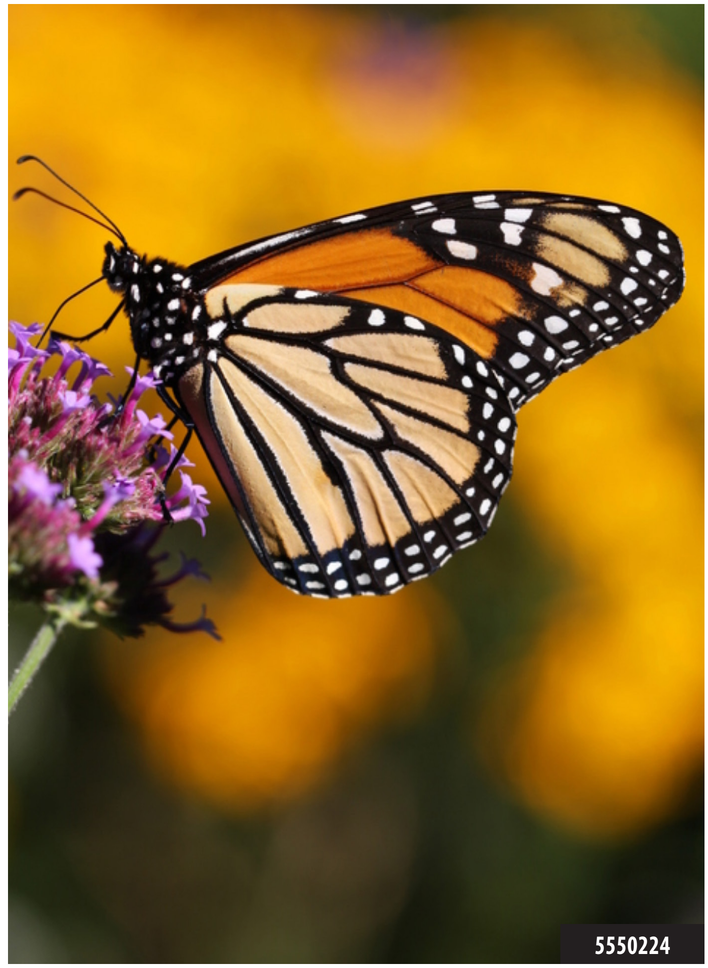


Figure 7.16. Lepidoptera.

Lepidoptera

Butterflies, Moths, and Skippers

Lepidoptera means "scale wing," referring to the scalelike coating on the wings.

Siphons and Scales

Lepidopterans have colored scales covering the wings and siphoning mouthparts that curl under their heads.

Complete Metamorphosis

Lepidopterans hatch from their eggs as larvae, usually referred to as caterpillars, which will pupate before becoming adults.

Figure 7.17. Diptera.

Diptera

Flies
Diptera means "two wings," as flies only have two full wings.

Two Wings and Aristate Antennae
All flies have two wings, and most also have aristate antennae and sponging mouthparts.

Complete Metamorphosis
Flies hatch from their eggs as larvae, usually called maggots, and they will pupate before they mature into adulthood.

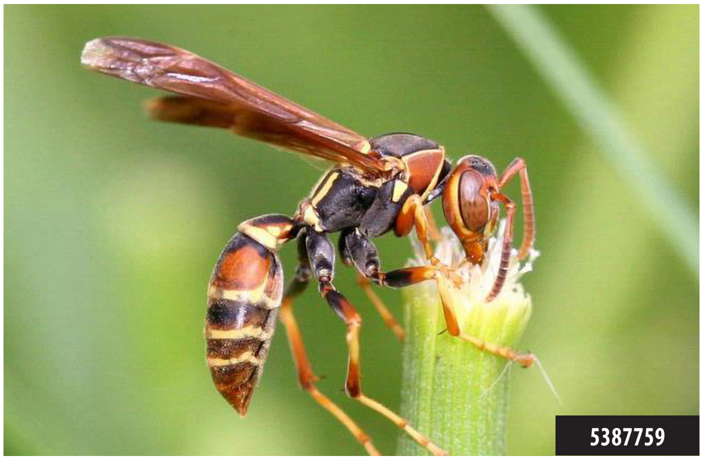


Figure 7.18. Hymenoptera.

Hymenoptera

Bees, Ants, Wasps, and Sawflies
Hymenoptera means "membrane wing," referring to the insects' four see-through wings.

Membrane Wings and Social Structures
Hymenoptera have chewing mouthparts and two pairs of membranous wings. Many live in social colonies.

Complete Metamorphosis
Hymenopterans hatch from their eggs as larvae and will pupate before reaching adulthood.

Inside of each order can be numerous families of insects. Family-level identification is also helpful when identifying a specimen, as the extra specificity may provide a more targeted management approach or reveal that something isn't a pest at all. Animal family names end in "-idae"—for example, Coccinellidae (lady beetles), Tettigoniidae (katydids), and Culicidae (mosquitoes). Most families also have distinct traits that help with quicker identification. To use Coccinellidae as an example, they are generally recognized by their bright warning coloration, spots, and domed appearance.

Beyond the family will be genus and species. Identification of insects to these levels usually requires the use of a dichotomous identification key and magnification equipment. Some species may be separated by something difficult to see, such as the number of hairs found on a specific part of the antennae. Other times, it's possible to recognize the species quickly and easily. For example, a Japanese beetle has a distinct enough appearance that it can be identified almost immediately. Genus and species names are combined to make an insect's binomial scientific name. To stick with Japanese beetle, its scientific name is *Popillia japonica*. Japanese beetle is this species' common name.

Common names are important, as they are what most people will use when discussing insects and they are easier to understand than Latin genus and species names. Common names can also be confusing though, as they vary by location and are sometimes applied to multiple insects. For example, the common name "potato bug" could refer to either a Colorado potato beetle or to a Jerusalem cricket, depending on whom you ask. Similarly, the insects that fly in the summer and glow could be called lightningbugs or fireflies, depending on where you are in the state of Kentucky. These confusing situations are why you might hear an entomologist using the more specific scientific names instead of common names.

Other common name issues can arise from the terms "fly" and "bug." Flies and bugs are both specific kinds of insects. Fly is the term broadly applied to the order Diptera, while bug or true bug is applied to the order Hemiptera. However, common names may borrow these terms and apply them to insects outside of those two orders. The way to tell if "fly" or "bug" is being used to describe an actual fly or bug is to look for a space before the word "fly" or "bug". The word "firefly" is a good example of this. Fireflies are actually a type of beetle; therefore, there is no space before the word "fly." A house fly, on the other hand, is a true fly, and there is a space before the term "fly" when writing the name out. With the term "bug," you can see this with a ladybug (a beetle) versus a bed bug (a true bug).

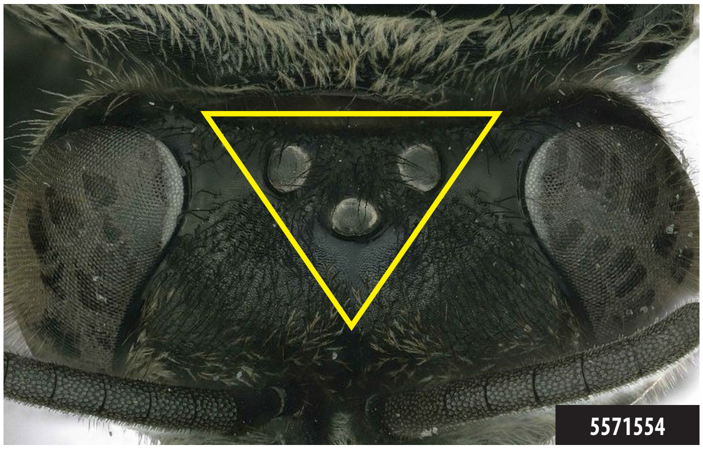


Figure 7.19. Insect ocelli, such as the ones inside of the yellow triangle here, are often in groups of three on top of an insect's head.

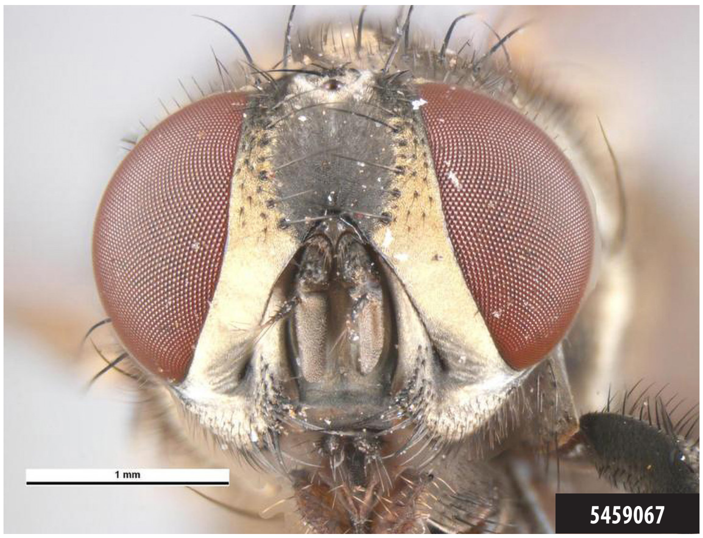


Figure 7.20. Compound eyes, like the two red ones on this house fly, can collect visual information from around the insect; most insects are considered to have poor vision, though.

Insect Anatomy and Development

As described before, insect anatomy is key to understanding how to identify insect specimens. Looking at the basic body plan of an insect, there are three body sections: the head, thorax, and abdomen. Each section will have specialized internal and external anatomical structures that help the insect be successful and help us to tell what it is.

Head

The head is where the insect receives most of the sensory information it needs to find other members of its species group, food, and shelter. This information is acquired through sensory organs housed on the head, namely the eyes, antennae, and mouth. Inside of the head is the first and largest of an insect's multiple ganglia, or brains.

Insect Eyes

Insects can have two kinds of eyes: simple eyes (also referred to as ocelli) and a pair of compound eyes. Ocelli are able to detect only light and darkness. Insects may use them to know what time of day it is. Ocelli often come in groups of three, arrayed in a triangle on top of the insect's head (Figure 7.19). Insects have a pair of compound eyes that gather more visual information (Figure 7.20). Each compound eye is made up of hundreds or thousands of lenses, each of which will send an image to the insect's brain. This multitude of images is compiled into a collage-like visual. Insect vision lacks depth perception, and they tend to be near-sighted. Insect compound eyes are capable of detecting ultraviolet light, though.

Insect Antennae

All insects have a pair of antennae, usually located on top of the head or at the front of the head. Antennae are used variously for smelling, touching, and even hearing. To facilitate smelling,

Figure 7.21. The two most common types of insect mouths are chewing (image of the beetle on the left) and piercing-sucking (wheel bug on the right).

the antennae are covered with small hairlike receptors that collect odorous cues. This allows the insect to detect food from afar, to confirm that something is food, and to detect pheromones produced by other members of its species. Antennae can be quite helpful for identifying insects to order and family, as there are lots of different shapes and forms of antennae (Table 7.1).

Insect Mouthparts

Anatomically, insect mouths are made up of multiple structures. There are mandibles, different kinds of palps, and pieces that function like lip covers, in a way. Taken as a whole, these pieces may be called the insect's mouthparts. Insects feed on a great diversity of food, and mouthparts can be specialized to help the insect consume whatever food it feeds on (Figure 7.21).

Chewing

The most common of insect mouths, chewing mouthparts feature two mandibles, opposing one another, that chew up food. Depending on the species, this could be for herbivory or for predation. Mandibles are usually toothed to facilitate chomping.

Piercing and Sucking

The second most common type of insect mouths, piercing and sucking mouthparts have been heavily modified to allow the insect to pierce a food source and then slurp the juices out of it. Piercing-sucking mouths can be used on plants by herbivores to draw out sap, on animals by parasites to draw out blood, or on other insects to consume their innards by predators. Hemipterans have piercing-sucking mouthparts, as do a few others like mosquitoes.

Chewing and Lapping

Chewing and lapping mouths are found on insects that chew pollen and drink nectar, such as honey bees. This type of mouth will have chewing mandibles but also a long tube or tongue to consume liquids as well.

Sponging

Found on many Dipterans (flies), sponging mouthparts have a structure that helps them to absorb liquids from surfaces. Some sponging mouths may be paired with sharp cutting organs to help gain access to blood.

Siphoning

Moths and butterflies have siphoning mouths, simple, tube-like mouths that curl up under the head when not in use. They can be unfurled and dipped into things like flowers to drink up liquid food, such as nectar.

Table 7.1. Insect antenna types, and insects that most commonly have them.

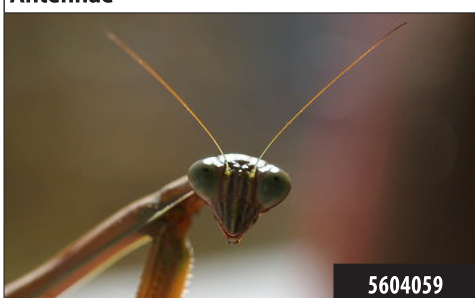
Antennae	Type	Bearing Insects
	*Filiform* The most basic of insect antennae, simple and threadlike	Found in almost every order, and prevalent in Orthoptera, Mantodea, Blattodea, Dermaptera, and Neuroptera
	*Serrate* Antennal segments have small triangular projections that appear like saw teeth to humans	Found mainly on beetles
	*Lamellate* Start out thin but have finger- or page-like projections at the tip	Found mainly in scarab beetles

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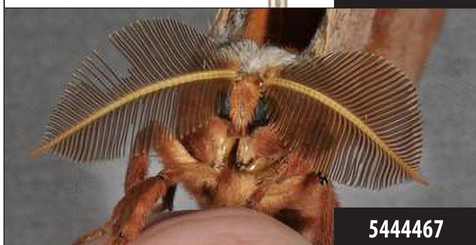
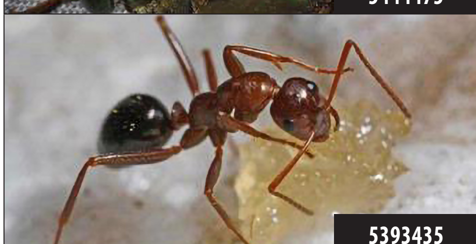
Table 7.1. Insect antenna types, and insects that most commonly have them.

Antennae	Type	Bearing Insects
	*Pectinate* Long, fingerlike projections on one side of antennal segments, like a comb	Found mainly on beetles, sawflies, and parasitoid wasps
	*Plumose* Feather-like, usually with projections on two sides of the antennae	Most common on moths and mosquitoes, but may only be on males in certain species
	*Aristate* Small, feather-like antennae that sit on top of a bulbous structure	Found typically on flies
	*Setaceous* Very simple and thin, looks like an individual hair	Found on fast flying insects, dragonflies, water bugs, cicadas, etc.
	*Geniculate* Elbowed antennae, look similar to filiform with a joint in the middle	Most associated with ants and other Hymenopterans
	*Capitate* Antennae terminate in a bulbous tip, knobbed in appearance	Found on butterflies as well as some Neuropterans and beetles
	*Clavate* Clubbed antennae that gradually get thicker toward the tip	Found on beetles and moths most often

Thorax

The next body section is known as the thorax. The thorax itself is split into three sections: the pro-, meso-, and metathoraxes. One pair of legs is attached to each section.

The thorax starts where the first pair of legs are and ends with the last pair of legs. This section specializes in locomotion; not only are the legs attached here to facilitate movement but if the insect is winged, this is where the wings will attach as well.

Insect Legs

Depending on the order they belong to, insects may have different kinds of legs. Legs may also help facilitate identification. Insect legs are structurally similar to human legs, with a coxa ball joint, a first section called the femur, a tibia, and tarsi at the end.

Walking

Most insects will have at least one or two pairs of walking legs. These are very simple legs with no special adaptations. They help the insect to scurry along (Figure 7.22a).

Jumping

Grasshoppers, katydids, crickets, and fleas are most famous for having jumping legs. This type of leg looks like a walking leg, except the femur will be larger and packed with more muscles, allowing the insect to jump many times its own body length (Figure 7.22b).

Natatorial

Aquatic insects can have natatorial legs. These are usually flattened and oar shaped, and sometimes they will have a dense coating of hairs that also help to push water as they swim (Figure 7.22c).

Fossorial

These legs are designed for digging into soil. Part of the leg will be modified to scrape soil. Scarab beetles, mole crickets, and several other families of insects will have a pair of them (Figure 7.22d).

Clasping

These legs have been modified to allow an insect to grasp onto hairs or feathers. They are most associated with lice (Figure 7.22e).

Raptorial

These predatory legs have been modified so that the tibia and femur can close on one another, similarly to a bear trap. Mantises, giant water bugs, and mantis wasps are the insects most commonly associated with these legs (Figure 7.22f).

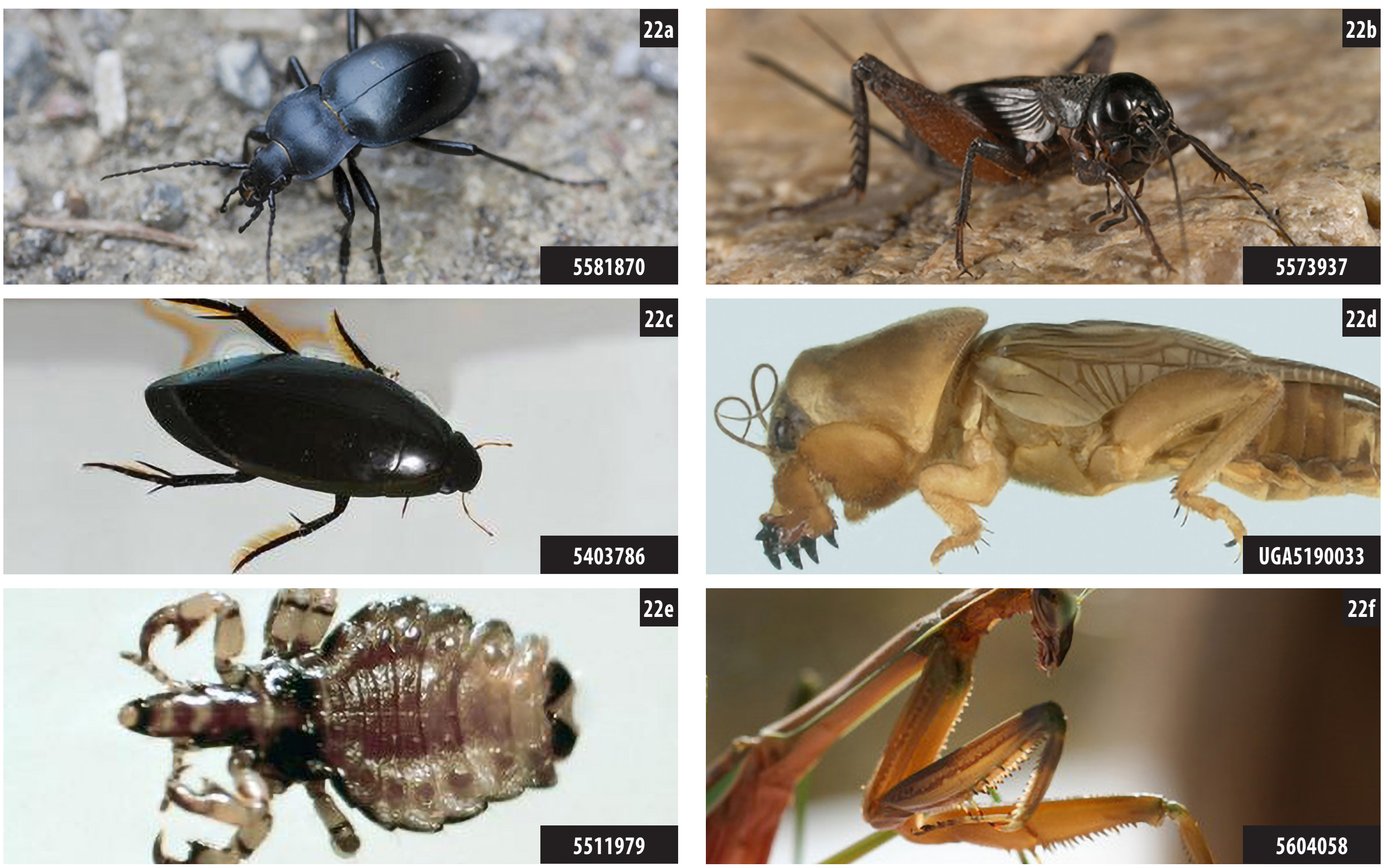


Figure 7.22. Insect legs are suited to the lifestyle of the bug they are attached to.

Insect Wings

Insects are the only invertebrates that have wings. Usually, they are clear and membranous, with noticeable veins inside of them. Some wings have been modified and can be helpful with identification. Lepidopteran wings are coated with scales and are opaque. The front wings of beetles, known as elytra, are hardened and leathery. They help to protect the softer, membranous hind wings.

Not all insects are winged. Some, like silverfish and firebrats, have never had wings. Others, like fleas and bed bugs, once had wings but over time they became greatly reduced, as these insects found other modes of movement and did not need the wings anymore. Only adult insects have wings.

Abdomen

The final body section is the abdomen. It can be made up of eight or more segments. Internally, the abdomen houses many important organs; much of the digestive tract, circulatory system, respiratory system, and nervous system are housed here. Most importantly, the insect reproductive system is in the abdomen. Externally, on female insects, an ovipositor may be noticed on some groups. These are often sword-like or stinger-like. Cerci may also be seen at the tip of some insects' abdomens. Cerci are tactile organs that serve as sort of rear antennae. Some cerci are short (like on cockroaches), while others may be quite long (mayflies). Earwig cerci are hardened and antler-like, helping to separate their order from others.

Insect Development

Insects use internal fertilization to reproduce. After mating, female insects can fertilize their eggs and then will usually lay them outside of the body. Depending on the type of insect, after an egg hatches, the insect will either be a nymph or a larva. Nymphs go through incomplete metamorphosis, and larvae go through complete metamorphosis.

Incomplete Metamorphosis

Also known as hemimetabolous development or gradual metamorphosis, incomplete metamorphosis involves a nymphal stage that looks similar to the adult form, except smaller and lacking wings (Figure 7.23). Gradually, the insect will develop through several nymphal stages, shedding their exoskeleton in between each. Hemiptera, Orthoptera, Mantodea, Blattodae, Dermaptera, and Odonata (amongst others) develop through incomplete metamorphosis.

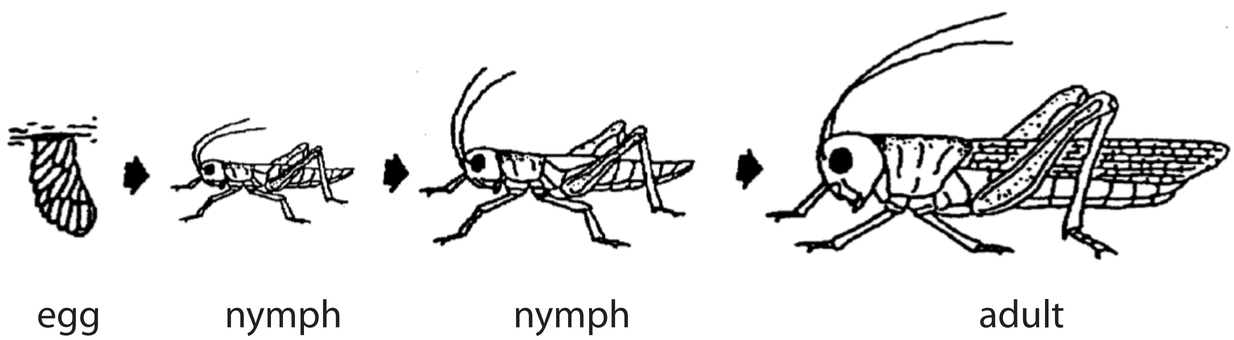


Figure 7.23. Stages of gradual metamorphosis.

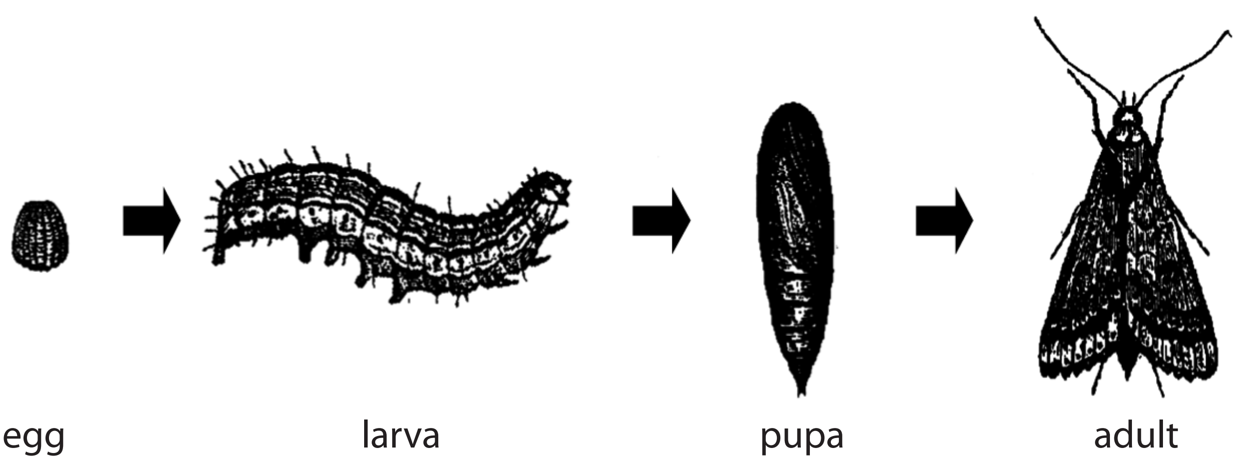


Figure 7.24. Stages of complete metamorphosis.

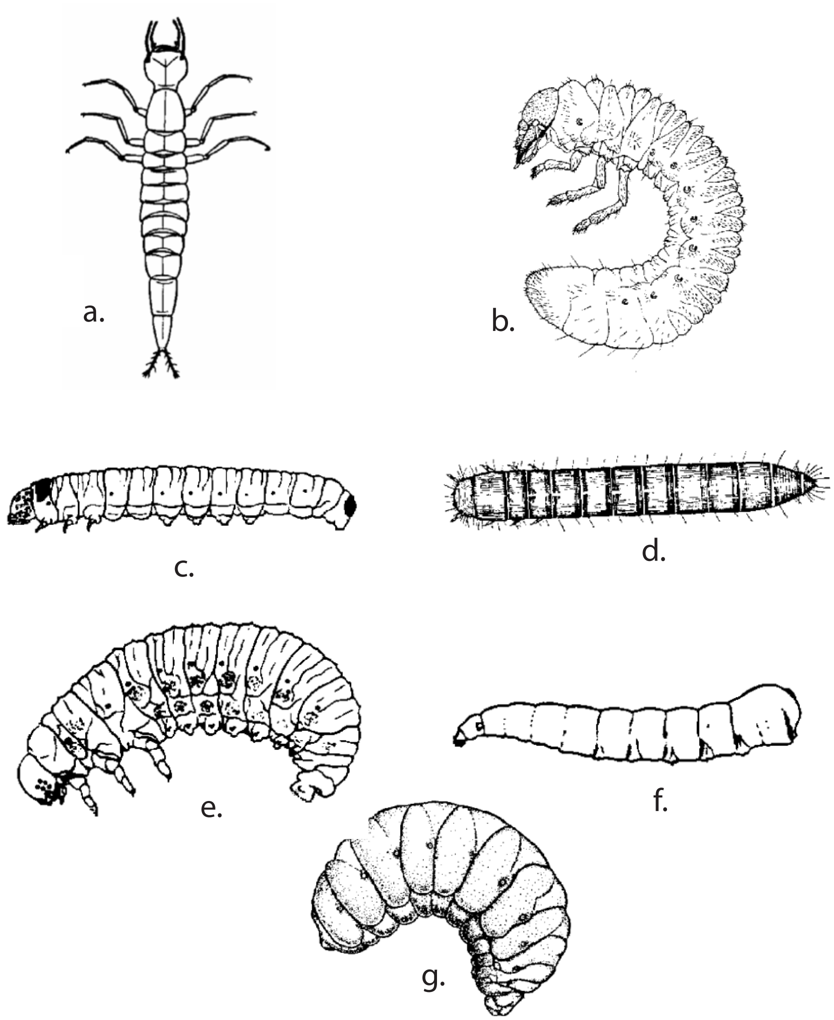


Figure 7.25. Basic larval types.

- **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.

Figure 7.25. Stages of complete metamorphosis.

Complete Metamorphosis

Also known as holometabolous development, this is the most common type of metamorphosis that insects go through (Figure 7.24). In this type, the egg will hatch and a larvae will emerge. Larval insects usually look radically different from their adult form (Figure 7.25). Larvae may have special names, such as caterpillars (immature Lepidoptera), grubs (immature Coleoptera), or maggots (immature Diptera). Larvae lack wings and usually feed on different food than the adult form will; for example, caterpillars eat leaves usually, while adult moths consume nectar. Between the larval and adult stages, the insect will pupate. Pupae are an intermediate stage between immature and mature forms. Coleoptera, Diptera, Lepidoptera, Hymenoptera, Neuroptera, and many other orders use this type of development.

Growing Degree Days and Overwintering

Insects generally can't control their own temperature, and their development speed is determined by the temperature around them. Each species has different requirements, but there is usually a temperature they need to reach in order to begin or continue developing. For the insect to move from one stage of life to the next, that temperature needs to be reached or maintained for a certain number of days. We call these "growing degree days," and we can use temperature data to calculate them and predict insect emergence times. Simply put, the cooler the temperatures, the slower they develop, and the warmer it is, the faster they develop.

Winter presents an issue for insects; the cold could mean death, since they can't warm themselves. To deal with this, different types of overwintering strategies have been developed. Some insects will literally leave the cold area and migrate to a warmer location to spend the winter months. The monarch butterfly is a famous example. Some insects, like stink bugs or lady beetles, will stay in the cold location but huddle together in a protected area to avoid cool air temperatures. Other species have timed their development so that they spend the winter as an egg or as a pupa, usually in a protected area. These stages don't require food and don't move, ideal traits in the dead of winter. Finally, some insects can produce antifreeze compounds in their body to prevent full freezing.

Identifying Insect Pests by Damage

While most insects may not be pests, the ones that are can cause considerable damage and can be expensive to manage. There are multiple categories of pests, clustered based on what they are causing damage to.

- Plant Pests: Plant pests may attack crop plants being grown for food or ornamental plants grown for beauty.
- Urban Pests: Insects and other arthropods that enter structures and cause issues can be addressed as urban pests. Some may be structural pests, such as termites, that actually harm the structure itself. Others may be annoyances, such as home-invading ants. Finally, some may be stored-product pests, organisms that will attack foodstuffs in storage and consume them. Indian meal moth is a good example.

Figure 7.26. Chewing damage can look like this skeletonized leaf, where scarabs have consumed the green tissue and left the veins behind.

Figure 7.27. Sucking damage causes leaves to cup and curl, with pests often hiding in the cupped area.

- Health Pests: These pests may be human health hazards or veterinary issues. Fleas, mosquitoes, and bed bugs are common examples that can serve as vectors for disease or cause emotional distress.

For Master Gardeners, the plant pests are usually the insect pests you will deal with most often. These pests attack different parts of the plant, including leaves, flowers, fruit, stems, and roots. As plant pests feed, they often leave behind diagnostic symptoms that can help to deduce what pest you are dealing with.

Chewing Pests

If pests chew on leaves, they can create damage such as skeletonization, where the leafy tissue is consumed and veins are left behind (Figure 7.26); shot hole damage, showing small, irregularly shaped holes in leaves; and complete defoliation, where the leaves are gone or only the midrib is left. Each of these is associated with specific types of pests; scarab beetles tend to skeletonize leaves, shot hole damage is usually caused by flea beetles, and complete defoliation is usually from caterpillars or sawflies.

Sucking Pests

Pests with piercing and sucking mouthparts will pull fluids from the host plant. This can result in droopy, wilted-looking leaves; cupped leaves; leaf yellowing; and early leaf drop (Figure 7.27). Sucking pests also generally produce honeydew, a sticky fecal material found near the population of pests.

Mining and Boring Pests

The mature stages of these plant pests feed inside of part of the host plant. Leafminers create diagnostic mines in the leaves of host plants. These tunnels can be noticed from the outside. There are three types: serpentine mines, blotch mines, and linear blotch mines. The shape, paired with the host plant name, will usually reveal what species is the problem. Wood-boring pests can create distinctive piles of frass on the outside of infested trees or leave behind diagnostic exit holes when they emerge as adults.

Gall Makers

These insects use secretions to induce the larval host plant to form a "home" around the immature insects. These galls come in different shapes and sizes; some look like small fingers, and others like apples. They can appear on leaves or stems. Usually, they present no hazard to the plant.

Aside from these direct feeding or damage issues, some insects serve as plant pathogen vectors as well. This is similar to human health pests: the insect picks up a pathogen from one host plant and then moves it to another host plant, proliferating the disease. Sucking pests, such as aphids, thrips, planthoppers, leafhoppers, and mites, are most commonly associated with disease vectoring, though some specific bark beetles may also serve as vectors.

Insect plant-disease vectors may have pathogens on their bodies or inside their mouthparts, prompting transmission. Some may indirectly spread disease by damaging the plant and creating a wound that a pathogen will enter to infect the host plant. Others may purposefully move fungal pathogens from tree to tree in order to grow them and consume them.

Abbreviated Guide to Pest Management on Plants

Management of plant pests should be done through an integrated pest management (IPM) approach (See Chapter 10, Integrated Pest Management, for more information). This means thinking about ways to utilize all of the tools for pest suppression that are available, rather than relying on any one kind of management method.

- Pest problems can be prevented somewhat by making sure that the right plant is put in the right place. Choosing species or varieties not adapted for Kentucky can lead to higher stress for the plant, reducing defense and making the plant more attractive to arthropod pests. Further, when planting, consider selecting varieties that are pest resistant.
- Avoiding monocultures when planting creates more diversity for the landscape and can also help minimize pest populations. Diverse plants can also mean more natural enemies, such as predaceous insects, in the landscape.
- Using good cultural practices such as sanitation of gardens in the fall can help by removing overwintering habitat for pests like squash bugs. Sanitation can also include the removal and destruction of diseased or heavily infested plants. Other cultural practices include proper watering, fertilization, and pruning.
- Monitoring for pests by observing plants in the landscape, regular sampling, or setting out traps can alert us to when pest populations are rising and becoming a problem before severe damage has occurred. Monitoring also allows for pest identification, which can help to provide more specific pest management solutions.
- Natural enemy populations help to suppress but not eliminate pests. Adjusting expectations for the landscape from perfection to a more natural equilibrium allows for beneficial predators and parasitoids to exist and function in a healthier ecosystem.
- Insecticides can be deployed for pest outbreaks or for issues with invasive species that don't have a natural solution. Organic and biorational products can be sprayed, hopefully with less impact on non-target organisms such as pollinating insects.

By following an integrated approach, growers can reduce reliance on insecticides and keep themselves and the environment healthy.

Other Resources to Consider:

Books
Garden Insects of North America by Whitney Cranshaw
Tracks and Signs of Insects and Other Invertebrates by Charney and Eisman

Web Resources
Kentucky Pest News
https://kentuckypestnews.wordpress.com/
University of Kentucky Department of Entomology Factsheets
https://entomology.ca.uky.edu/entfacts

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