

Lesson 3: Insect Identification

Lesson 2 presented information on where to look for insects, how to collect them, and how to prepare specimens for a collection. The next step is to learn the details of insects' bodies, the distinguishing features of each order, and how insects are divided into groups.

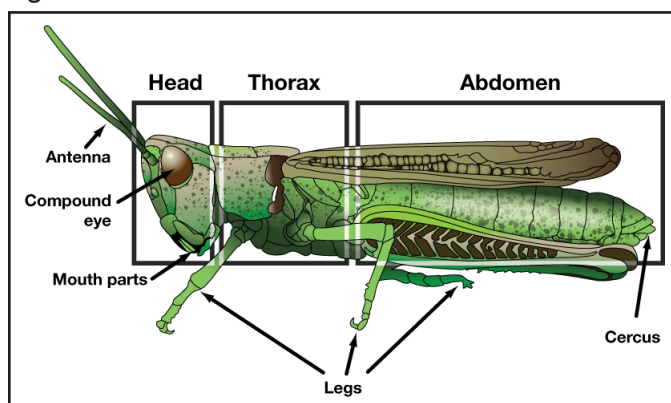
Distinguishing Characteristics of an Insect

What exactly is an insect? In Lesson 1, an insect was defined as a small six-legged animal. In this lesson, an insect will be more clearly defined. What determines which animals are put into this class and which are not? There are certain characteristics which set insects apart from other animals. An insect is a small animal without a backbone that has the following external characteristics as an adult.

- ◇ A hardened external skeleton
- ◇ Three distinct body regions: head, thorax, and abdomen
- ◇ One pair of segmented antennae
- ◇ Three pairs of segmented legs on the thorax segment
- ◇ One pair of compound eyes (Some insects have no eyes.)
- ◇ One or two pairs of wings (Some adults are wingless.)

Before becoming adults, insects are called *immatures*. The shape of immatures depends on the species. The best way to study and identify insects is to look at the three main body sections: the *head*, *thorax*, and *abdomen*. See Figure 3.1

Figure 3.1 – Three Main Sections

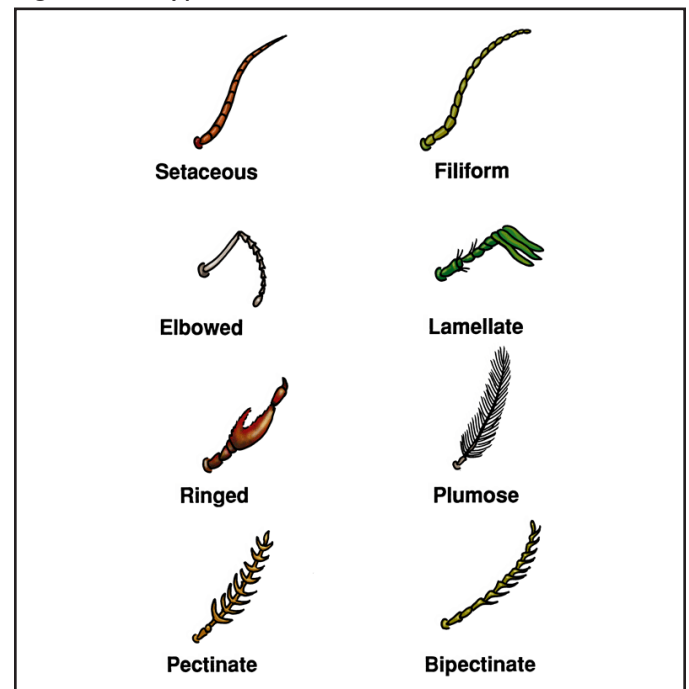


The Three Main Sections of an Insect

Head: The head is the hardened region at the front of the body, which includes the eyes, antennae, and mouth parts. There are two types of eyes. Simple eyes are small eyes located on top of the head of adults. Compound eyes are the large eyes found on most adult insects. These eyes contain a few to several thousand individual eye units. Often insects can only see light and dark areas and cannot see objects distinctly.

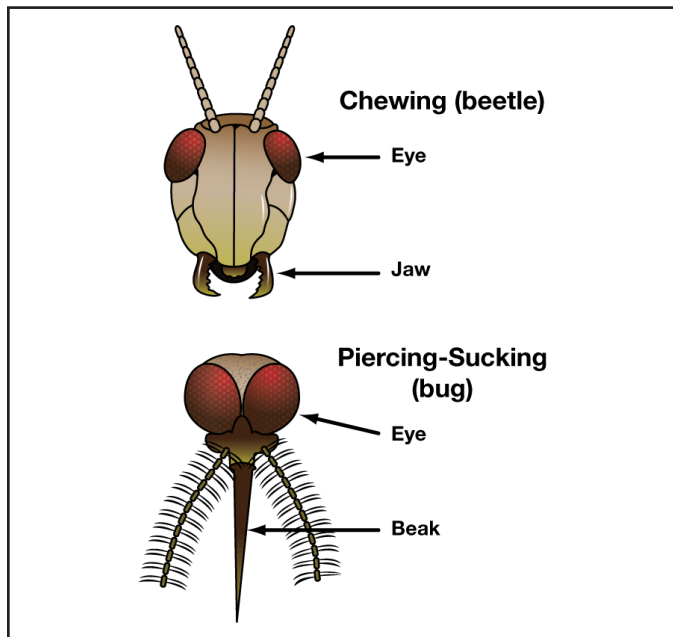
Insects have one pair of antennae. Antennae are two long, jointed feelers that grow from the insect's head. Antennae are flexible and come in a variety of shapes. See Figure 3.2. Antennae function as sensors to detect the odor, sound, taste, and feel of the surrounding environment. The mouth parts are also in the head region. Chewing and piercing-sucking are the two main types of mouth parts. See Figure 3.3. Some insects will have a modification or adaptation of these. Mouth parts determine how the insect feeds. Chewing mouth parts are strong, curved, and toothed. They are used for chewing, cutting, crushing, or grinding. Chewing mouth parts crush hard seeds and tear food into pieces. Mouth parts may have other functions as well. Chewing jaws can be used like scissors or tongs. They can also dig like little shovels or plow like tiny bulldozers.

Figure 3.2 – Types of Antennae



Entomology

Figure 3.3 – Mouth Parts



Some insects use their strong jaws to squeeze their enemies to death or to cut off their heads.

Piercing-sucking mouth parts are long and needle-like for piercing leaf surfaces or skin. Special sucking structures suck up the fluids. Examples of mouth parts that are a variation of chewing and piercing-sucking are rasping-lapping, reduced chewing, chewing-sucking, and sponging. How these are used depends on the particular insect species.

Thorax: The thorax is the second section of an insect's body. This section contains the nerve centers and muscles that control the insect's movement. Wings and legs are attached to the thorax. Insects have three pairs of legs. Each leg has five parts, although sometimes the parts are hard to see. The legs come in many forms depending on their functions, such as running, jumping, grasping, or swimming. See Figure 3.4.

Adult insects may not have wings. There is a great variety in the shape, size, color, thickness, and vein pattern of insect wings. See Figure 3.5. The shape of the wings and the pattern of the veins are used widely in identification.

Abdomen: The abdomen is the third section of an insect's body. It may be visible or hidden underneath the wings.

This section contains the internal organs of the insect. It is the location of the stomach and intestines, where food is digested and absorbed. There is also a place that is used to store food and to carry it back to the nest for other insects. The sexual organs are in the abdomen as well. The abdomen has glands that secrete different types of fluids, such as liquids that mark their trails or drive enemies away. This section may also have a needle-like projection for piercing or stinging.

Life Stages of Insects

The development of insects refers to growth in size and changes in form. There are three stages of development for every insect: the embryo stage, the immature stage, and the adult stage. See Figure 3.6. Insects begin life as an egg.

Insects may lay from a few to many thousand eggs at a time. The insect lives as an embryo within the egg. The egg is well supplied with a nutritious yolk and surrounded by a delicate outer shell. It may take days, weeks, or months for the insect to hatch. After hatching, the little insect continues to feed and grow through several more stages until it reaches the adult stage.

Figure 3.4 – Types of Legs

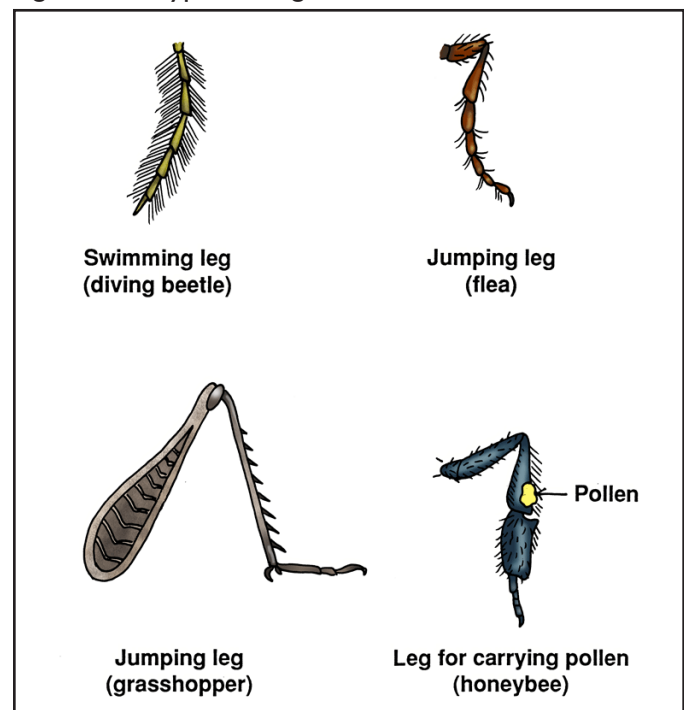
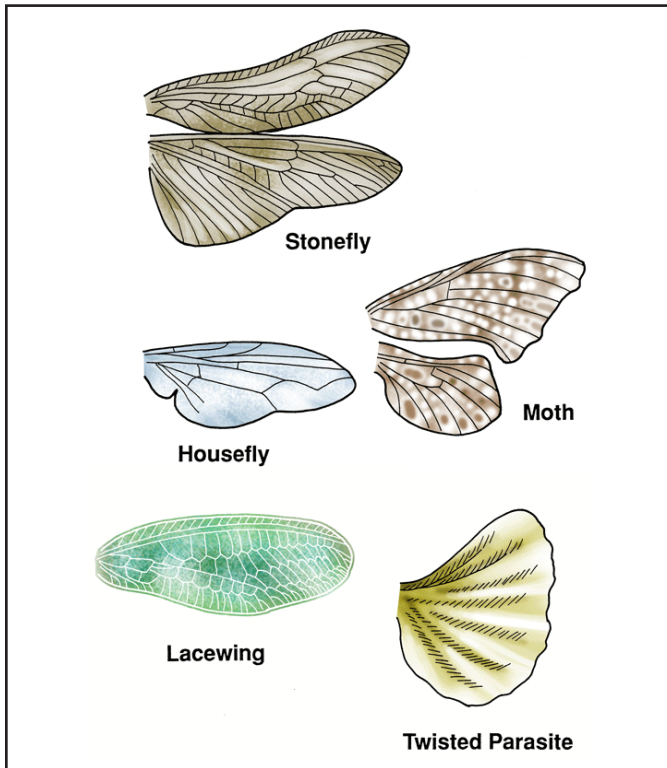
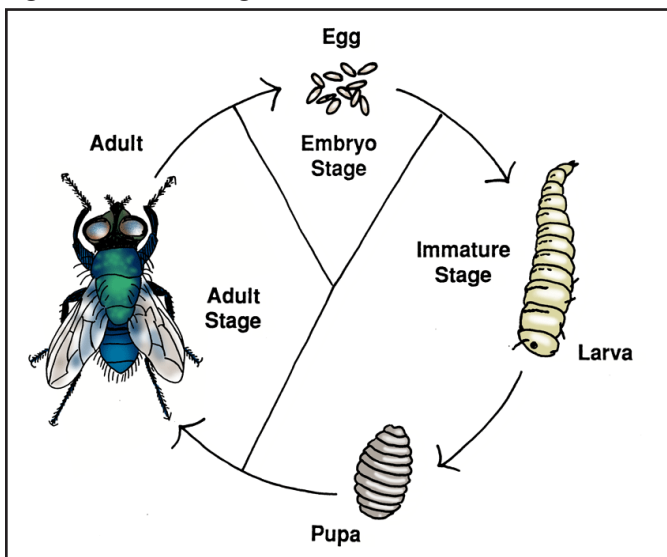


Figure 3.5 – Examples of Wings



After the insect hatches, it is called an *immature*. The life of an immature insect is divided into growth stages called *instars*. During each instar, the insect changes in form and size. As the insect grows, it forms an outer layer to protect its body from the environment. This layer is hard and rigid. When the insect grows too big to continue living in this hard layer, it begins to break out of it. The older layer is

Figure 3.6 – Life Stages

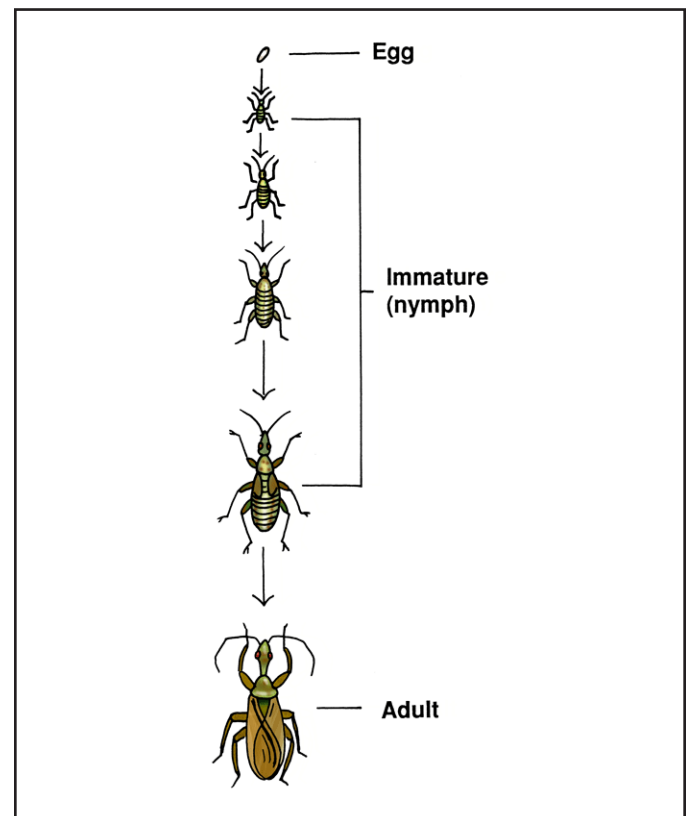


shed and a new outer layer is formed. The process of shedding the old layer is called *molting*. The most dramatic changes in the growth and form of an insect are seen when the insect molts.

Insects go through a series of instar growth, molting, instar growth, molting, etc. This continues until it becomes an adult insect. The entire process of development is called *metamorphosis*. Most insects go through one of two basic types of metamorphosis, incomplete and complete. There are a few primitive species of insects that do not go through metamorphosis at all.

Incomplete metamorphosis is the first type of insect development. See Figure 3.7. The immature insects look like the adults, only smaller. The immatures of incomplete metamorphoses are called *nymphs*. The changes are mainly an increase in size and the development of wings and sexual organs. Nymphs usually eat the same type of food as the adults. Examples of insects having incomplete metamorphoses are the grasshopper, thrip, stink bug, leafhopper, and aphid.

Figure 3.7 – Incomplete Metamorphosis



Entomology

The second type of insect development is complete metamorphosis. See Figure 3.8. These insects do not look like the adults when in the immature stage. The immatures of complete metamorphoses are called *larvae*. Larvae are small, white forms that do not have eyes or legs. They do have a head and mouth parts. Examples of insects having complete metamorphoses are the lady beetle, weevil, fly, and moth. Insects with complete metamorphoses have also one additional stage of development called the *pupa*. When the larva becomes mature, it sheds its skin (or molts) one more time and emerges as a pupa. The pupa is shaped like an insect with the legs and antennae folded against its body. The larvae of some insects surround themselves with a cocoon just before they molt and emerge as pupas.

Although it does not eat and barely moves, great changes take place in the body of the pupa. Most of the structural changes take place during the pupa stage. The adult's digestive system and reproductive system are fully formed. The adult's wings, legs, antennae, and mouth parts develop completely. When the adult's body is completely

formed, the insect breaks out of the outer, pupal skin. If there is one, the cocoon is left at the same time. Other insects may help the young one break out.

When the insect first emerges as an adult, the wings are crumpled and the body is soft. Within minutes to hours, the adult's body dries, hardens, and develops color. The wings expand as air blows between them and their structure becomes more rigid. The adult starts its normal life. Depending on the species, adults may live from 1 hour to 20 years. In general, adults live only a few weeks.

Insect Classification

In order to identify each type of animal, the animal kingdom is divided into many groups. Insects belong to one of the basic divisions of the animal kingdom called *Arthropoda*. This division also includes centipedes, crabs, lobsters, scorpions, and spiders. *Arthropoda* is divided into several *classes*. Insects make up the class *Insecta*. *Insecta* is a Latin word that can be broken down into its basic meanings: in = "into" and sect = "cut." An insect is identified by its segmented body. This class is further divided into *orders* of insects. The different orders are determined by certain characteristics, such as wing structure, mouth parts, and life cycle. Presently, entomologists agree on 29 orders of insects.

Orders are further divided and sub-divided into other groups. Each of these groups becomes more and more specific until, at last, each insect species can be identified by its own name. See Figure 3.9.

Each insect is identified by a scientific name. This name has two parts: the *genus* name (written capitalized) followed by the *species* name (written lower case). The genus is like a person's last name, or family name. The species is like a person's first name. Insects may also have common names. Insects' common names would be like nicknames. For example, a person may have his name listed as "Doe, Jonathan," but his friends call him Johnny. An insect may have the scientific name "*Romalea microptera*," but is commonly called a grasshopper. When learning scientific names, it is very helpful to find out what the name means. This often gives a clue to some part of the insect's life and makes it easier to remember.

Figure 3.8 – Complete Metamorphosis

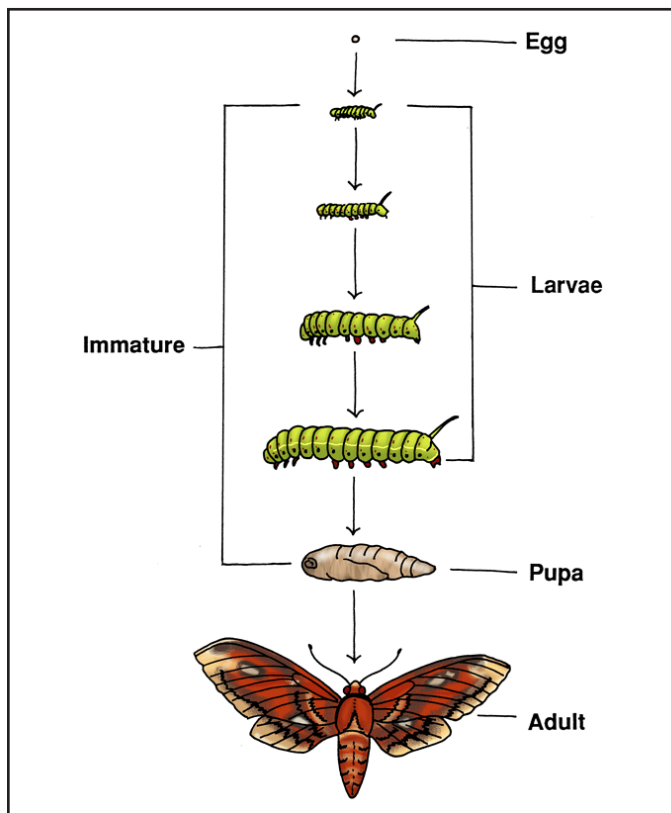


Figure 3.9 – Insect Classification

Phylum – Arthropoda
Class – Insecta
Subclass – Pterygota
Infraclass – Neoptera
Series – Exopterygota
Superorder – Orthopteroidea
Order – Orthoptera
Suborder – Caelifera
Family – Acrididae
Subfamily – Romaleinae
Genus – Romalea
Species – microptera
Scientific name: Romalea microptera
Common name: Eastern lubber grasshopper

It is impossible to memorize all the insects and their classification. Books such as field guides or insect keys should be kept close at hand and referred to often. Insect guides contain information such as a description of the insect, distinguishing features of the order, how different insects are related to one another, and the lifestyle and environment of the insect. Each guide is a little different so the introduction on how to use the book should always be read first. Beginners are advised to select a guide that has many clear pictures or drawings. The various parts of the insects should be clearly identified and labeled.

The 29 orders and a brief description of each are summarized in the following paragraphs. The summaries include the scientific name, the meaning of the name, the common name, the number of species in each order, the type of metamorphosis, the type of mouth parts, and the main characteristics that distinguish each order.

The Insect Orders

1. **Collembola** • “glue peg” • springtails • 1,500 species • no metamorphosis • chewing mouth parts, withdrawn into head • wingless; long antennae; reduced compound eyes or none; most species can jump using a forked springing organ on the abdomen
2. **Protura** • “first tail” • Proturans • 170 species • no metamorphosis • piercing-sucking or chewing mouth parts, withdrawn into head • wingless; no eyes; only insects with no antennae; front legs carried upright like antennae and used to sense touch
3. **Diplura** • “double tail” • campodeids, japygids • 660 species • no metamorphosis • chewing mouth parts, withdrawn into head • wingless; long, slender antennae; no eyes or small eyes shaped like a slit
4. **Thysanura** • “tassel tail” • bristletails, silver fish • 350 species • no metamorphosis • chewing mouth parts • wingless; long, slender antennae; compound eyes reduced or absent; usually scaly body; two or three bristlelike tails; run swiftly or jump when disturbed
5. **Ephemeroptera** • “short-lived, wings” • mayflies • 1,000 species • incomplete metamorphosis • chewing mouth parts • usually two pairs of membranous wings that are held flat over body when at rest, hind wings much smaller than front wings; very short antennae; large eyes; two or three long tails; adults do not eat and die soon
6. **Odonata** • “toothed” • damselflies, dragonflies • 5,000 species • incomplete metamorphosis • chewing mouth parts • two pairs of equal-sized, transparent, and membranous wings that cannot be folded; very small antennae; huge eyes; strong fliers; cannot walk, but legs used to catch prey in air; mate in flight
7. **Dermaptera** • “skin wings” • earwigs • 1,200 species • incomplete metamorphosis • chewing mouth parts • wingless or two pairs of wings: front wings short and leathery, hind wings large and membranous, folded under front wings when at rest; forceps on abdomen
8. **Grylloblattodea** • “cricket cockroach” • rock crawlers, icebugs • 12 species • incomplete metamorphosis • chewing mouth parts • wingless; legs adapted for running; small eyes are long and segmented; antennae are long; live in low-temperature places; active at night; rare

Entomology

9. **Isoptera** • “*equal wings*” • termites • 2,000 species • incomplete metamorphosis • chewing mouth parts • two pairs of similar, membranous wings held flat over the body when at rest; wings shed after mating flight; workers and soldiers are wingless
10. **Dictyoptera** • “*net wings*” • cockroaches and mantids • 5,300 species • incomplete metamorphosis • chewing mouth parts • front wings are thick and hind wings are membranous and folded; have short wings or are wingless, fly poorly
11. **Phasmida** • “*phantom*” • walking stick or leaf • 2,000 species • incomplete metamorphosis • chewing mouth parts • slow-mowing; some are wingless and look like sticks; wings and legs of others look like broad leaves; can change color
12. **Orthoptera** • “*straight wings*” • crickets, locusts, grasshoppers • 20,000 species • incomplete metamorphosis • chewing mouth parts • two pairs of wings: front wings narrow and leathery, hind wings are broad and membranous and folded under front wings when at rest; medium to long antennae; some species wingless, some species make shrill creaking sounds by rubbing special body structures together
13. **Embioptera** • “*lively wings*” • web spinners • 140 species • incomplete metamorphosis • chewing mouth parts • females and some males are wingless, most males have two pairs of membranous wings; front legs have organs for spinning silk
14. **Plecoptera** • “*pleated wings*” • stone flies • 1,300 species • incomplete metamorphosis • chewing mouth parts • two pairs of membranous wings: folded flat over body when at rest, hind wings larger than front wings; long antennae; small eyes
15. **Zoraptera** • “*pure, wingless*” • zorapterans • 16 species • incomplete metamorphosis • chewing mouth parts • have four wings or are wingless: wings have few veins, adults break off wings; compound eyes and small eyes; thread-like, segmented antennae; rare
16. **Psocoptera** • “*gnawing wings*” • bark lice, book lice • 1,700 species • incomplete metamorphosis • piercing-sucking mouth parts • two pairs of membranous wings: roofed over back when at rest, front wings larger than hind wings, some species are wingless
17. **Mallophaga** • “*to eat wool*” • chewing lice • 2,675 species • incomplete metamorphosis • chewing mouth parts • wingless; have reduced eyes or no eyes; parasites of birds and a few mammals, feed on feathers, hair, and skin
18. **Anoplura** • “*unarmed tail*” • sucking lice • 2,900 species • incomplete metamorphosis • piercing-sucking mouth parts • wingless; short antennae; have reduced eyes or no eyes; parasites that suck the blood of mammals
19. **Thysanoptera** • “*fringe wings*” • thrips • 4,500 species • incomplete or complete metamorphosis • chewing mouth parts • two pairs of wings fringed with long hairs and fold flat over body when at rest, some species are wingless; short antennae; females of many species can reproduce without mating; males are unknown in some species
20. a) **Hemiptera** • “*half wings*” • true bugs, chinch bugs • 28,000 species • incomplete metamorphosis • piercing-sucking mouth parts • two pairs of wings: bases of front wings are thick and leathery, hind wings are membranous and fold under front wings when at rest, some species are wingless
b) **Homoptera** • “*same wings*” • aphids, cicadas • 32,000 species • incomplete or complete metamorphosis • chewing mouth parts • wingless or one or two pairs of membranous wings, roofed over body when at rest; females of some species can reproduce without mating
21. **Neuroptera** • “*nerve wings*” • ant lions, lacewings, alderflies, and dobson flies • 4,500 species • complete metamorphosis • piercing-sucking mouth parts, sucking parts are shaped like a coiled tube when not in use • two pairs of wings: similar,

membranous, covered with many vein's, and roofed over body when at rest; long, slender antennae; larvae and adults are predatory

22. **Coleoptera** • “*sheath wings*” • beetles • 350,000 species • complete metamorphosis • chewing or chewing-lapping mouth parts • two pairs of wings: front wings modified into thick, horny wing covers, hind wings membranous and fold under the front wings when at rest, some species are wingless
23. **Strepsiptera** • “*twisted wings*” • strepsipterans • 300 species • complete metamorphosis • piercing-sucking mouth parts • males have one pair of membranous hind wings, front wings are reduced to clublike parts; females do not have antennae, eyes, wings, or legs; they live in other insects
24. **Mecoptera** • “*long wings*” • scorpion flies • 300 species • complete metamorphosis • reduced chewing mouth parts • two pairs of long, slender, and membranous wings, laid flat or roofed over the body when at rest, some species are wingless; long, slender antennae; large eyes; long legs; tip of abdomen of some males are curved like a scorpion's tail
25. **Siphonaptera** • “*tube, wingless*” • fleas • 1,000 species • complete metamorphosis • reduced chewing mouth parts • wingless; body flattened from side to side; simple or no eyes; long hind legs for jumping; parasites that suck blood of birds and mammals
26. **Diptera** • “*two wings*” • flies, mosquitoes • 70,000 species • complete metamorphosis • chewing mouth parts • front wings transparent, hind wings replaced by short, knobbed structures; large eyes
27. **Trichoptera** • “*hair wings*” • caddis flies • 3,000 species • complete metamorphosis • piercing-sucking or sponging mouth parts • two pairs of hairy, membranous wings, roofed over the body when at rest; long antennae; larvae live in cases of silk and debris near or on water; adults eat little

28. **Lepidoptera** • “*scale wings*” • butterflies, moths • 165,000 species • complete metamorphosis • piercing-sucking mouth parts • two pairs of scaly, usually broad, wings, front wings are usually larger than hind wings; long antennae; large eyes

29. **Hymenoptera** • “*membrane wings*” • ants, bees, wasps • 110,000 species • complete metamorphosis • chewing or chewing-sucking mouth parts • two pairs of wings: small, stiff, and membranous, interlock during flight, front wings are larger than hind wings, worker ants and a few other insects are wingless

Summary

Insects are identified and classified according to common characteristics. Features commonly used are the wings, body shape, mouth parts, and type of metamorphosis. Insects are grouped into 29 orders based on these characteristics. Insect identification guides or keys are very helpful references. They contain a systematic way of finding a great variety of information on many types of insects.

Credits

Bland, R.G. *How to Know the Insects*. Dubuque, IA: Wm. C. Brown Company Publishers, 1978.

Borror, D.J., and R.E. White. *A Field Guide to the Insects*. Boston, MA: Houghton Mifflin Company, 1970.

Evans, Howard E. *Insect Biology: A Textbook of Entomology*. Reading, MA: Addison-Wesley Publishing Company, Inc., 1984.

The Random House Encyclopedia. New York: Random House, Inc., 1977.

