Getting to know the insects

IOWA STATE UNIVERSITY
Extension and Outreach
Agriculture and Natural Resources

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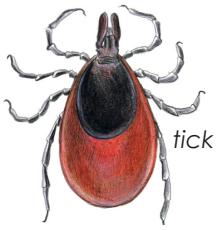
I. INSECTS AND THEIR RELATIVES

Every organism, including insects, are given an unique scientific name and grouped into a hierarchy system for easy reference. This is a standard method used around the world. The hierarchical system is as follows:

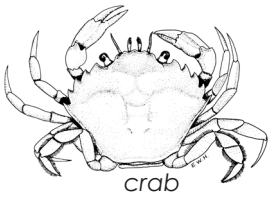
Kingdom → Phylum → Class → Order → Family → *Genus Species*

Use this acronym to remember the sequence: "*King Phillip Called On Five Giant Soldiers.*" Identifying insects to genus and species often takes an expert, so don't feel disappointed if you have trouble with this part! Some of the easily recognized insects also get a common name because the scientific name can be difficult to pronounce. Although common names are useful, an insect with a common name in Iowa doesn't necessarily have the same common name in New York. In the United States, common names are standardized by the Entomological Society of America (*www.entsoc.org*).

Insects are organisms in the **Kingdom** Animalia. All the animals are then grouped into several phyla with similar internal and external characteristics. The insects are in the **Phylum** Arthropoda because they have an exoskeleton with segmented bodies and jointed appendages. Arthropods are divided into classes, such as Arachnida, Chilopoda, Crustacea, and Diplopoda. Insects belong to the **Class** Hexopoda. The following descriptions of the most common arthropod classes:


tick

• **Arachnida** (spiders, ticks, mites, scorpions) – a very diverse arthropod class, most are predatory. Arachnids have two major body regions (cephalothorax and abdomen) and four pair of legs, but lack antennae and wings.

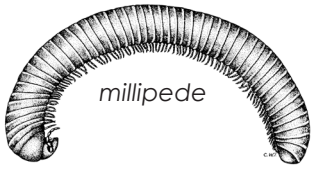

crab

• **Crustacea** (crayfish, lobsters, crabs, pillbugs) – mostly an aquatic group. Crustaceans have two body regions (cephalothorax and abdomen), two pair of antennae, and at least five pair of legs.


centipede

• **Chilopoda** (centipedes) – members are predatory and can inflict painful bite. Centipedes have two body regions (head and trunk), flattened body shape, one pair of legs per segment and one pair of antennae.

• **Diplopoda** (millipedes) – members are herbivores. Millipedes have two major body regions (head and trunk), rounded body shape, two pair of legs per segment, and one pair of antennae. Millipedes are rarely plant pests, but large numbers can congregate in window wells and other damp places.


millipede

• **Hexapoda** (insects, springtails, diplurans, and proturans) – members have diverse feeding habitats. Hexapods have three major body regions (head, thorax, abdomen), three pair of legs, two pair of wings (except primitive forms and flies), and one pair of antennae.

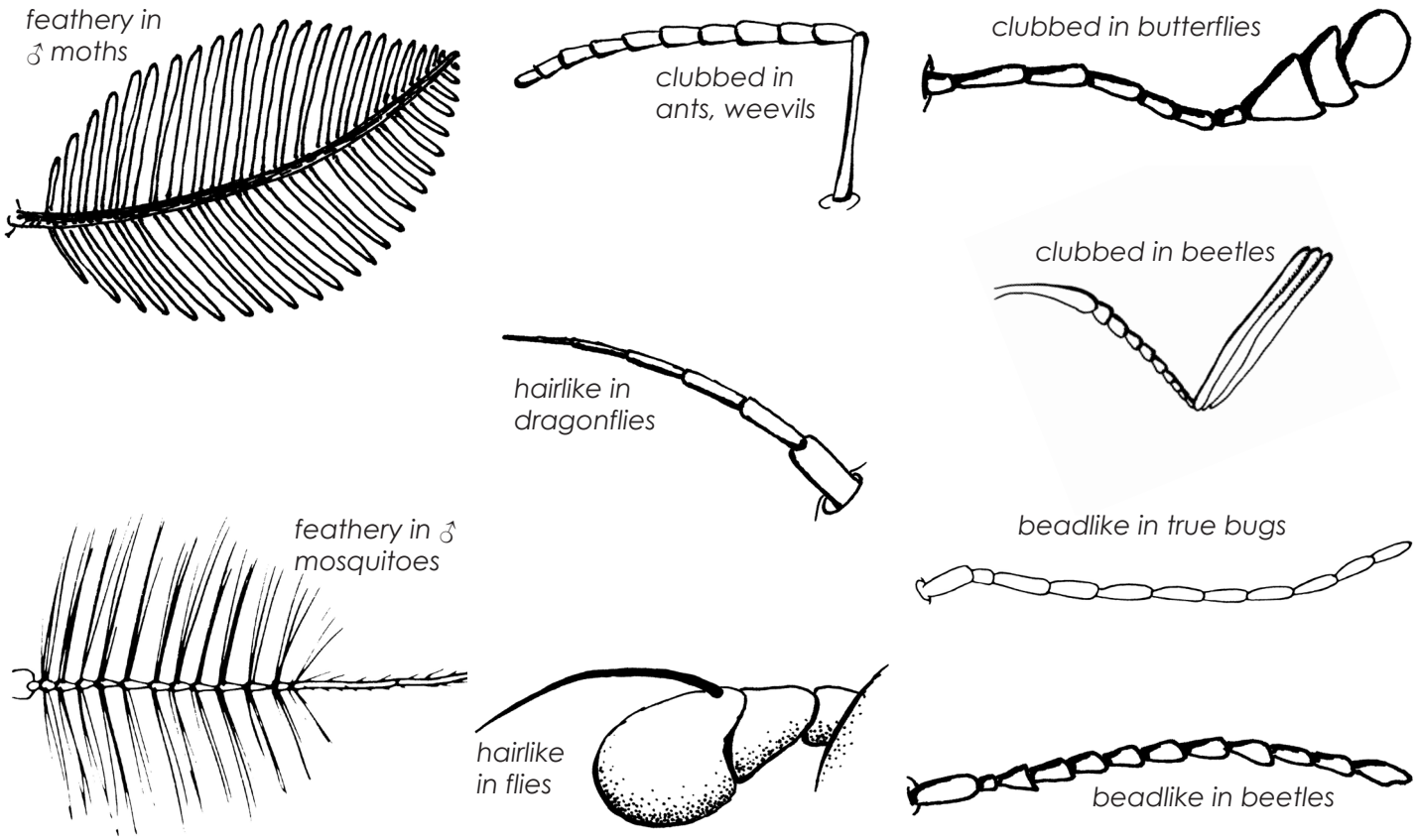
II. INSECT ANATOMY AND BIOLOGY

A. The Insect Body

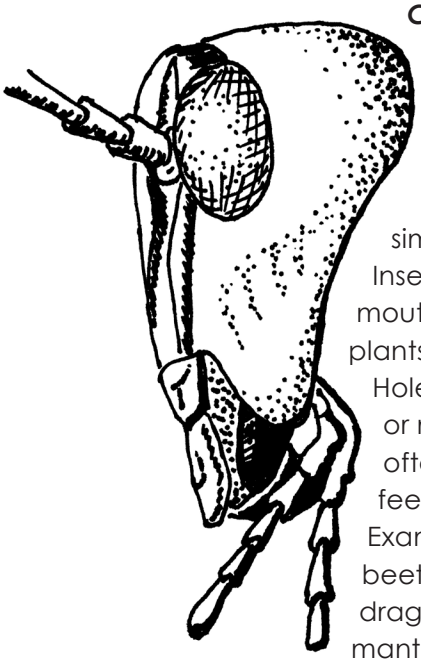
1. *Overall Body Plan*. Insects are very successful animals for several reasons, including a strong exoskeleton with jointed appendages, the ability to fly, and diverse feeding habits. The **exoskeleton** is very rigid and strong, and is made up of many waxy layers called the cuticle. The exoskeleton offers protection against predators, reduces water loss, provides a place for muscle attachment, and inhibits disease from entering the body. Jointed appendages allow for flexibility during feeding and locomotion. Flight has enabled insects to migrate long distances and live in many different habitats.

Adult insects consist of three major body regions: **head**, **thorax**, and **abdomen**. The head is where the mouthparts, eyes, one pair of antennae, and brain are located. The function of the head is for sensory and eating. The thorax is between the head and abdomen, and is where three pair of legs and two pair of wings are located (except for primitive insects which are wingless, and flies which only have one pair of wings). The function of the thorax is locomotion through flight and/or with their legs. The abdomen is the last major body region and is attached to the thorax. In some insects, the major body regions are not distinct because they have become highly modified. Insects are often categorized by their wings, legs, mouthparts and antennae.

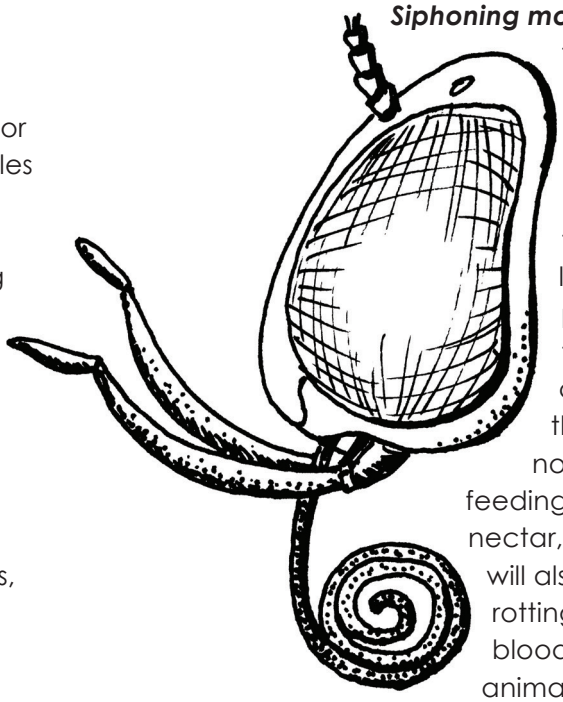
2. *Insect Head* (including antennae and mouthparts). The most obvious features of the insect head are the compound eyes and **antennae**. The antennae are highly variable depending on function and are generally located between the compound eyes. Although some insects have excellent vision (i.e., dragonflies, flies), most insects rely on their antennae to guide them to food and mates. Insect antennae can "taste" the air and send messages to the brain about food, predators and suitable locations to lay eggs. The following drawings are examples of common insect antennae:



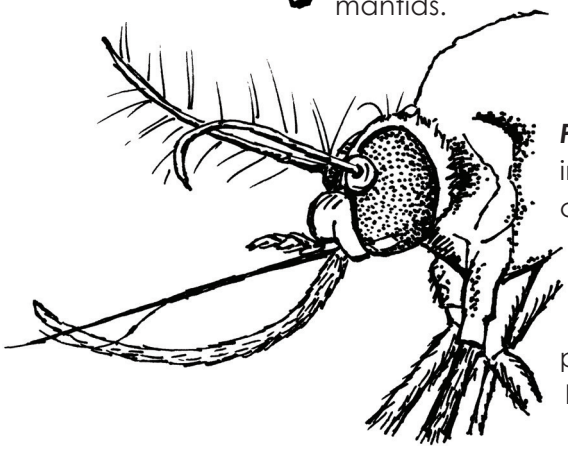
Insects have variable mouthparts that allow them to take advantage of different food sources:



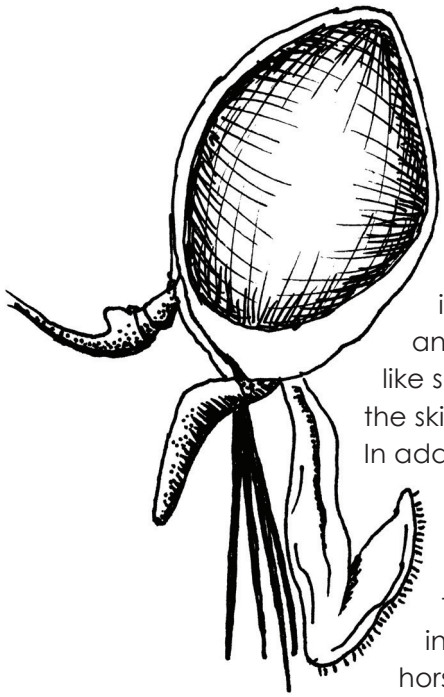
Chewing mouthparts are the most common type for insects. Mandibles rip and chew similar to humans. Insects with chewing mouthparts can eat plants or animals. Holes in leaves or missing tissue is often evidence of feeding on plants. Examples include: beetles, grasshoppers, dragonflies, and mantids.



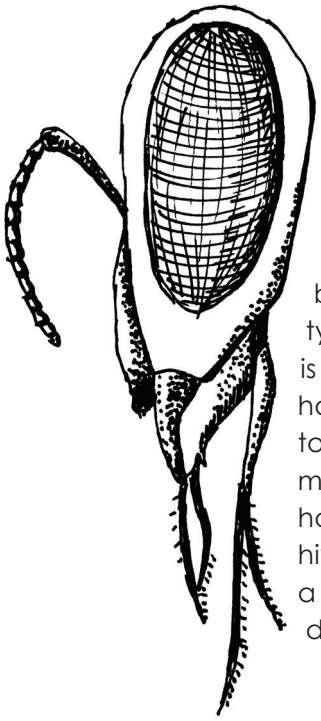
Siphoning mouthparts are found in adult butterflies and moths. These insects suck up liquid food through a straw-like tube called a **proboscis**. Note the mouthpart is coiled up under the head while not feeding. Fluid feeding insects prefer nectar, but some species will also feed on water, rotting fruit juices, blood, or decaying animal tissues.



Piercing-sucking mouthparts belong to another large group of insects. The mandibles have formed a thin tube tor **stylet** hat can pierce plant or animal tissue. Often the mouthparts are tucked under the body while not feeding. Some insects with piercing-sucking mouthparts are capable of vectoring disease, like malaria and bean pod mottle virus. They are considered painless feeders. Examples include: mosquitoes, aphids, plant/leaf hoppers, cicadas, sucking lice, and bed bugs.



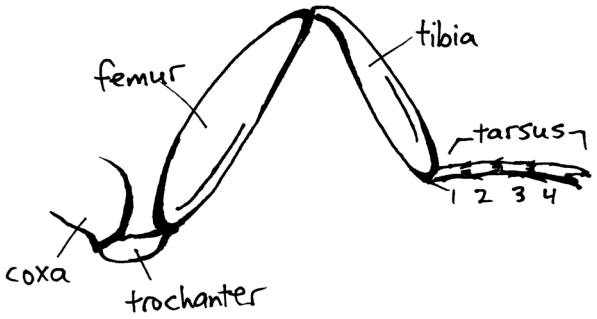
Rasping-sponging mouthparts are highly modified from the basic chewing type. The rasping sponging mouthpart is specialized to cut animal tissue with scissor-like serrated blades. Slicing the skin is often very painful! In addition, to the cutting blades, a sponge-like mouthpart will soak up blood as it pools on the surface. Examples include: deerflies and horseflies.



Chewing-lapping mouthparts are modified from the basic mouthpart type. An example is honey bees that have mandibles to eat pollen and mold wax for the honeycombs in the hive. They also have a lapping tongue for drinking nectar.

3. *Insect Thorax* (including legs and wings). The thorax is made up of three segments: **prothorax** (front), **mesothorax** (middle), and **metathorax** (hind). The prothorax is located directly behind the head and is where the first pair of legs are attached. It can form a protective shield over the head, thorax or abdomen. The mesothorax is between the prothorax and metathorax, and is where the second pair of legs and first pair of wings are attached. The metathorax is located between the mesothorax and the first abdominal segment, and is where the third pair of legs and second pair of wings are attached.

Insect **legs** are freely movable and multi-segmented (coxa, trochanter, femur, tibia, and tarsus). In general, insects have walking legs, but they can be highly modified depending on the function. Some caterpillars will have prolegs on their abdomen and are not considered true legs.



Insect wings are also highly variable depending on the function. In general, the basic insect wing is clear or membranous, but can be thickened for protection, or covered in fine hairs or scales. The wing is supported by thickened veins which aid in flight. Wing texture, shape, venation, and resting position help classify insects.

Insect wings are also highly variable depending on the function. In general, the basic insect wing is clear or membranous, but can be thickened for protection or covered in fine hairs or scales. The wing is supported by thickened veins which aid in flight. Wing venation is not always obvious but the arrangement of veins can help identify insects based on the pattern. Wing texture, shape, venation, and resting position help classify insects. Here is a list of common insect orders with a description of wing types:

• **Beetles** (Coleoptera = sheath winged) – forewings, called **elytra**, are hardened and often cover the thorax and abdomen; hindwings are membranous; at rest, the elytra are held over the back but do not cross over.

• **Earwigs** (Dermaptera = skin winged) – forewings are hardened similar to elytra, but are often shortened leaving the abdomen exposed.

• **Flies** (Diptera = two winged) – forewings are membranous and hindwings have been reduced to small knob-like **halteres.**

• **True bugs** (Hemiptera = half winged) – forewings, called **hemelytra** (the basal half is hardened and the distal half is membranous), and membranous hindwings are crossed over the back at rest.

• **Ants, bees, wasps** (Hymenoptera = membranous winged) – wings are clear.

• **Termites** (Isoptera = equal winged) – wings are of equal size and shape, usually extendidng well past the end of the abdomen.

• **Dragonflies** (Odonata = tooth) – wings are membranous and often have many veins and crossveins.

• **Moths and butterflies** (Lepidoptera = winged) – wings are membranous but covered with many colorful scales that easily come off the wings.

• **Grasshoppers** (Orthoptera = straight winged) – forewings, called **tegmina**, are leathery and held over the back at rest; hindwings are membranous and can be very colorful.

• **Lacewings** (Neuroptera = nerve winged) – wings are membranous and have many veins and crossveins.

• **Thrips** (Thysanoptera = fringe winged) – wing edges have long hairs.

• **Caddisflies** (Trichoptera = hairy winged) – wings covered with many fine hairs; at rest wings are held roof-like over the back, but do not cross over.

B. Respiration, Circulation, Digestion, Excretion

Insects do not have lungs, and **respiration** and circulation are separate networks (unlike in vertebrates where blood and oxygen are delivered through arteries and veins). Instead, fresh oxygen is delivered to the tissues through a complicated network of tubes called tracheae. The tracheae exchange oxygen through **spiracles** (openings) on the side of the thorax and abdomen. Insects have an open circulatory system where hemolymph (similar to our blood) is washed over tissues and organs with a simple heart. The heart delivers essential energy to all the organs and removes waste particles for excretion.

The digestive system of insects is very similar to other animals and is made up of a stomach and intestines to break down food for energy and absorb water. The entire alimentary canal is located within the main body cavity that extends from the mouth to the anus. The digestion and excretory systems are highly variable and depend on the type of food eaten (i.e., liquid or solid). Insects absorb digested materials into the surrounding blood. Waste materials from chewing insects excrete frass pellets and fluid feeders excrete **honeydew.**

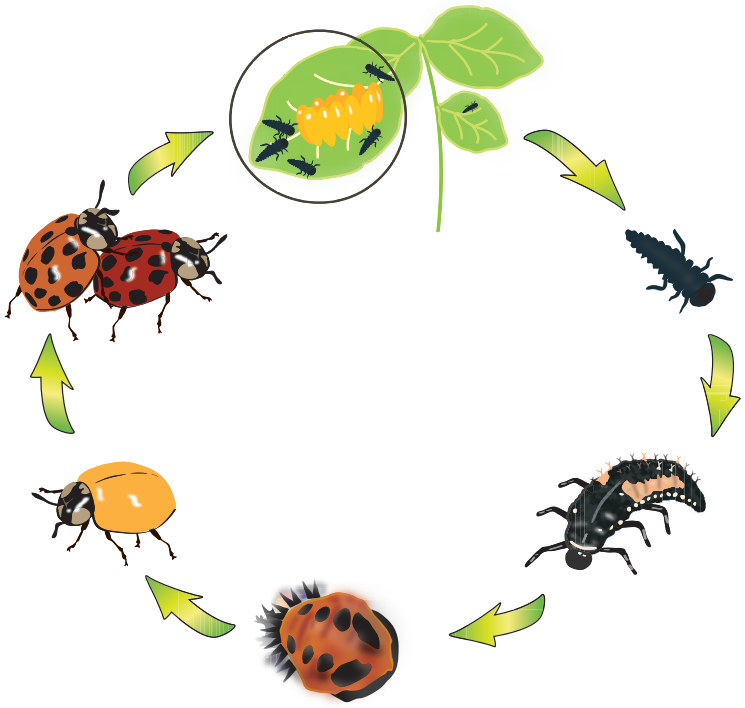
C. Molting and Metamorphosis

Insects have to go through tremendous changes to increase their size and become adults. Instead of growing at a gradual rate like humans and other vertebrates, insects grow in distinct life stages. Their body size is limited by their hardened exoskeleton. **Molting** is the process of shedding the exoskeleton so that their overall body size can increase. Immature insects (nymphs and larvae) are vulnerable to predation during each molting process because the new exoskeleton takes time to completely harden. After the molting process is finished, the insect can no longer expand in size until the next molt.

The insect brain regulates the molting process by releasing molting hormones in the body. Insects are cold-blooded animals and the speed of development is regulated by temperature. The length of time between molts is determined by how much food the insect eats, the quality of food, and other environmental conditions. For example, if the temperature is warm outside, an insect will develop and grow faster than if the temperature is cold. Once an insect becomes an adult, it no longer produces molting hormones and no further growth is possible.

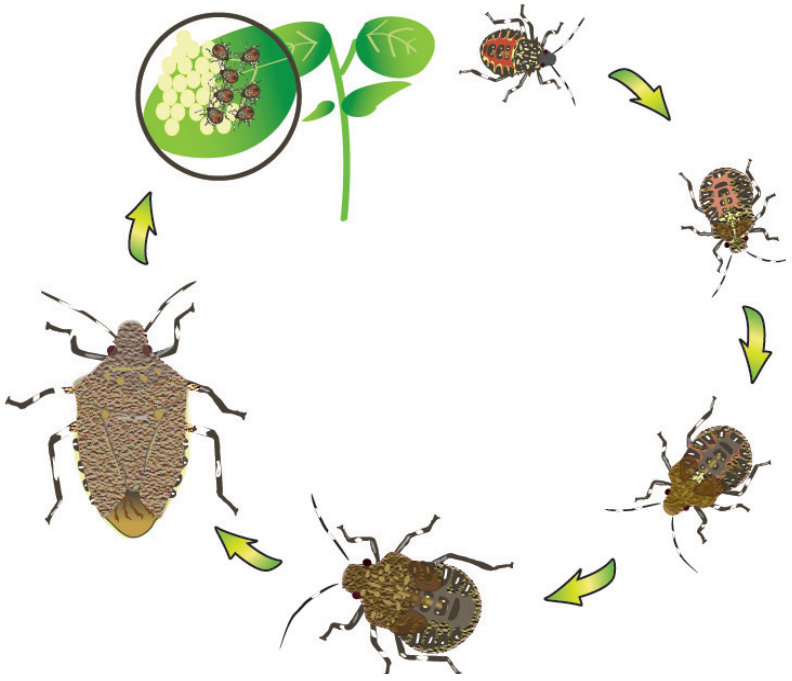
The overall life change an insect goes through to become an adult is called **metamorphosis** or sometimes **life cycle**. Some of the biggest changes include producing wings and reproductive parts. Metamorphosis allows insects to take advantage of different habitats because the immature stages can feed on different food sources. Female insects typically lay eggs on a plant, on the ground or on another animal. Some insects, like aphids (Hemiptera), give birth to live young because the eggs hatch inside the mother. Most insects go through complete or incomplete metamorphosis.

1. Complete metamorphosis is a four-stage process involving an egg, larva, pupa and adult. About 85 percent of insects go through complete metamorphosis. Female insects lay single eggs or egg clusters that hatch into **larvae**. Immatures typically look very different from the adults and are sometimes given specialized names. For example, immature flies (Diptera) are **maggots**, immature butterflies and moths (Lepidoptera) are **caterpillars**, and immature scarab beetles (Coleoptera) are often called **grubs**. Eventually, larvae will become inactive and molt into a non-feeding stage called a pupa. **Pupae** take time to develop complex adult features, such as wings, mouthparts and reproductive organs. Pupae can also have specialized names depending on type. For example, butterfly pupae (Lepidoptera) are **chrysalids**, moth pupae (Lepidoptera) are **cocoons**, and fly pupae (Diptera) are **puparia**. Adults will emerge from pupal cases with fully developed wings ready to fly. Other examples of insects with complete metamorphosis include lacewings (Neuroptera) and ants (Hympenoptera). Often larvae and adults will be feeding in diverse habitats and on different food because the mouthparts can be different. Adult butterflies have siphoning mouthparts and caterpillars have chewing mouthparts.



Example of a complete life cycle

2. Incomplete metamorphosis is a three-stage process involving an egg, nymph and adult. Sometimes this is also called simple metamorphosis. Female insects lay eggs or egg masses that will eventually hatch into small nymphs that are smaller, wingless versions of adults. Nymphs and adults have the same mouthparts and often live in similar habitats. Nymphs molt 3 - 7 times before becoming functional adults; sometimes the nymphs are called **instars**. The nymphs get larger with each molt, and small wing pads gradually develop into wings. Examples of insects with incomplete metamorphosis include grasshoppers (Orthoptera), boxelder bugs (Hemiptera) and walking sticks (Phasmida). Typically eggs or adults are the overwintering life stage.

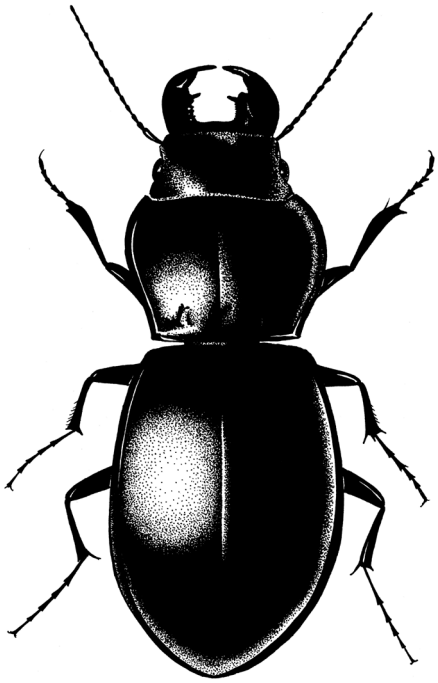


Example of an incomplete life cycle

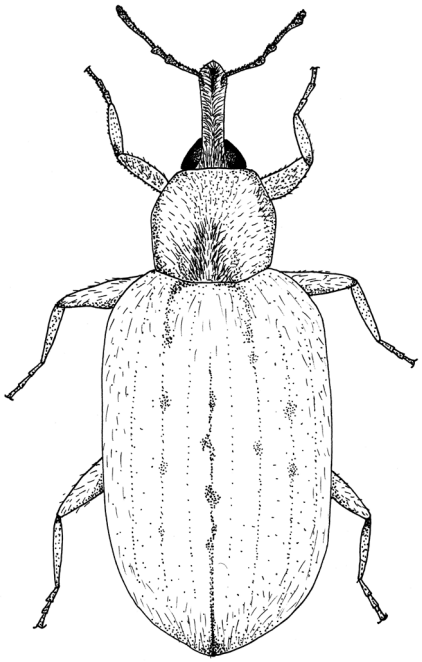
III. IMPORTANT INSECT ORDERS IN FIELD CROPS

A. **COLEOPTERA** – beetles, weevils

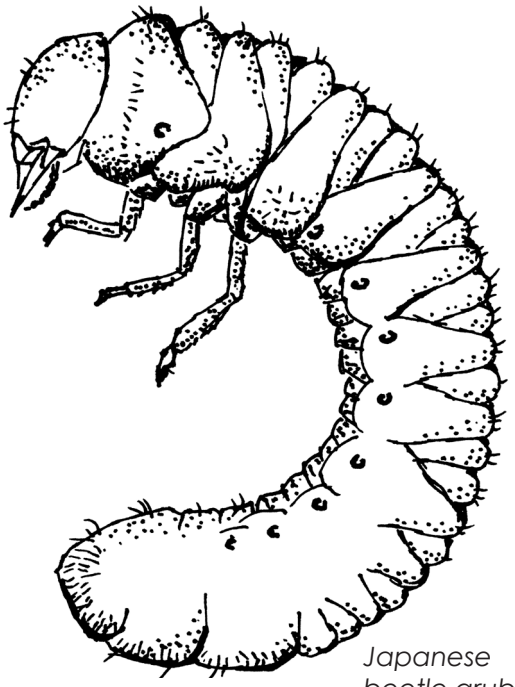
1. Adults have hardened forewings (**elytra**) that cover the thorax and abdomen, and membranous hindwings used for flight. At rest, the elytra are held straight down the back and do not cross over.
2. Chewing mouthparts – can be herbivorous, carnivorous, or omnivorous.
3. Adults have obvious antennae, usually beadlike or clubbed at the end. Weevils have elbowed antennae at the end of a snout.
4. Larvae with obvious head, three pair of legs on the thorax (except weevil larvae are legless), and no prolegs on the abdomen.
5. Complete metamorphosis and 1 - 5 generations per year depending on species. The overwintering stage is variable depending on species.



ground beetle

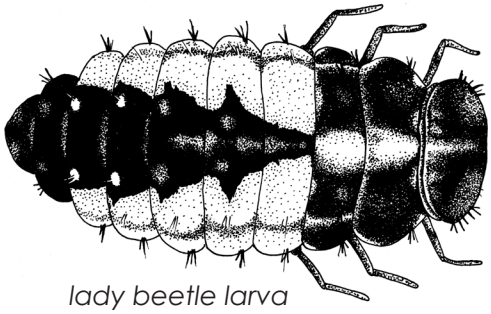


alfalfa weevil



Japanese beetle grub

wireworm larva



lady beetle larva

B. **DERMAPTERA** – earwigs

1. Adults have shortened, hardened wings that do not fully cover the abdomen, and beadlike antennae.
2. Chewing mouthparts – can be herbivorous, carnivorous or omnivorous.
3. Obvious forcep-like pinchers at the end of the abdomen.
4. Require moist, cool places and are nocturnal.
5. Incomplete metamorphosis with one generation per year, and adults are the overwintering stage.

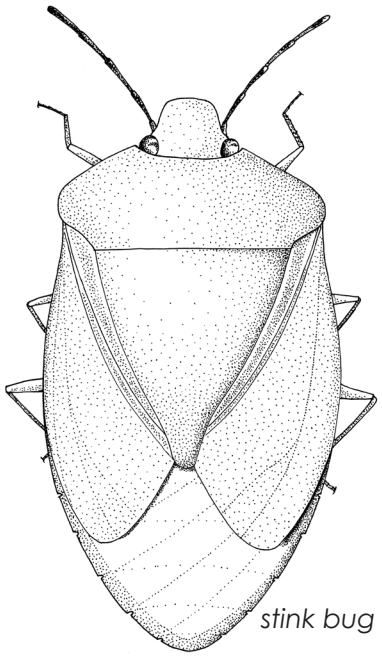
earwig

C. **DIPTERA** – flies, gnats, midges, mosquitoes

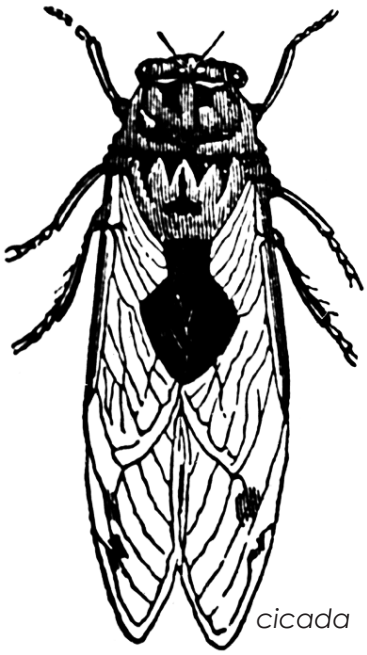
1. Adults have one clear pair of wings and hindwings reduced to knob-like **halteres** for balance.
2. Adult antennae can be feathery or hair-like.
3. Adults can have a variety of mouthparts, including piercing sucking (mosquito), sponging (house fly) or rasping sponging (horse fly).
4. Larvae are legless; generally aquatic and filter organic matter from water; some advanced forms (**maggots**) possess mouth hooks to feed on animals.
5. Complete metamorphosis; multiple generations per year and variable overwintering stages depending on species.

D. **HEMIPTERA** – true bugs (e.g., stink bug, lygus bug), aphids, hoppers, mealybugs, scales

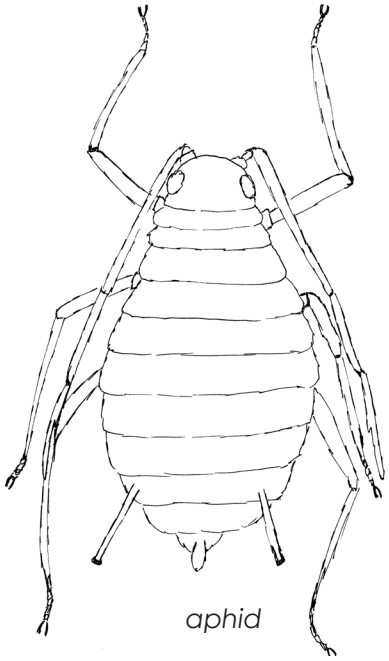
1. True bugs have **hemelytra** forewings (basal half is leathery and distal half is membranous) and membranous hindwings that cross over the back at rest. Other members (e.g., aphids, hoppers) have membranous forewings and hindwings that do not cross over the back.
2. Nymphs and adults resemble each other except adults have fully formed wings.
3. Nymphs and adults are fluid feeders with piercing sucking mouthparts and excrete honeydew. They can be herbivorous or carnivorous, and both life stages feed on the same hosts.
5. Aphids, scales, and mealybugs are soft-bodied, and can be protected in a waxy substance.
6. Incomplete metamorphosis; multiple generations per year and eggs or adults can be the overwintering stages depending on the species.



stink bug



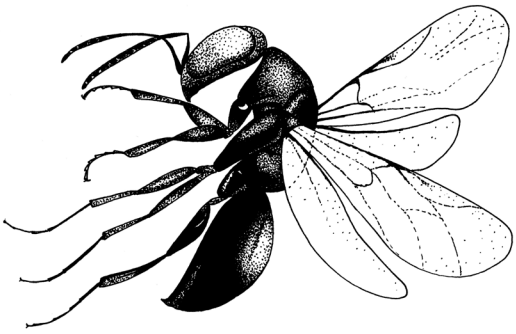
cicada



aphid

E. **HYMENOPTERA** – ants, bees, horntails, sawflies, wasps

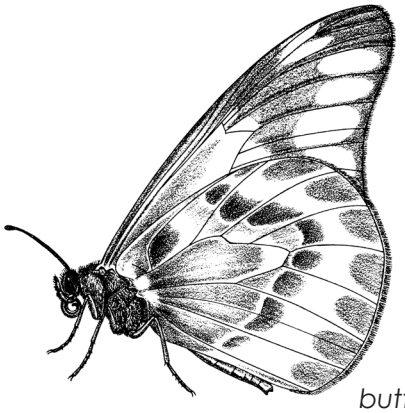
1. Adults have two pair of membranous wings and some females have a sting.
2. Larvae have chewing mouthparts, and can be legless (ants, bees wasps) or have legs and **prolegs**.
3. Adults generally have chewing mouthparts to gather pollen and/or a lapping tougue for nectar. Some are **parasitoids** on aphids and other insects.
4. Complete metamorphosis; multiple generations per year and variable overwintering stages depending on species.



parasitic wasp

F. **LEPIDOPTERA** – butterflies, moths, skippers

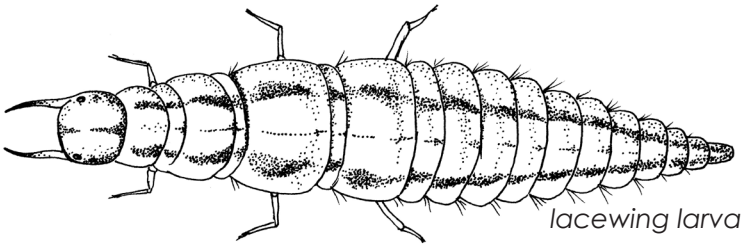
1. Adults have membranous wings covered in numerous scales.
2. Larvae and adults are generally soft-bodied.
3. Larvae have chewing mouthparts and prolegs on the abdomen.
4. Adults have siphoning mouthparts that coil under the head at rest; can have feathery or clubbed antennae.
5. Complete metamorphosis; 1 - 5 generations per year, and the overwintering stage is variable depending on species.



butterfly

G. **NEUROPTERA** – lacewings; and **MEGALOPTERA** – alderflies, dobsonflies

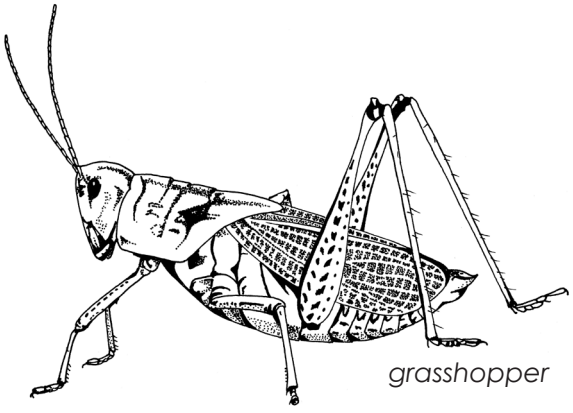
1. Adults have membranous wings with many veins and are nectar feeders.
2. Larvae are predatory and can be aquat
3. Complete metamorphosis; 2 - 3 generations per year and the overwintering stage is variable depending on species.



lacewing larva

H. **ORTHOPTERA** – crickets, grasshoppers, katydids; and **MANTODEA** – mantids

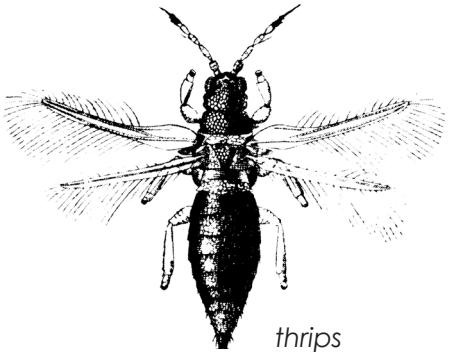
1. Adults have leathery forewings (**tegmina**) and membranous hindwings.
2. Nymphs and adults resemble each other and feed on the same hosts.
3. Nymphs and adults have chewing mouthparts.
4. Hindlegs in Orthoptera are enlarged for jumping, and forelegs in Mantodea are enlarged for grasping prey.
5. Incomplete metamorphosis; multiple generations per year depending on the species, and the overwintering stage is the egg.



grasshopper

I. **THYSANOPTERA** – thrips

1. Adults have membranous wings with long, fringed hairs.
2. Nymphs and adults have punch-sucking mouthparts.
3. Nymphs and adults are soft-bodied inseccts.
4. Incomplete metamorphosis with multiple generations per year.



thrips

IV. COLLECTING AND SAMPLING INSECTS

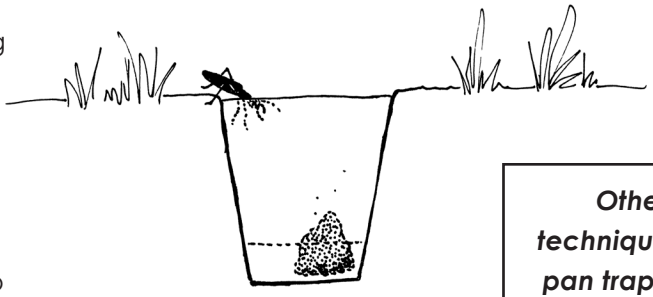
Sweep netting is the most common collecting technique. Nets can be made of a tough canvas for brushing through vegetation or made of a fine mesh for collecting delicate flying insects.

Shake collecting and ***in-field counts*** are common techniques in field crops. Insects that aren't very mobile or easily disturbed, like aphids and caterpillars, will cling to plants. Shake plants on a piece of paper or into a bucket. Sometimes just looking at and counting insects on plants is a very accurate sampling method.

Light trapping is a great technique for observing and collecting night-flying insects. Set up a UV black light, or simply hang out near a porch or street light. Many adult flying insects are strongly attracted to lights.

Aspirators are a less common collecting technique, but are useful when you have quick flying or skittish insects. Whiteflies and parasitoid wasps can be sucked up and collected in a vial for later viewing.

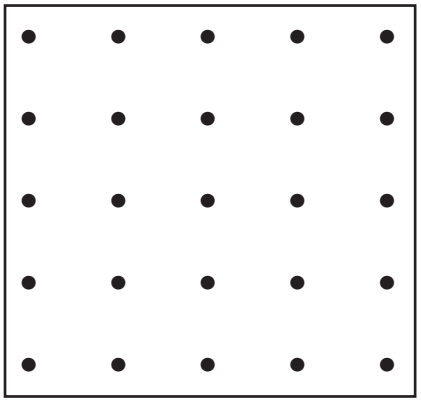
Pitfall trapping is a useful collecting technique to capture running or soil-dwelling insects. Cups are placed flush with the ground, and sometimes a bait is placed in the cup as an attractant. As insects move along the ground, they drop into the cups.



Other insect collecting techniques include sticky traps, pan traps, and berlese funnels.

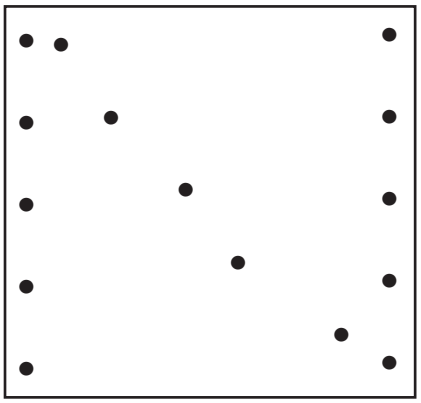
Why are insects so successful?

- small size
- multigenerational
- flight
- metamorphosis
- wide variety of food and habitat choices



Key points about scouting for insects

- start looking before you expect to see them
- sample on a regular basis
- try to sample entire field
- use a defined walking pattern for an unbiased sample



Common tools for scouting insects

- notebook, journal or electronic device (smartphone or tablet)
- sweep net
- hand lens

Recognize insect injury

- chewing insects will remove plant tissue, girdle stems, defoliate, skeletonize, and clip (e.g., beetles, grasshoppers, caterpillars)
- piercing-sucking insects cause discoloration, stippling, mottling, punctures, and stunting (e.g., aphids, leafhoppers, stink bugs

IPM, Integrated Pest Management

- using multiple, proactive tactics to discourage pests
- promoting sustainable agriculture, yield protection and profitable decisions
- ***economic injury level:*** lowest pest population density that will cause economic damage (i.e., bushels per acre in field crops)
- ***economic threshold:*** lowest pest population density at which action should take place to avoid economic injury (i.e., pests per plant or percent defoliation)
- ***gain threshold:*** break even point, based on predicted market value and control costs, at which action should take place (note: does not take pest biology in account)

V. USEFUL REFERENCES

Borror and DeLong's Introduction to the Study of Insects, 7th ed. 2004. N.F. Johnson and C.A. Triplehorn. Brooks Cole. ISBN 0030968356.

Entomology and Pest Management, 6th ed. L.P. Pedigo and M.E. Rice. 2008. Prentice Hall. ISBN 0135132959.

Garden Insects of North America: the ultimate guide to backyard bugs. 2004. W. Cranshaw. Princeton University Press. ISBN 0691095612.

The Practical Entomologist. 1992. R. Imes. Fireside. ISBN 0671746952.

VI. USEFUL ONLINE TOOLS

4-H Youth Development Programs, *http://oregon.4h.oregonstate.edu/faculty-staff*

BugGuide, *http://bugguide.net*

Creating an entomology project, *https://www.ent.iastate.edu/soybeanresearch/content/extension*

VII. GLOSSARY

Abdomen – the third major body region of an insect, following the head and thorax, where digestion, excretion, and respiration occur.

Antennae – pair of segmented appendages located on the head near the eyes used for sensory.

Anterior – in front of, before.

Appendages – any part attached by a segmented joint to the body, including legs and antennae.

Carnivorous – a flesh eater; see herbivorous and phytophagous.

Caterpillar – larva of butterflies, moths or skippers (Lepidoptera).

Chewing mouthparts – mouthparts with mandibles fitted for chewing.

Chrysalid – the pupa of a butterfly (Lepidoptera); sometimes called a chrysalis (plural, chrysalids or chrysalides).

Cocoon – a covering of the pupa, partly or wholly made of silk of many Lepidoptera and Trichoptera.

Coxa – the basal segment of the leg, between the thorax and trochanter.

Cuticle – a waxy secretion covering the body that prevents water loss and invasion of foreign bodies.

Detritivorous – feeding on organic matter; see necrophagous and saprophagous.

Dorsal – the upper surface.

Elytra – the leathery, hardened forewing of beetles (Coleoptera) and earwigs (Dermaptera) forming a cover to protect the hindwings and abdomen; see hemelytra and tegmina.

Exoskeleton – the external skeleton made up of a hardened cuticle and where the muscles are attached.

Femur – the third and usually stoutest segment of the leg, between the trochanter and tibia.

Forelegs – the first pair of legs attached to the first thoracic segment (prothorax).

Forewings – the first pair of wings attached to the second thoracic segment (mesothorax); can be thickened to protect the hindwings and abdomen.

Frass – insect excrement often mixed with plant or animal fragments.

Grub – a generalized term used to describe a larva, particularly a scarab beetle (Coleoptera: Scarabeidae).

Haltere – modified hindwing for sensory, balance and stability during flight of Diptera.

Head – first major body region, before the thorax, where the brain, mouthparts, eyes and antennae are located.

Hemelytra – basal portion or anterior forewing which is thickened in certain Hemiptera; see elytra and tegmina.

Herbivorous – feeding on non-woody plant tissue; see carnivorous and phytophagous.

Hindlegs – the third pair of legs attached to the third thoracic segment (metathorax).

Hindwings – the second pair of wings attached to the third thoracic segment (metathorax).

Honeydew – sugary fluid excreted from fluid-feeders such as aphids and leafhoppers (Homoptera).

Host – the organism in which a parasite or parasitoid lives on or in to develop.

Immature – the life stage before the adult (imago) commonly referred to as nymph or larva.

Instar – stage between molts of immature insects.

Invertebrate – with a backbone.

Larva – the immature stage between the egg and pupal stages of insects with complete metamorphosis. *Note*: the term larva is now often incorrectly used to describe the immature stages of all insects; see nymph.

Lateral – related to or attached to the side.

Leg – one of paired jointed appendages of the thorax; used for locomotion, defense and bringing food to the mouth; usually consisting of the coxa, trochanter, femur, tibia, tarsus and pretarsus.

Life cycle – the series of developmental changes insects undergo to sustain a population, including fertilization, reproduction and death.

Maggot – legless larva lacking a distinct head usually used to describe certain Diptera.

Mandible – tooth-like structure in chewing insects; often used to crush, chew or puncture cells.

Maxilla – pair of secondary jaws found behind the mandibles (plural, maxillae).

Mesothorax – the second thoracic segment where the second pair of legs and first pair of wings are attached.

Metamorphosis – series of changes an insect passes through in its growth from egg to adult.

Metathorax – the third thoracic segment where the third pair of legs and second pair of wings are attached.

Molting – shedding of the exoskeleton and development of a new cuticle to increase overall body size and sometimes to attain more adult features.

Monophagous – feeding on one kind of food, such as one plant species; see oligophagous, omnivorous and polyphagous.

Necrophagous – feeding on dead or decaying material; see detritivorous and saprophagous.

Nectar – sugary secretion of the plant, produced by the flowers; a food source of Lepidoptera and some Diptera.

Niche – specialized geographical location or unique habitat for feeding or breeding.

Nymph – an immature stage of insects with simple metamorphosis; see larva.

Oligophagous – having a restricted range of plant food choices; an example would be a single family or a single genus of plants; see monophagous, omnivorous and polyphagous.

Omnivorous – feeding generally on animal or vegetable food or both.

Ootheca – a collection of enclosed eggs; examples include cockroaches (Blattaria) and praying mantids Mantodea).

Order – a group of closely related families.

Ovipositor – the organ in which eggs are deposited, formed by a prolongation or modification of the posterior end of the female abdomen.

Parasite – any organism that lives in or on another host to obtain shelter or food; typically does not kill the host; see host, hyperparasitism and parasitoid.

Parasitoid – any organism that lives in or on another host to obtain shelter and food; typically will kill the host; see host, hyperparasitism and parasite.

Parthenogenesis – egg development without fertilization; an example is aphids (Homoptera).

Piercing-sucking mouthparts – mandibles and maxillae have been modified for piercing plant or animal tissue; examples include aphids (Hemiptera) and mosquitoes (Diptera).

Polyphagous – eating many different kinds of food; see monophagous, oligophagous and omnivorous.

Posterior – hind or rear.

Predaceous – preying upon other organisms as larvae or adults; examples are Coleoptera, Dermaptera, Odonata and Mantodea.

Predator – an organism that kills other animals for food.

Proboscis – any extended mouth structure; examples include Hemiptera, Homoptera and mosquitoes (Diptera).

Proleg – any appendage that serves the purpose of a leg; fleshy and on the abdomen of caterpillars (Lepidoptera).

Prothorax – the first thoracic segment where the first pair of legs are attached; can be highly modified to conceal the head or abdomen.

Pupa – the inactive stage, between larva and adult, of insects that go through complete metamorphosis; called chrysalids in butterflies (Lepidoptera), cocoons in moths (Lepidoptera) and puparia of certain flies (Diptera) (plural, pupae).

Puparium – a hardened case made from the skin of the last larval stage in certain Diptera.

Rasping-sponging mouthparts – slashing mouthparts that cut animal skin followed by sponging mouthparts that soak up blood.

Respiration – breathing through spiracles to deliver oxygen to all the cells of the body while removing carbon dioxide as waste.

Saprophagous – feeding on dead or decaying animal or vegetable material; see detritivorous and necrophagous.

Scale – a flat outgrowth of the body wall typically as modified hair-like setae on the body and wings of Lepidoptera; or a waxy protective covering in certain families in Homoptera.

Scavenger – an animal that feeds on dead plants, animals, decaying materials or animal wastes.

Segment – subdivision of the body or an appendage between areas of flexibility.

Spiracle – external opening found on the lateral edge of the abdomen; used for gas exchange in the tracheal respiratory system.

Sponging mouthparts – an advanced fly (Diptera) with nonbiting mouthparts lacking stylets in which liquid is "sopped" up.

Stylet – a small, stiff process that may be modified mouthparts for piercing plant or animal tissue.

Tarsus – the leg segment having 1 to 5 tarsomeres, attached to the tibia, also bearing the pretarsus (plural, tarsi).

Tegmina – a hardened, leathery forewing with reduced wing venation typically found in grasshoppers, crickets and katydids (Orthoptera); see elytra and hemelytra.

Tibia – the fourth leg segment between the femur and tarsus (plural, tibiae).

Thorax – the second major body region, between the head and abdomen, of the insect body where the legs and wings are attached; see prothorax, mesothorax and metathorax.

Trachea – spirally-ringed air tubes for respiration.

Trochanter – the second leg segment, between the coxa and femur.

Ventral – the underside of the body.