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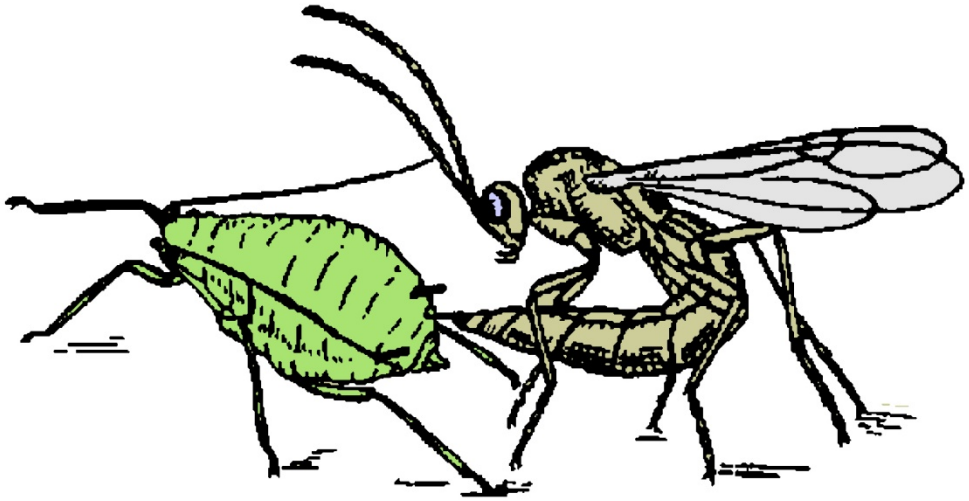

Identifying Insects

Reference

CMG GardenNotes

#310 Identifying Insects: Reference and Study Questions
#311 Taxonomy of Arthropods (Insects and Insect Relatives)
#312 Insect Anatomy and Growth
#313 Insect Orders
#314 Key #1—Key to Insects Associated with Gardening
#315 Key #2—Key to Insect Orders
#316 Worksheet: Identifying Insects
#317 Homework: Identifying Insects
#318 Homework: Entomology

Books

- ***Garden Insects of North America*** by Whitney Cranshaw. Princeton University Press. 2004.
- ***Insects and Diseases of Woody Plants of the Central Rockies*** by Dr. Whitney Cranshaw, Colorado State University Extension # 506A. 2004.
- ***Pests of the West*** by Dr. Whitney Cranshaw. Fulcrum Publishing. 1998. ISBN: 1-55591-401-2

Curriuclum developed by David E Whiting, Extension Consumer Horticulture Specialist (retired), Colorado State University. Revised by Mary Small, Colorado State University Extension.

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Learning Objectives

At the end of this unit, the student will be able to:

- Identify common insects to taxonomic orders.

Review Questions

1. Describe the identifying characteristics of the following orders:

   a. *Coleoptera* (beetles)
      1) Adults
      2) Typical *grubs*
      3) Some borer larva in trees

   b. *Diptera* (flies)
      1) Adults
      2) Larva: *maggot*

   c. *Hemiptera*, *Suborder Heteroptera*,(true bugs)

   d. *Hemiptera, suborder Homoptera*
      1) Aphids
      2) Scale

   e. *Hymenoptera* (bees, wasps, sawflies, etc.)
      1) Adults
      2) Sawfly larva

   f. *Lepidoptera*
      1) Adults (butterflies, moths)
      2) Larva: *caterpillars*

   g. *Orthoptera* (Grasshoppers, katydids, and crickets)

2. How do you quickly tell the following orders of insects apart?

   a. Caterpillars (*Lepidoptera* larva) from sawfly larva (*Hymenoptera*)
   b. *Diptera* adults (flies) from *Hymenoptera* adults (bees, sawflies, hornets etc.)
   c. Hemiptera, *Homoptera* suborder nymphs from *Heteroptera* suborder nymphs
   d. Hemiptera, *Homoptera* suborder adults and *Hemiptera* suborder adults
   e. *Beetles* (Coleoptera) from true bugs (*Hemiptera, suborder Heteroptera*), and cockroaches (*Blattaria*)

3. What orders and families have maggot or maggot-like larva?

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CMG GardenNotes #311

Taxonomy of Arthropods
(Insects and Insect Relatives)

Outline:

Introduction

Insects and Mankind

Insects are the most abundant and diverse form of life found on earth. Over three-quarters-of a million species are known to exist, more than the number of all kinds of animals and plants put together. Insects are a vital part of the world's ecosystem.

Insects are a major link in the world food chain. Insects like bees, wasps, flies, bugs, and beetles pollinate crops. Insects destroy various weeds in the same manner that they can injure crops. Insects improve the physical conditions of the soil, and promote its fertility by decomposing plant residues and aerating the soil. Insects help control insect pests as predators and parasites. Only a few of the thousands of species are pests of mankind or his crops.

Most books list insect pests according to host plants, or by orders (beetles, bugs, flies, etc.) and families (aphids, scales, leaf beetles, etc.). When gardeners can identify insects to order, they will be able to identify the majority of pests by the process of elimination. Most routine garden pests are readily identifiable to order, some to families. However, there are always a few insects, with atypical appearances, that do not fit standard descriptions.

Insect Orders

"Order" is one of the levels of taxonomy. Most common names for insects describe the insect *orders*. For example, "beetle" is the common name for members of the *Coleoptera* order, and "butterflies" and "moths" for the *Lepidoptera* order.

Insect Identification

Identifying an insect is easy when:

- The insect is large enough to see.
- The insect is associated with plant damage.
- The insect has typical characteristics for the order and family.

Insect identification is more difficult when:

- The insect is too small to see characteristics.
- The insect is not associated with plant damage.
- The insect has atypical characteristics for the order or family.
- The insect has moved on, leaving only damage symptoms.

Taxonomy of *Arthropoda* (Insects and Insect Relatives)

The phylum *Arthropoda* includes insects, plus spiders, mites, tick, sowbugs, centipedes, millipedes, and more. They are characterized by chitinous exoskeletons, segmented bodies and jointed appendages.

Class

- ***Arachnida*** — Spiders, mites, ticks, scorpions, and daddy-long-legs
- ***Chipoda*** — Centipedes
- ***Crustacae*** — Lobsters, crabs, shrimp, sowbugs, and pillbugs
- ***Diplopoda*** — Millipedes
- ***Symphyla*** — Garden centipedes
- ***Hexapoda*** (or *Insecta*) — Insects

Orders of Hexapoda

- ***Coleoptera*** — Beetles
- ***Diptera*** — Flies
- ***Lepidoptera*** — Butterflies and moths
- ***Hemiptera*** — True bugs
- ***Homoptera*** — Aphids, cicadas, leafhoppers, scales
- ***Hymenoptera*** — Ants, bees, hornets, sawflies, wasps
- etc.

Family

Some insects, such as beetles, are easy to identify to family, while others, like flies, are more difficult.

Genus and species

Actual identification of an insect to genus and species requires a very high level of expertise.

Insect Relatives

Class: *Arachnida*
Spiders, Mites, Ticks, Scorpions, Daddy-Long-Legs

Arachnids (spiders, mites, and ticks) have four pair of legs and two body regions, the ***cephalothorax*** (a fusion of head and thorax) and the abdomen. [Figure 1]

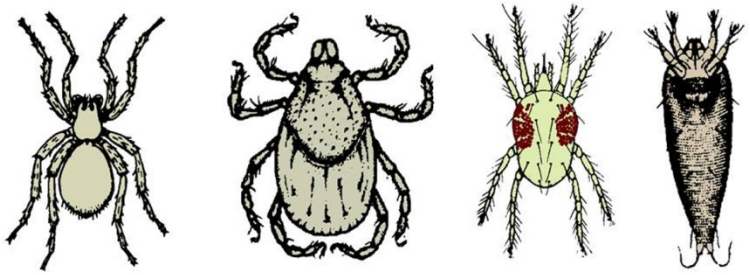

Figure 1. Arachnids (left to right): spider, dog tick, two-spotted mite, eriophyid mite

Class: *Crustacea*
Sowbugs, Pillbugs, Shrimp, Lobster, and Crayfish

Pillbugs and sowbugs are land crustaceans that usually have 5-7 pair of legs. They have two pair antennae and two body regions. The pillbug will roll into a ball, the sowbug cannot. [Figure 2]

Pillbugs and sowbugs are organic matter feeders, occasionally feeding on tender roots. Pillbugs and sowbugs can become a pest when numbers become very high or when they invade a home.

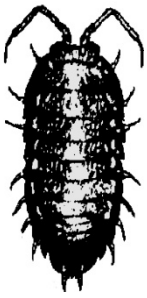

Figure 2. Sowbug

Class: *Diplopoda*
Millipedes

Millipedes have <u>two pair of legs per body segment</u> (except the first three). The body is usually cylindrical, 1 to 1 1/2 inches long, with short antennae. They may have 15 to 150 body segments, with 30 being common. [Figure 3]

Millipedes are usually found in damp and dark places, such as under leaves, under stones or boards, in rotting wood and in soils high in organic materials. If touched or picked up when crawling, they will curl up. They frequently invade homes, especially after a heavy rainstorm. They are not known to bite people. However, some species will give off an ill-smelling fluid. Most are scavengers and feed on decaying plant materials and overripe fruit. A few species attack living plants.

Figure 3. Millipede

Class: *Chilopoda*
Centipedes

Centipedes have flattened bodies with typically 40-50 body segments and one pair of legs per body segment. [Figure 4]

They are predatory, feeding on small spiders, carpet beetles, sowbugs, millipedes, and other small insets.

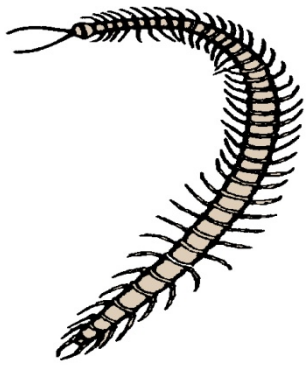

Figure 4. Centipede

Class: *Symphyla*
Garden Centipede

Garden centipedes are small (1/4" long), translucent relatives of centipedes. They have 12 pairs of legs at maturity and are usually found in the upper 6 inches of soil. They feed on germinating seeds and underground parts of plants. Centipedes, predatory mites and predaceous ground beetles are predators of symphylans.

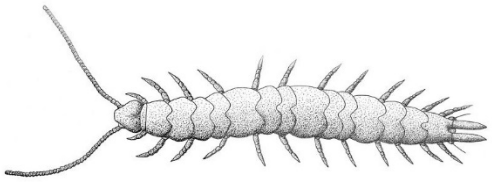

Fig 5. Garden Symphylan

Author: David Whiting, Consumer Horticulture Specialist (retired), Colorado State University Extension.
Line drawings: USDA; Symphyla: Wikimedia Commons. Revised by Mary Small, CSU Extension.

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Insect Anatomy and Growth

Outline

Identification and classification of insects is based on their structure and physiology. A basic understanding of insect physiology will enable the gardener to identify most insects to order and some to family.

External Structure

The exterior body wall, called an ***exoskeleton***, provides the structural support for the insect. It is composed of five distinct layers made of waxy lipoproteins and *chitin* (a cellulose like polymerized glucosamine). The acid resistant exoskeleton protects the insect from excessive dryness, humidity, and disease organisms.

This external skeleton is somewhat cylindrical and typically made up of 21 hardened, ring-like *segments*. These segments are arranged in three groups or body regions, the ***head***, ***thorax*** and ***abdomen***. The body may be covered by ***setae*** (hairs) and may have external protuberances, such as horns, spines, or spurs. [Figure 1]

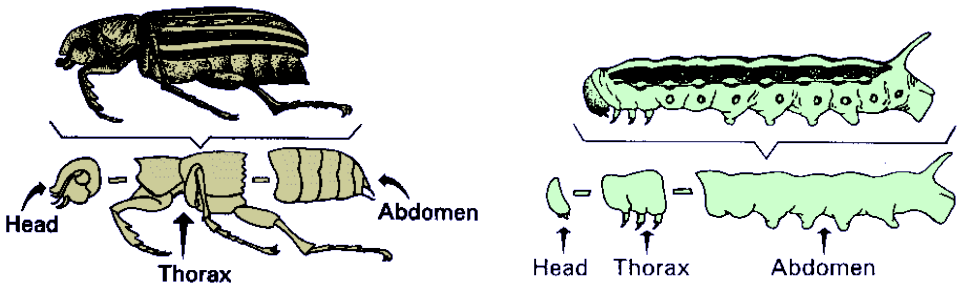


Figure 1. Body regions of beetle (left) and caterpillar (right).
[Line drawing: Colorado State University Extension]

Head

The head serves as a sensory center and for the intake of food. Main features of an insect's head include the eyes, antennae, and mouthparts.

Eyes

Insects have two types of eyes. To detect movement, most adult insects have a pair of lateral **compound eyes** comprised of multiple *ommatidium* (cornea). The number of ommatidia in the eye determines how well insects see. For example, dragonflies have approximately 50,000 per eye, house flies about 4,000 and ants about 50. These large compound eyes often occupy the greater portion of the insect head. Insects with large compound eyes are often predators, while insects with small compound eyes are often the prey. [Figure 2]

The ***ocelli*** or simple eyes are used for light responsiveness. Two or three are typically located between the larger compound eyes on most insect adults. Some immatures may have one to eight lateral ocelli. [Figure 2]

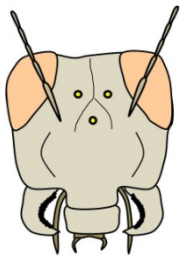


Figure 2. Grasshopper head; note large eyes, three ocelli between eyes, and large mandibles (chewing mouthparts). [Line drawing: David Whiting]

Antennae

All adult insects and many immature stages have a pair of segmented antennae, used for sensory function. Many modifications in form occur and these variations are often used in identification.

Mouthparts

The most remarkably complicated structural feature of insects is the mouth. Mouthparts are modified for various types of feeding, chewing, or sucking.

The ***mandibles*** or ***chewing mouthparts*** move horizontally on insects. Insects with chewing mouthparts consume the plant or insect they are feeding upon. [Figure 3]

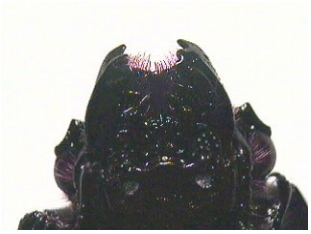


Figure 3. Chewing mouthparts of a beetle. [Photograph by David Whiting]

Sucking-type mouthparts vary greatly for different feeding habits. ***Piercing-sucking*** mouthparts are typical of the *Hemiptera* (true bugs), *Homoptera* (aphids, scales) and blood sucking lice, fleas, mosquitoes, and the so-called biting flies. These are designed to punch and suck on the plant's sap, victim's blood, or in the case of predatory insects to suck out the insides of the victims. [Figures 4 & 5]

Figure 4. **Piercing-sucking mouthparts of a cicada** — Insects with piercing-sucking mouthparts feed on plant sap, blood, or in the case of predators, their victim's insides. They do not consume the plant or insect tissues. [Photograph by David Whiting]

Figure 5. **Lapping mouthparts** — Flies are an example of an insects with lapping mouthparts. . [Line drawing: Colorado State University Extension]

The **siphoning** type found in butterflies and moths is a long coiled tube designed to suck up nectar. It looks like a cinnamon roll coiled up under the head. [Figure 6]

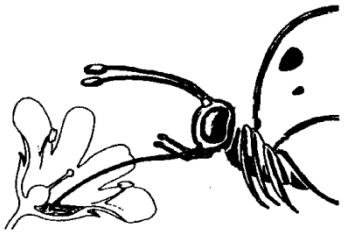


Figure 6. **Siphoning mouthparts** — Butterflies and moths have a coiled siphoning tube. To reach the nectar in flowers, the uncoiled tube may be longer than the butterfly's body. [Line drawing: Colorado State University Extension]

Intermediate types of mouthparts include the ***rasping-sucking*** type found in thrips, and the ***chewing-lapping*** types found in honey bees, wasps, and bumble bees.

Thorax

The **thorax** is made up of three segments (*prothorax, mesothorax and metathorax*).

Legs – A pair of legs is attached on each thorax segment. The insect's leg consists of five independent movable parts. Legs may be specially adapted for leaping, walking, digging, grasping, swimming, etc.

Wings – Insects may have one or two pairs of wings or no wings. The wings are attached to the latter two thorax segments. The wing ***venation*** (arrangement of the veins) is different for each species of insect and is often a means of identification. Wing surfaces are covered with fine hairs, scales or may be bare. On beetles, the thickened front wing, call ***elytra***, serves for protection when not in flight.

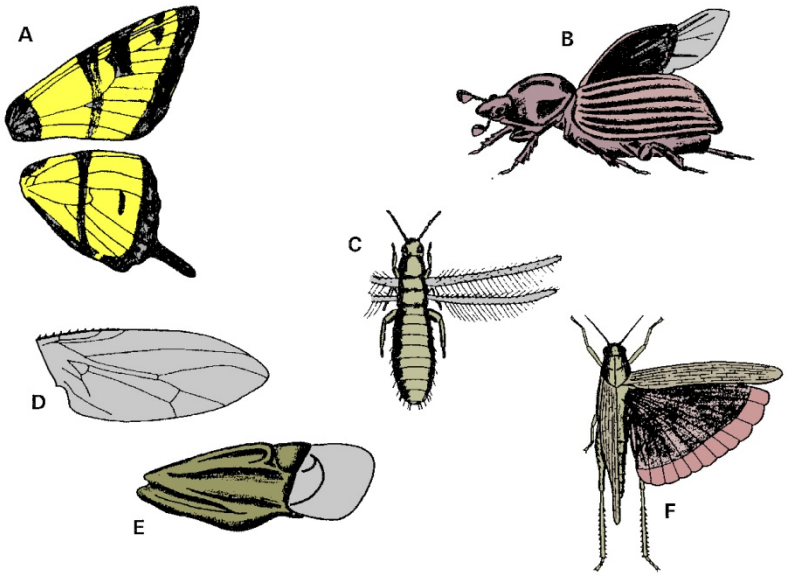


Figure 7. Types of insect wings: (A) scaly wing of moths and butterflies, (B) armor-like (elytron) and membranous wings of beetles, (C) feather wings of thrips, (D) membranous wing of a fly, (E) half-leathery/half-membranous wings (memelytron) of true bugs, and (F) wings of grasshoppers. Line drawing: Colorado State University Extension]

Abdomen

The **abdomen** may have eleven or twelve segments, but in most cases they are difficult to distinguish.

Prolegs (fleshy leg-like projections) occur on some larva such as caterpillars and sawfly larva. Prolegs, with tiny crochet-type hooks on the bottoms help the insect cling to plants. [Figure 8]

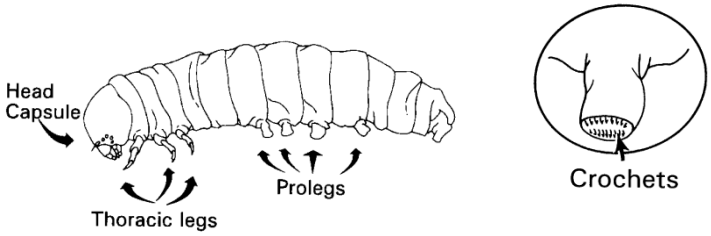


Figure 8. **Prolegs** (leg-like appendages on the abdomen of caterpillars and sawfly larvae) have small crochet-like hooks that help the insect cling to plants.
[Line drawing: Colorado State University Extension]

Some insects have a pair of appendages called ***cerci*** at the tip of the abdomen. The pinchers on earwigs are the best-known example of cerci. Cerci may be short, as in grasshoppers, termites and cockroaches, extremely long as in mayflies, or curved as in the earwigs. They are sensory structures and may be used for defense or capturing prey. [Figure 9]

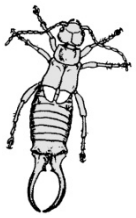


Figure 9. Earwig with cerci (pinchers) on end of abdomen.

Some groups have additional long segmented ***filaments***, which appear like antennae. [Figure 10]

Figure 10. Silverfish with three filaments on end of abdomen.

The females of some insects have a prominent structure for depositing eggs, called an ovipositor. In bees, wasps, and ants the ovipositor is modified into a stinger. [Figure 11]

Figure 11. Horntail with large ovipositor on end of abdomen

The ***spiracles***, external openings used for respiration, are also present on the abdomen. Digestion, respiration, excretion, and reproduction are the main functions of the abdomen.

Internal Structure and Physiology

The muscular, digestive, circulatory, respiratory, nervous, and reproductive systems of insects are highly efficient. The insect's skeletal system has already been discussed as part of the external structure.

While insect **muscles** are very small, they are very strong and often capable of extremely rapid contractions. Grasshoppers are said to have over 900 distinct muscles and some caterpillars over 4,000. In comparison to humans, insect muscle tissues are very strong.

The **circulatory system** of insects is an open type. The blood is pumped by the heart from the abdomen toward the head, bathing the organs in the body cavity. Blood functions to transport nutritive materials to the tissues and to carry away certain wastes. With a few exceptions, the blood of insects contains no red corpuscles, and plays no part in respiration.

The **respiratory system** consists of a series of slender branching tubes or *tracheae*, which divide and subdivide throughout the body. Movement of oxygen and carbon dioxide is primarily by diffusion. Breathing-like movements help to ventilate the tracheae.

Insects have a two-part **nervous system**. The sympathetic nervous system controls functions of the heart, digestion, respiration, and possibly other systems. The peripheral nervous system controls sensory stimulations from the external environment.

Most insect **reproduction** is sexual, (the union of an egg cell from the female with the sperm cell from the male). Some species are capable of producing young without fertilization (***parthenogenesis***). A few species carry the eggs internally, giving birth to live young (***ovoviviparous***). Glands of the insect reproductive systems are similar to that found in higher animals.

Growth and Metamorphosis

The series of events from egg to adulthood constitutes the insect's ***life cycle***. The life cycle varies for each insect species. For example, mosquitoes under optimum environmental conditions may develop from egg to adult in 10 days, whereas the periodical cicadas require 13 to 17 years to complete their life cycle.

An understanding of an insects' life cycle is a critical element in insect management practices.

Because the *exoskeleton* cannot expand sufficiently to accommodate an increase in size, it is cast off during the process called ***molting***. The number of moltings varies considerably in the insect world. The form of an insect between successive molts is called an ***instar***.

The ***pupa*** is a non-feeding stage during which the larval structures are transformed into adult structures. ***Cocoon*** refers to pupal cases made of silk from the modified salivary glands of the larva. ***Chrysalis*** is a term that denotes the pupa of a butterfly.

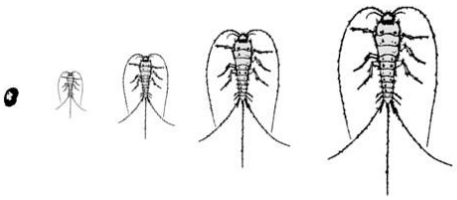
Metamorphosis

One of the most distinctive features of the insect world is ***metamorphosis***, the marked or abrupt change in form, structure, and habit. Four basic types of metamorphosis are observed in the insect world.

No Metamorphosis

Upon hatching from the egg, the young insect with "no metamorphosis" development looks exactly like the adult except for size and minor differences in spines and setae (hairs). Size is the major change between each instar. Some species may molt after sexual maturity. The young and adults live in the same environment, and have the same types of mouthparts and feeding habits. These groups of very primitive, wingless insects include the *Thysanura* (silverfish) and *Collembola* (springtails). [Figure 12]

Figure 12. No Metamorphosis of silverfish: from egg (left), nymphs, and adult (right)

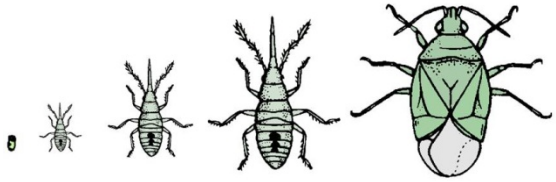


Simple Metamorphosis

In simple metamorphosis, the insect goes through three basic changes, egg, nymph, and adult. The nymphs typically go through three to five instars. Some books further divide simple metamorphosis into gradual and incomplete types.

In **gradual metamorphosis**, the newly hatched insect resembles the adult in general body form, but lacks wings and external genital appendages. With each successive molt, the nymph resembles the adult more than it did in the previous instar. Both nymphs and adults have the same type of mouthparts and food habits. Grasshoppers, squash bugs, and aphids are examples of insects with gradual metamorphosis. [Figure 13]

Figure 13. Simple-Gradual Metamorphosis of stink bug: from left to right: egg, nymphs, and adult.



Incomplete metamorphosis is characteristic of some orders with aquatic nymphs, such as *Emphemeroptera* (mayflies), *Odonata* (dragonflies), and *Plecoptera* (stoneflies). The changes that occur during the immature instar stages are more pronounced than in the case of insects with gradual metamorphosis, but not nearly so dramatic as in complete metamorphosis. The young, called *nymphs* or *naiads,* are aquatic insects found in rivers and streams, while the strikingly different fly-like adult is aerial. [Figure 14]

Figure 14. Simple-Incomplete Metamorphosis of Dragonfly from egg (left), naiads, and adult (right)

Complete Metamorphosis

Insects with complete metamorphosis have four developmental stages; **eggs**, **larva**, **pupa**, and **adult**. The insect may have several instars and molts as a larva, but it does not pick-up the characteristics of the adult with each molting. The larval stage is primarily an eating and growing state. All larvae have chewing or modified chewing mouthparts. [Figure 15]

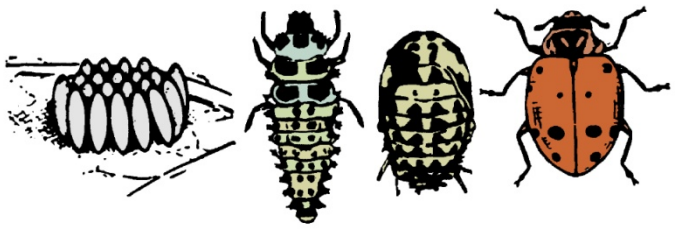


Figure 15. Complete metamorphosis of beetle from left to right: egg, larva (grub), pupa, and adult.

Various names apply to the larvae of insects from different orders. Beetle larvae are known as ***grubs***, butterfly and moth larvae are called ***caterpillars***, and the larvae of flies are known as ***maggots***. Grubs typically have three pair of legs on the thoracic segment and no prolegs on the abdomen. Caterpillars have three pair of legs on the thoracic segment and up to five pair of prolegs (fleshy leg-like structures on the abdomen). By comparison, sawfly larvae have more than five pair of prolegs. Maggots are typically legless.

When the larvae have attained maturity, they cease to feed and following a period of inactivity transform into the pupa stage. In the pupa stage the insect usually remains inactive and does not feed, but undergoes marked physiological and morphological changes. The insect emerges from the pupa stage as a functional adult.

In the case of many insects, provisions are made by nature to protect the helpless pupa. Some seek protection in the ground, while others hide under the bark of trees. Some spin cocoons of silk (moths) or pupate in the last larval skin (flies).

The primary function of the adult insect is reproduction. In many insect groups, the adults die soon after mating and laying eggs. Some adults do little or no feeding.

Insects with complete metamorphosis may have entirely different types of mouthparts and food habits in the larval and adult stages. For example, caterpillars (larva of butterflies and moths) have chewing mouthparts and feed on a variety of materials, while the adults have siphoning mouthparts and normally feed on plant nectar. Flea larvae feed on inert organic materials with their chewing mouthparts, while the adults suck the blood of their hosts.

Diapause is defined as a state or period of suspended activity in any stage of the life cycle. This state is initiated or terminated by environmental stimuli, such as photoperiod (length of the daylight), temperature, moisture, nutrition, or a combination of these. Diapause should not be confused with the cycles in metamorphosis.

Because eggs and pupa are non-feeding stages, they are resistant to insecticides. This is important point to remember when dealing with insect management.

Insect Names

All insects are classified into order, family, genus and species using scientific Latinized names. Scientific names are unique for that insect throughout the world. Genus names always begin with a capital letter, and species names are written entirely in lower case. Scientific names are printed in italics or underlined. In technical papers, the first entry of an insect name is followed with the name of the author whom first described the species. For example the honey bee, first described by Linnaeus is written *Apis mellifera* Linnaeus.

Common names, generally used by the public, often refer the insect to its groups such as orders, suborders, families or subfamilies, rather than individual species.

For example, "beetle" applies to all species in the order *Coleoptera*; “leaf beetle" applies to species in the family *Chrysomelidae*.

Generally, only the insect species commonly known by the public have common names. Most insect species occurring in the world do not have a common name.

Most common names of insects that consist of a single word (i.e., beetles, earwigs, thrips, or termites) refer to an entire order. Most common names applied to families consist of two or more words, the last being the name of the larger groups. For example, Carrion beetles, lady beetles, bark beetles, and blow flies.

Some common names are used for insects in more than one order, such as "fly" and "bug". The correct use and spelling of these words will help you identify orders. When a "bug" belongs to the *Hemiptera* order (often referred to as the "true bugs") it is written as two words (bed bugs, stink bugs, water bugs). When it does not belong to this order, it is written as one word (sowbugs, pillbugs, ladybugs). The same principle applies to "flies" and the fly order *Diptera*. Insects in the Diptera (fly) order are written as two words (house fly, deer fly, flower fly). When the fly-like insect is of another order, it is written as one word (dragonfly, stonefly, Mayfly).

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Line drawings from USDA. Photographs by David Whiting. Reviewed by Mary Small, Colorado State University Extension.

- Colorado Master Gardener *GardenNotes* are available online at www.cmg.colostate.edu.
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Reviewed July 2017

MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #313

Insect Orders

Outline

Anoplura
Sucking Lice

- Feeds by sucking blood from mammals.
- Some species (head lice and crabs lice) feed on humans.

Metamorphosis: Simple/Gradual

Figure 1. Sucking lice

Features: [Figure 1]

- Wingless
- Mouthparts: Piercing/sucking, designed to feed on blood.
- Body: Small head with larger, pear-shaped thorax and nine segmented abdomen.

Blattaria (Subclass of *Dictyoptera*)
Cockroaches and Woodroaches

- Most species are found in warmer subtropical to tropical climates.
- The German, Oriental and American cockroach are indoor pests.
- Woodroaches live outdoors feeding on decaying bark and other debris.

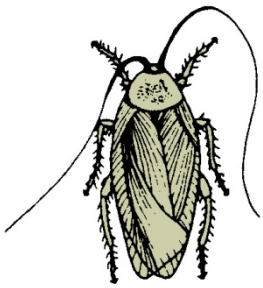


Figure 2. American cockroach

Metamorphosis: Simple/Gradual

Features: [Figure 2]
- o Body: Flattened
- o Antennae: Long, thread-like
- o Mouthparts: Chewing
- o Wings: If present, are thickened, semi-transparent with distinct veins and lay flat.

Coleoptera
Beetles and Weevils

- *Coleoptera* is the largest order of insects with 290,000 species worldwide and some 24,000 species in North America.
- Many species are plant feeders; some are predaceous (ground and lady beetles), scavengers (scarab and hide beetles), or aquatic.
- The term *weevil* refers to a snout beetle.

Metamorphosis: Complete
[Figure 3]

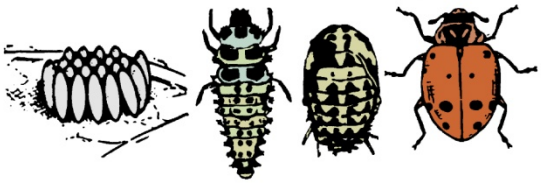


Figure 3. Coleoptera metamorphosis (left to right): egg, grub, pupa, and adult

Adults:
- o Wings: two pair
  - Front pair, called ***elytra***, are greatly thickened and shell-like (form fitting) and make a straight line down the back when at rest.
  - Hind wings are membranous and protected by the front pair.
  - A few beetles are wingless, or have only the front pair.
- o Mouthparts: Chewing
- o Antennae: Noticeable, generally quite stout
- o Cerci (tail-like appendage): None

Larva:
- o Legs:
  - Larva that feed externally on plants are the typical "grub" with head capsule, three pair of legs on thorax, and no prolegs on the abdomen. [Figure 4]

- Some larva that feed internally in plants (e.g., bark beetles, and wood borers) may be maggot-like with no head capsule and no legs.

- Mouthparts: Chewing

Figure 4. Grub with head capsule, three pair of legs on the thorax, and no prolegs on abdomen.

Beneficial families include:

- Blister beetles, *Meloidae*
- Carrion beetles, *Silphidae*
- Checkered beetles, *Eleridae*
- Darkling beetles, *Tenebrionidae*
- Fireflies, *Lampyridae*
- Ground beetles, *Carabidae*
- Lady beetles, *Coccinellidae*
- Rove beetles, *Staphylinidae*
- Scarab beetles, *Scarabaeidae*
- Soldier beetles, *Cantharidae*
- Tiger beetles, *Cicindelidae*

Pest families include:

- Bark and ambrosia beetles, *Scolytidae*
- Blister beetles, *Meloidae*
- Carpet beetles, *Dermestidae*
- Click beetles or wireworms, *Elateridae*
- Ground beetles, *Carabidae*
- Leaf beetles, *Chrysomelidae*
- Longhorned beetles or roundheaded borers, C*erambycidae*
- Metallic wood beetles or flatheaded borers, *Buprestidae*
- Sap beetles, *Nitidulidae*
- Scarab beetles including rose chafer, *Scarabaeidae*
- Seed beetles, *Bruchidae*
- Weevils, *Curculionidae*

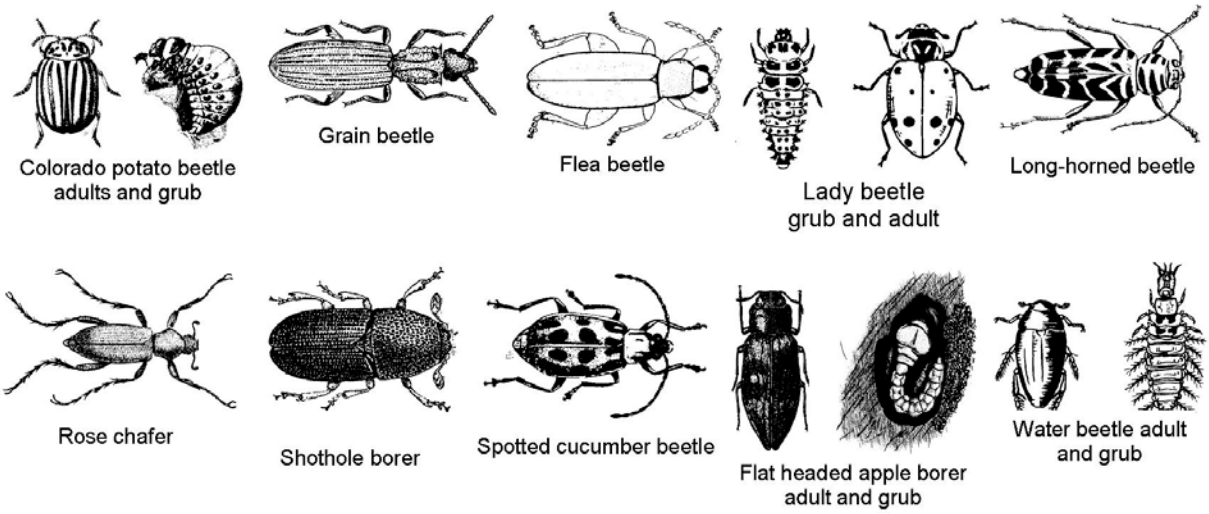


Figure 5. Examples of common beetles

Collembola
Springtails

- Very tiny (1-2 mm) soft-bodied insect almost always associated with soil.
- Very common but rarely observed due to tiny size.
- Most feed on algae, fungi, and other organic matter. Some are predators of other insects and mites found in the soil.

Metamorphosis: None

Features: [Figure 6]
- o Wingless
- o Mouthparts: Chewing
- o "Springtail": (furcula) often present, used to jump.

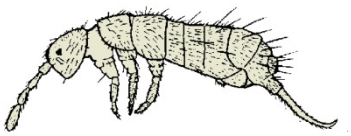


Figure 6. Springtail

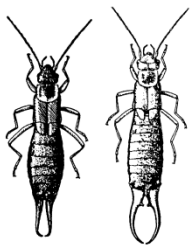
Dermaptera
Earwigs

- Introduced from Europe as a biological control.

Metamorphosis: Simple/Gradual

Features: [Figure 7]
- o Mouthparts: Chewing; generally feed on decaying organic matter, occasionally on plants and insects.
- o Wings: 2 pair
  - ▪ Front wings are short, leathery, without venation and meet in a straight line down the back when at rest.
  - ▪ Hind wings are membranous, broad, with veins radiating from a center, folded both lengthwise and crosswise when at rest.
  - ▪ Note: Wings can be confused with those of beetles, but beetles do not have forceps-like cerci (tail-like appendage).
- o Body: Elongated, flattened insects
- o Cerci: Strong moveable forceps-like cerci on the abdomen end. Cerci cannot produce a painful pinch, but the mouthparts can.
- o Habit: Over-winters as adults. During the day, earwigs hide in dark, moist areas. They are often assumed to cause a plant problem when they may simply be hiding on or near the plant.

Figure 7. Earwigs: Female (left) has straight cerci, male (right) has curved cerci.



Diptera
Flies, Gnats, Midges, and Mosquitoes

- Around 99,000 species worldwide, with some 17,000 in North America.
- Feeding habits vary widely, for example
    - Scavenger (house fly, blow fly)
    - Blood sucking (mosquitoes)
    - Plant galls (gall midges)
    - Predators (flower flies, robber flies)
    - Aquatic

Metamorphosis: Complete [Figure 8]

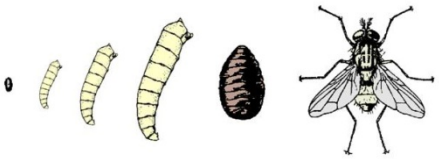


Figure 8. Complete metamorphosis of flies.

Adults [Figures 8-10]

- Wings: One pair, membranous
    - One pair is a quick identifcation for *Diptera*.
    - Note: Count the wings! Some *Diptera* look like bees or wasps. Some *Hymenoptera* (bees and wasps) look like flies. *Diptera* has one pair. *Hymenoptera* have two pair, the hind pair is typically smaller and hidden under the front pair.
- Mouthparts: Highly variable
    - Sponging (house fly)
    - Cutting-lapping (horse fly)
    - Piercing-sucking (mosquito)
- Body: Typically soft bodied and often hairy.

Figure 9. House fly.

Larva [Figures 8 and 10]

- Vary greatly in appearance.
- Larva of advanced forms, like the house fly, are ***maggot*** type
    - No head capsule
    - Mouth hooks
    - Legless
- Lower forms, such as mosquitoes, have a head capsule.

Pupa: Typically pupate in last skin of larva.

Beneficial families include:

- Bee flies, *Bombyliidae*
- Crane flies, *Tipulidae*
- Gall gnats *Cecidomylidae*
- Robber flies, *Asilidae*
- Syrphid or flower flies, *Syrphidae*
- Tachinid flies, *Tachinidae*

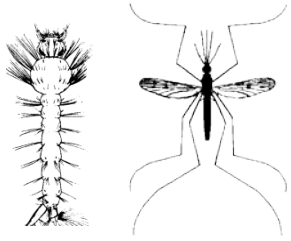


Figure 10. Mosquito maggot and adult.

Pest families include:

- Cabbage, onion, and seed corn maggots, beet leaf miner, *Anthomyiids*
- Biting midges, *Certopogonidae*
- Black flies, *Simuliidae*
- Blow flies, *Calliphoridae*
- Crane flies, *Tipulidae*
- Fruit flies, *Tephritidae*
- Gall gnats *Cecidomylidae*
- Horse and deer flies, *Tabanidae*
- Horse bot flies, *Hippoboscidae*
- Leafminer flies, *Agromyzidae*
- Mosquitoes, *Culicidae*
- Muscids (house flies), *Muscidae*
- Sand flies (no-see-ums), *Psychodidae*
- Syrphid or flower flies, *Syrphidae*
- Vinegar flies, *Drosophilidae*

Ephemeroptera
Mayflies

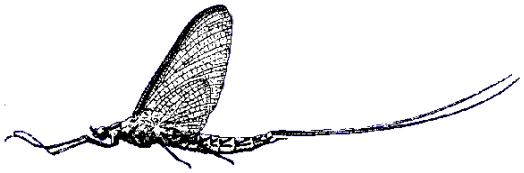
- Small aquatic naiads found in the bottom of streams and lakes. Serves as a source of food for fish.
- No interaction with gardening activities.

Metamorphosis: Simple/Incomplete

Adults: [Figure 11]

- Wings: two pair
  - Front wings large and triangular shaped.
  - Hind wings small and rounded.
  - Wings held vertically over body.
- Antennae: Small, bristle-like
- Filaments: Two very long tail-like filaments.
- Mouthparts: Adults do not feed and only live a few days.

Figure 11. Mayfly adult



Naiads: [Figure 12]

- Body: Aquatic naiads vary in shape, most are broad, and have functional gills along the sides of the abdomen.
- Mouthparts: Chewing.
- Molting: Frequent; 20 to 60 times

Figure 12. Mayfly naiad .

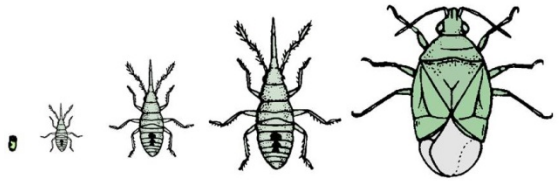
Hemiptera Order, Suborder: Heteroptera
TRUE BUGS: Plant Bugs, Squash Bugs, Stink Bugs

Note: Research has led to the re-ordering of insects. True bugs are the Hemiptera order, but now have their own suborder. In older references you will still find Hemiptera without the suborders.

- This order includes many important insect predators.

Metamorphosis: Simple/Gradual [Figure 13]

Figure 13. Metamorphosis of stink bugs.



Features: [Figure 14]
- o Mouthparts: Piercing-sucking
  - Jointed beak is typically visible, and originates from top of head in front of eyes.
- o Wings: two pair
  - Front wings (called *hemielytra*) are thickened at base and membranous at end.
  - Hind wings are membranous.
  - When at rest, the wings overlap at the tips forming a large triangular plate (the *scutellum*) on the back.
- o Body: Usually broad and somewhat flattened

Beneficial families include:
- o Ambush bugs, *Phymatidae*
- o Assassin bugs, *Reduvlidae*
- o Coreids, *Coreidae*
- o Damsel bugs, *Nabidae*
- o Flower or minute pirate bugs, *Antocoridae*
- o Leaf or plant bugs, *Miridae*
- o Stink bugs, *Pentatomidae*

Pest families include:
- o Chinch and lygus bugs, *Lygaeidae*
- o Coreids, squash bugs, *Coreidae*
- o Lace bugs, *Tingidae*
- o Stink bugs, *Pentatomidae*

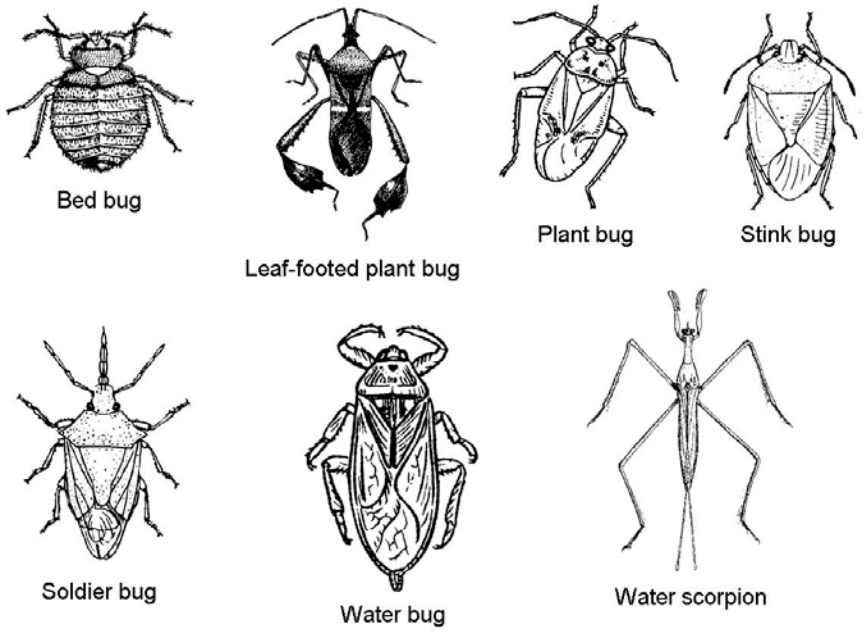


Figure 14. Examples of common *Hemiptera* (true bugs)

Hemiptera Order, Suborder: Auchenorrhyncha
Hemiptera Order, Suborder: Sternorrhynca
Aphids, Cicadas, Leafhoppers, Mealybugs, Scale and Whiteflies

Note: Research has led to the re-ordering of insects. These insects used to be in their own order, Homoptera, but are now a sub-order of Hemiptera. You will still find references to Homoptera. You may also still find references to Hemiptera without the suborders.

- All species are plant feeders, often feeding on phloem sap.
- Excretion of honeydew is common to many members of the order.
- Insects of this order are carriers of several plant pathogens.

Metamorphosis: Simple/Gradual
- Nymphs and adults similar in appearance (except male scales and whiteflies).

Features: [Figure 15]
- Mouthparts: Piercing-sucking
  - *Auchenorrhyncha* mouthparts arise from under the head; *Sternorrhyncha* mouthparts arise from between the forelegs.The jointed beak-like mouthparts not easily visible.

  Note: In contrast, in the *Heteroptera* suborder, mouthparts are more visible and originate from top of head, in front of eyes.
- Wings: two pair
  - Membranous
  - Typically held roof-like at rest
  - Many forms are wingless

- Nymphs have no wings, but wing pads may be observed on some older nymphs.

Pest families include:
Suborder Auchenorrhyncha:

- Cicadas, *Cicadidae*
- Leafhoppers, *Cicadellidae*
- Planthoppers, superfamily *Fulgoroidea*
- Spittlebugs, *Cercopidae*
- Treehoppers, *Membracidae*

Suborder Sternorrhyncha:

- Adelgids, *Phylloxeridae*
- Aphids, *Aphididae*
- Armored scales, *Diaspididae*
- Mealybugs, *Pseudococcidae*
- Psyllids (many gall insects), *Psyllidae*
- Soft scale, *Coccidae*
- Whiteflies, *Aleyrodidae*

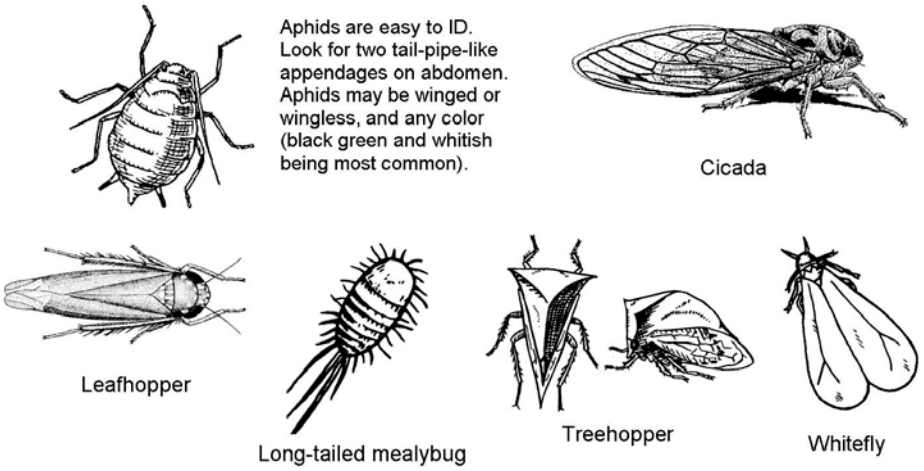


Figure 15. Examples of common *Hemiptera in either Auchenorrhyncha or Sternorrhyncha*

Hymenoptera
Ants, Bees, Horntails, Sawflies, and Wasps

- Large order with some 103,000 species worldwide and 18,000 in North America.
- Order includes many important parasites and predators.
- This order has the most highly developed insect behaviors and social patterns.
- Most species live in nests.

Metamorphosis: Complete

Adults [Figure 16]

- Wings: 2 pair, membranous
  - Hind wing is usually smaller and often hidden under front wing.
  - Front and hind wings may be attached.
- Mouthparts: Typically chewing or chewing-sucking
- Body: Most species have a distinct constriction between the thorax and abdomen (wasp waist). The sawfly/horntail group does not have a "wasp waist").
- Antennae: Jointed, sometimes elbowed
- Stinger: Female abdomen usually provided with a saw, piercing organ, or stinger.

Larva

- Larvae of most species are rarely observed, often developing in a nest or as an internal parasite.
- Head: Distinct head capsule
- Legs: None (except sawfly larva)
  - Sawfly larva look like caterpillars but have six-plus pair of prolegs.
  - Note: Caterpillars (*Lepidoptera)* have five or fewer pair prolegs.
  - Some sawfly larva are legless and slug-like.
- Mouthparts: Chewing

Wasp or Bee?

Wasps have a slender and thin body, a narrow waist, slender, cylindrical legs and a skin that generally lacks much hair. Yellow jackets, bald-faced hornets, and paper wasps are the most common wasps encountered by people.

Wasps are predators, feeding on insects and other arthropods. During late summer and autumn when insect prey becomes more scarce, many wasps become scavengers and are especially attracted to sweets and other carbohydrates.

Bees are robust-bodied and very hairy compared with wasps. The hair on bees is branched giving them a fuzzy or soft appearance. Their hind legs are flattened, with bristle-fringed areas for collecting and transporting pollen. Bees laden with pollen will appear to have yellow hind legs because of the pollen loads. Bees are vegetarians, feeding on nectar and pollen.

Beneficial families include:

- Ants and parasitic wasps, superfamily *Scolioidea*
- Bees, superfamily *Apoidea*
- Chalcid wasps, *Chalcidoidea*
- Digger wasps, superfamily *Sphecoidea*
- Ichneumon and braconid wasps, superfamily *Ichneumonoidea*
- Social wasps, superfamily *Vespoidea*

Pest families include:

- Ants, superfamily *Scolioidea*
- Gall wasps, superfamily *Cynipoidea*

- Horntails, superfamily *Siricoidea*
- Sawflies, *Tenthredinoidae*
- Social wasps, superfamily *Vespoidea*

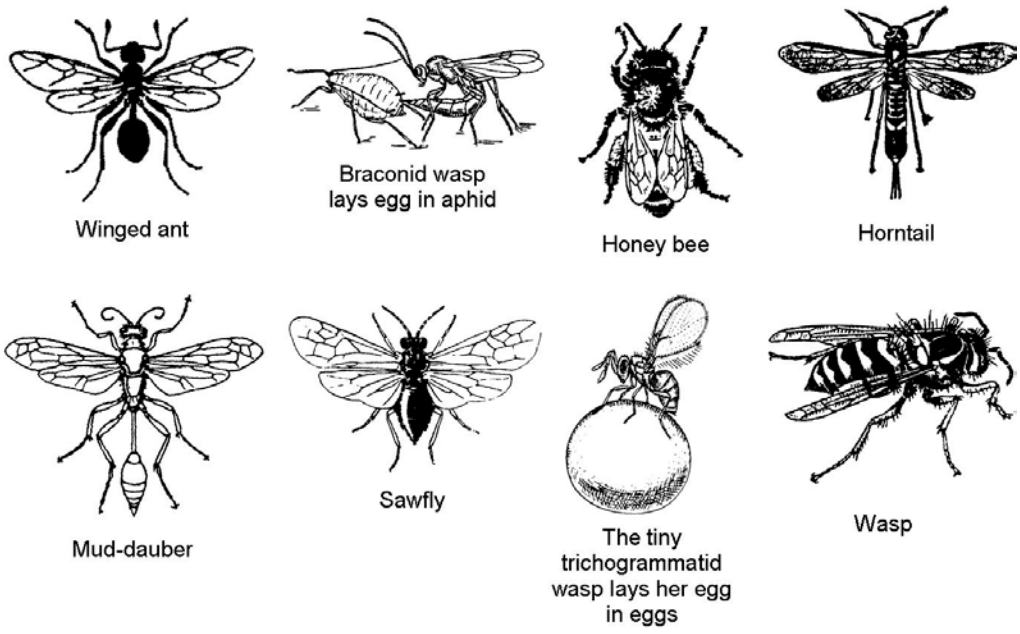


Figure 16. Examples of common *Hymenoptera*

Isoptera
Termites

- Termites are social insects living in colonies. Colorado species live below ground.
- Workers avoid exposure and are rarely seen except when disturbed. Only the winged reproductive adults leave the colony.

Metamorphosis: Simple/Gradual

Features: [Figure 17]
- Color: Creamy white
- Wings: two pair that are the same size and longer than the body.
- Body: rectangular-shaped with NO constriction (wasp waist) between thorax and abdomen.
- Antennae: Straight and beaded
- Mouthparts: Chewing

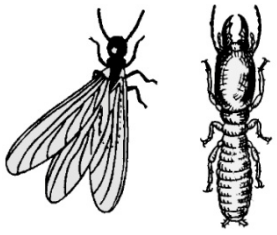
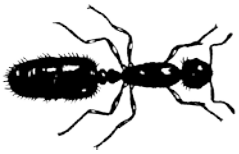


Figure 17. Winged adult termite (left), and worker termite (right)

Ant or Termite?

	Ant	Termite
		
Color	Black, red, yellowish, etc.	Creamy white
Waistline	"Wasp waist"	No constriction
Antennae	Jointed, sometimes elbowed	Straight and bead-like
Wings on adult	Front wing larger and hind wing smaller; wings may be attached.	Front and hind wings same size, longer than body.
Worker's body	Typical "ant" shape	Rectangular body with large chewing mouthparts
Observed	Commonly seen crawling around	Worker termite rarely seen except when disturbed.

Lepidoptera
Butterflies and Moths

Metamorphosis: Complete

Adults [Figure 18]
- o Wings: Two pair
  - Typically covered with small overlapping scales.
  - Often but not always highly colored.
- o Mouthparts: Coiled sucking tube designed to siphon fluids like nectar.
  - Some adults do not feed.

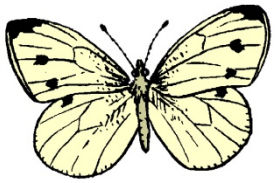
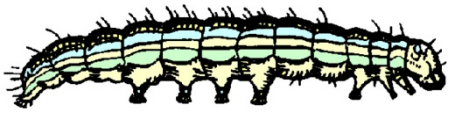


Figure 18. The wings of butterflies and moths are generally covered with colorful scales.

Larva: ***Caterpillars*** [Figure 19]
- o Legs: Three pair on thorax
- o Prolegs: Up to five pair of prolegs (fleshy leg-like appendage with crochet-like hooks on the end which helps hold the insect to plants).
  - Note: Sawfly larva look like caterpillars but typically have six or more pair prolegs.
- o Decorations: Often highly colored or decorated with spines or other appendages.
- o Mouthparts: Chewing, with voracious appetites.

Figure 19. Caterpillars (larval stage of Lepidoptera) have three pair of jointed legs on the thorax plus up to five pair of prolegs on the abdomen.



Pupa

- Cocoon, made of silk spun from saliva glands

Families of interest include:

- Bagworm moths, *Psychidae*
- Carpenterworm moths, *Cossidae*
- Clearwing moths (squash vine borer, lilac borer), *Sesiidae*
- Giant silkworm moths, *Saturniidae*
- Leafrollers, Tortricidae
- Measuringworms, *Geometridae*
- Monarch, viceroy, red admiral, morningcloak and angelwings butterflies, *Nymphalidae*
- Noctuids (cutworms, armyworms, fruitworms, corn earworm, cabbage loopers), *Noctuidae*
- Olethreutid moths, *Olethreutidae*
- Prominents (redhumped caterpillars), *Notodontidae*
- Pyralids (corn borer, sod webworm, meal moths), *Pyralidae*
- Royal moths, *Citheroniidae*
- Silkworm moths, *Bombycidae*
- Sphinx or hawk moth, hornworms, *Sphingidae*
- Swallowtail or parsleyworm, *Papilionidae*
- Tent caterpillars, *Lasiocampidae*
- Tineids, (cloths moths), *Tineidae*
- Tussock moths, *Lymantriidae*
- White or yellow butterflies (imported cabbageworm), *Pieridae*

Mallophaga
Chewing or Biting Lice

- Tiny parasite of birds and some mammals.
- Feeds on blood, feathers, hair, skin, or sebaceous fluids.

Metamorphosis: Simple/Gradual

Features: [Figure 20]

- Flattened, oval
- Head larger than thorax
- Antenna short
- Eyes very small or absent
- No wings
- Legs short and modified to hold to feathers or fur
- Lives only on hosts

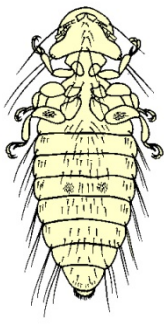


Figure 20. Chewing lice.

Mantodea
Mantids

- Predators of other insects, which they capture with front legs and eat.
- Winter is spent in the egg mass covered with a tough polystyrene-like coat.

Metamorphosis: Simple/Gradual

Features: [Figure 21]
- Legs: Foreleg designed for grasping and holding prey
- Body: Elongated
- Mouthparts: Chewing
- Antennae: Long, thread-like
- Wings: If present, are leathery and over abdomen. Absent in nymphs.

Figure 21. Mantid

Neuroptera
Antlion, Lacewing, Snakeflies, and Dobsonflies

- Order includes many important predators.
- No harmful species are known.
- The antlion is the larva of the common lacewing. Some forms are aquatic.

Metamorphosis: Complete

Adults [Figure 22]
- Wings: Two pairs
  - Membranous, similar in size and texture
  - Large membranous wing, usually with many veins and cross veins.
  - Held roof-like over body when at rest.
- Mouthparts: Chewing; some are predators, while others feed on nectar or pollen.
- Cerci: None
- Tarsus (foot): Five segments

Figure 22. Lacewings: Left: adult, Right: Antlion (lacewing larva)

Larva [Figure 23]
- Mouthparts: Forward-projecting curved pointed jaws designed to grasp prey, which they crush and suck out the insides.

- Body: Often elongated
- Legs: Three pair

Figure 23. Antlion (lacewing larva)

Odonata
Dragonflies and Damselflies

Metamorphosis: Simple/Incomplete

Adults [Figure 24]
- Eyes: Very large eyes that may cover much of head.
- Wings: Two pair
  - Large, elongated, highly veined.
  - Dragonflies hold wings horizontally when at rest. Damselflies project wings back over body when at rest.
- Mouthparts: Chewing, prominent, used to capture and consume winged prey in flight.
- Antennae: Small, bristle-like

Figure 24. Dragonfly adult

Naiads [Figure 25]
- Aquatic insect that feeds on mosquito larva and other aquatic life
- Eyes: Large
- Mouthparts: Uniquely hinged jaw that can project forward to capture prey.
- Gills: Three leaf-like gills at end of abdomen (damselfly only.)

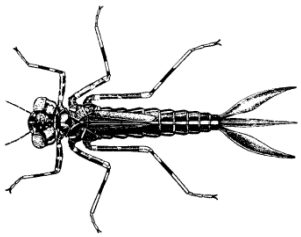


Figure 25. Dragonfly naiad

Orthoptera
Crickets, Grasshoppers, and Katydids

- Note: Older books place mantids (*Mantode*a), walking sticks (*Phasmida*) and roaches (*Blattaria*) in the order *Orthoptera*.
- Most are plant feeders. A few are predators or scavengers.

Metamorphosis: Simple/Gradual

Features [Figure 26]
- Mouthparts: Chewing
- Wings: Two pair
  - Front wings more or less parchment-like with distinct venations.
  - Hind wings membranous and folded fan-like when at rest.
  - Wings may be used to make sounds.
- Legs: Hind legs enlarged for jumping.
- Cerci (tail-like appendages): 1 pair on most adults

Pest families include:

- Crickets, *Gryliidae*
- Short-horned grasshoppers, *Acrididae*
- Long-horned grasshoppers (katydids, meadow grasshoppers, and Mormon crickets), *Tettigoniidae*

Figure 26. Orthoptera (left to right): grasshopper, cricket, and katydid.

Phasmida
Walking Stick

- Feeds on plant leaves.
- Stick-like form provides camouflage.

Metamorphosis: Simple/Gradual

Features: [Figure 27]

- Body: Very elongated, stick-like
- Mouthparts: Chewing
- Wings: typically none

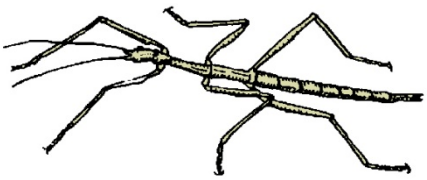


Figure 27. Walking stick

Plecoptera
Stoneflies

- Aquatic naiads cling to stones in streams and serve as food for other aquatic insects and fish.
- There is no direct interaction with gardening activities.

Metamorphosis: Simple/Incomplete

Adults [Figure 28]

- Wings: Two pair, elongated wings fold flat over body when at rest.
- Antennae: Long, filament-like
- Filament: (tail-like): Two

Figure 28 Stonefly adult

Naiads [Figure 29]

- Aquatic naiad typically found under stones in rivers and lake shores.

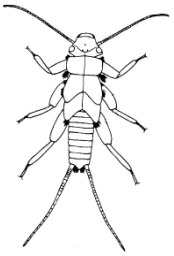


Figure 29. Stonefly naiad.

Psocoptera
Psocids or Booklice

- Common but inconspicuous insect rarely observed due to tiny size.
- Found in warm, damp places feeding on molds, fungi, cereals, pollen, etc.
- Occasionally invade the home.

Metamorphosis: Simple/Gradual

Features: [Figure 30]
- Size: Tiny, less than 1/8 inch
- Wings: Two pair on some adults
  - Held roof-like over body when at rest
  - Front pair larger
  - Veins prominent
  - Non-winged specimens common
- Mouthparts: Chewing
- Antennae: Slender and as long or longer than body

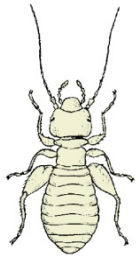


Figure 30. Booklice

Siphonaptera
Fleas

- Household pest of pets and people.

Metamorphosis: Complete

Adults [Figure 31]
- Size: Less than 1/8 inch
- Wingless
- Body: Flattened sideways, dark colored, covered with bristles that project backwards
- Mouthparts: Piercing/sucking, designed to suck blood.

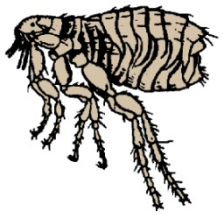


Figure 31. Flea

Thysanoptera
Thrips

- It is a very common insect, but due to tiny size is rarely observed.
- Feeding leaves the plant looking scarred, as they rasp the leaf or flower surface and suck the fluids.

Metamorphosis: Simple/Gradual

Features: [Figure 32]
- Wings: Two pair
  - Slender wings fringed with hairs

- Often absent.

- Mouthparts: Rasping-sucking; typically feed on flowers and leaves.
- Tarsi (feet): One or two segmented, each with a balloon-like structure on the end.
- Size: Minute, less than 1/8 inch long.

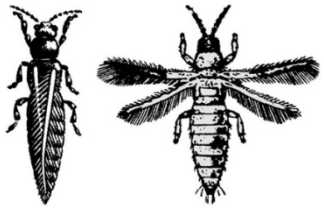


Figure 32. Thrips

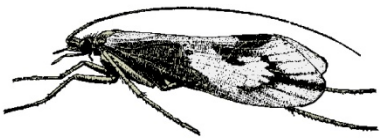
Trichoptera
Caddisflies

- Aquatic naiad.
- Not associated with gardening activities.

Metamorphosis: Simple/Incomplete

Adults [Figure 33]
- Wings: Two pair
  - Covered with fine hairs
  - Held roof-like over body at rest
  - Resemble moths with hairy wings.
- Antennae: Extended back over body

Figure 33. Caddisfly



Naiads
- Aquatic naiad
- Some live in cases constructed of silk, pebbles, sticks, and leaves. Others construct silken nests.
- Some are free-living and actively hunt other insects.

Zygentomaa
Silverfish and Firebrats

- Found in cool, moist, dark places.
- General feeder on starches and carbohydrates, including paper, wall paper, vegetables and grain products.

Metamorphosis: None

Features: [Figure 34]
- Size: Small, ¼" to ½"
- Wingless
- Mouthparts: Chewing
- Cerci: Pair, long tail-like
- Active, fast moving

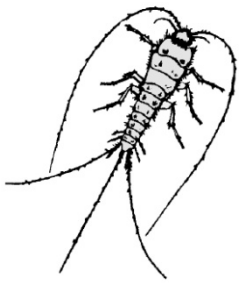


Figure 34. Silverfish

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Line drawings from USDA. Revised by Mary Small, Colorado State University.

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