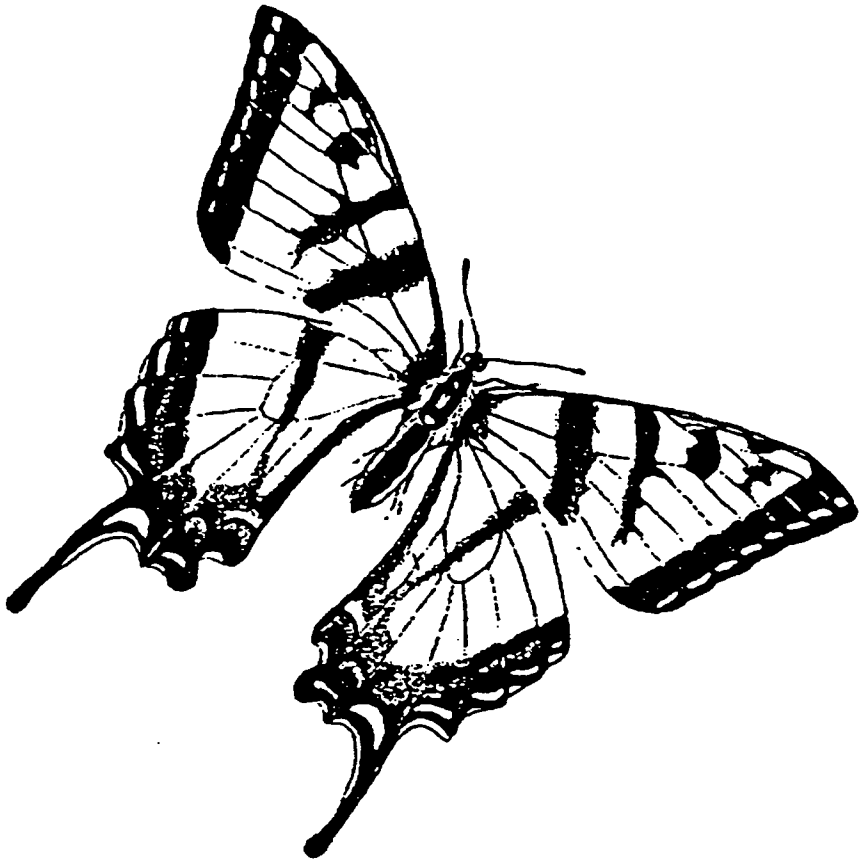
$4.00

4-H Entomology Manual



OREGON STATE UNIVERSITY EXTENSION SERVICE

4-H 3221
Revised July 1997

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About Insects—An Introduction

Insects are a very successful group of animals. They were on earth long before humankind. Fossil insects over 250 million years old have been discovered.

There are more different kinds of insects on earth than there are all other kinds of living things put together. Over 700,000 insect species have been described, and estimates are that at least that many more species are yet to be identified.

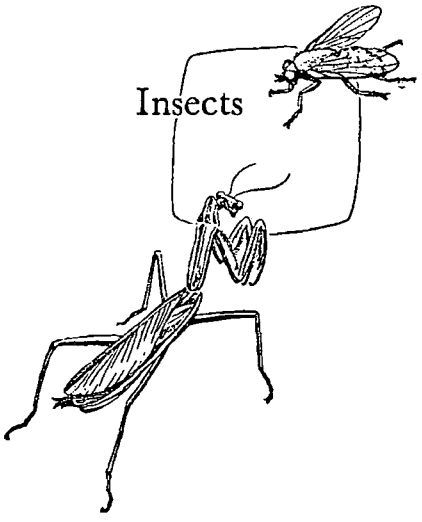
The great diversity of insects astounds even the entomologist. Insects are found almost everywhere from the highest mountains to the desert, in lakes, in soil, in jungles, and in your own backyard.

Insects range in size from the microscopic to species of 20-inch wingspreads and several ounces in weight.

Some insects may be considered ugly; others beautiful. Some insects benefit humankind by pollinating plants; others compete with us for crops.

Insects benefit humans by pollinating crops and providing food. Insects also compete with humans by eating and damaging crops and transmitting diseases.

Insects serve as food for other animals such as birds, fish, or mammals. Many insects are predators, attacking other insects or small animals. The vast majority of insects are not directly important to humans, but this does not make them less interesting to the 4-H member.



Learning about Insects

There are many ways to learn about insects. You already have been exposed to some of the ways through reading, films, or personal encounter. No one can entirely avoid insects, even if one tries.

A purposeful study of insects could involve reading about them, observing live insects, or working with collections of preserved insects. The best approach is to do all these things.

In reading about insects you can learn what others have found out about them: their variety, life stages, habits, food, where and how they live, and many more facts. Your county Extension 4-H Office has an excellent reading list available. Your local library has a wealth of information for the asking.

Books in themselves cannot convey the excitement of watching live insects in their natural environment. J. Henri Fabre was one famous entomologist whose observations and notes contributed greatly to science. You, too, can contribute to your own knowledge as well as others' through skillful observation.

Live insects can be reared in cages, in covered potted plants, or with other food sources. Accurate recorded observations are more important than casual collecting.

Collecting insects may serve many useful purposes. The close, careful examination of insects can be done only with preserved specimens. The science of identifying insects requires microscopic study, even dissection. The study of the insect parts, form, and color necessitates collecting. In order to establish the variety of insects, seasonal occurrence, and abundance, they must be collected.

Collecting requires equipment as well as knowing when, where, and how to collect. Collected insects need preservation, proper storage, and display. Ideas on how to accomplish these tasks are found in this manual.

All of us have picked up a little knowledge on insect identification. Often we are wrong. Most people call all insects "bugs" which, of course, is not accurate. Often, spiders, centipedes, and sowbugs are misidentified as insects.

The study of insects may lead to a lifetime hobby or to entomology as a profession. In most cases it furnishes an interesting and informative venture into an important field from which much can be learned about insects and their relationships with humans.

Entomology is quite important as a companion study with other projects such as plant, animal, and forestry sciences.

Whatever your involvement in time or effort, it's certain to be worthwhile.

Objectives

1. To develop leadership talents, improve strength of character, and work toward effective citizenship
2. To learn skills necessary to collect, display, and study insects
3. To learn the life history and habits of representative insects and understand their relationship to humans/human populations
4. To learn to recognize the major groups (orders) of insects
5. To apply knowledge acquired in this project to other projects and to related community activities
6. To understand simple and basic biology, which will unveil new avenues of experience, interest, and career opportunities

The Value of Insects

It's impossible to measure in dollars the enjoyment or esthetic value of watching beautiful butterflies flitting about over fields or flowers or the chirp of a cricket on a warm summer evening.

The value of the honeybee and other pollinating insects can be measured and it totals many millions of dollars annually. Without insect pollinators, many of our crops could not be grown. Countless indirect benefits of insects are incompletely understood, but their importance as food for birds, fish, and other wildlife cannot be overestimated.

Insects perform services as scavengers; they help keep harmful animals and plants in check and have been useful in medicine. Insects provide people with honey, beeswax, silk, and other products of commercial value.

Insects have been used as food by humans for centuries past and are even today in some cultures. They are valuable subjects for scientific study in genetics and have been used in experimental ventures into outer space.

What is an Insect?

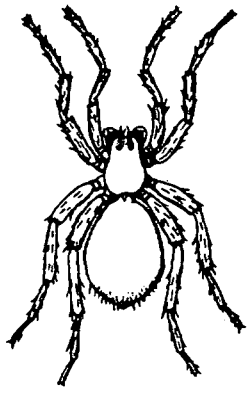
To study insects, we must be able to distinguish insects from similar animals. No one will mistake a bird or a mammal or a fish for an insect, but how about a tick or a scorpion?

The animal kingdom is divided into many groups called phyla (Fila). The phylum to which insects belong is called *Arthropoda* (Arthrop'o-da). All arthropods have jointed legs and an external skeleton, called an exoskeleton.

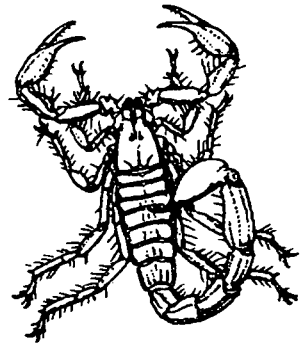
The phylum arthropoda is divided into categories called *classes*. Some of the common *classes* of arthropods along with their major characteristics are illustrated below. It's important that entomologists recognize all of these animals, even though some are not insects, because entomologists often are asked to identify and/or control them.

Arthropods—Common Classes and Their Characteristics

Arachnida (uh-rack 'nida)—spiders, mites, ticks, chiggers, scorpions. Two body regions (head and thorax combined into one region). No antennae. Four pairs of legs.

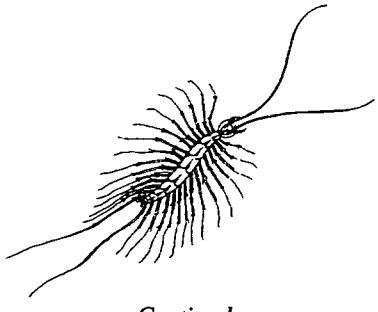


Spider



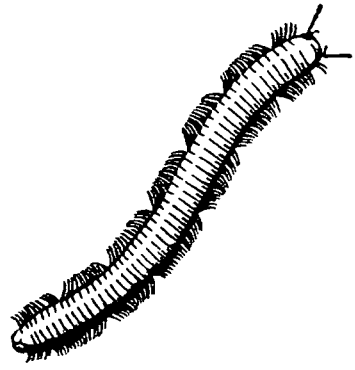
Scorpion

Chilopoda (ki' low-poda)—centipedes. Generally, flattened bodies. Many segmented, long-bodied animals. One pair of moderately long antennae. One pair of legs to each body segment. Swift running, usually soil-inhabiting.



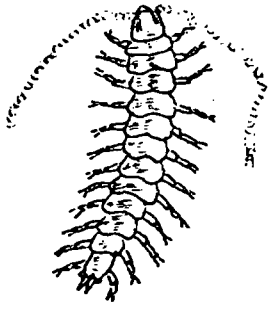
Centipede

Diplopoda (Dip' low-poda). Generally rounded shape, many-segmented, long-bodied animals. One pair of short antennae. Two pairs of legs to each body segment. When disturbed, they coil up.



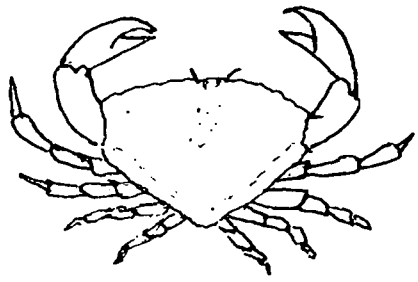
Millipede

Symphyla (sim-phyla). Twelve pairs of legs with two claws at tip of each leg.

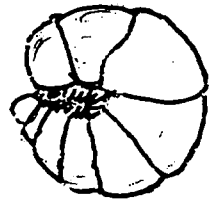


Symphylan

Crustacea (crus-tay sea-uh)—crayfish, crab, shrimp, sowbugs, etc. Head and thorax combined into one part called a cephalothorax. Many with two pairs of antennae. At least five pairs of legs. Nearly all have aquatic respiration.

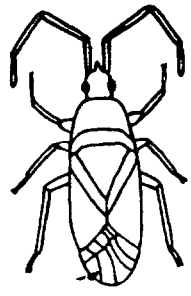


Crab

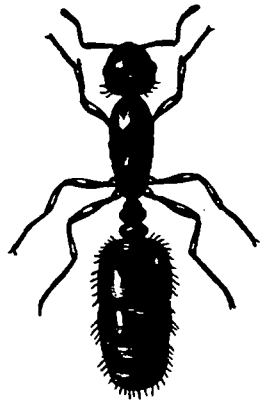


Pillbug

Hexapoda or *Insecta*—ants, bees, grasshoppers, butterflies, etc. Body divided into three general regions (head, thorax, and abdomen). Three pairs of legs. One pair of antennae. Usually adults have two pairs of wings, but some groups have none.



Plant bug



Ant

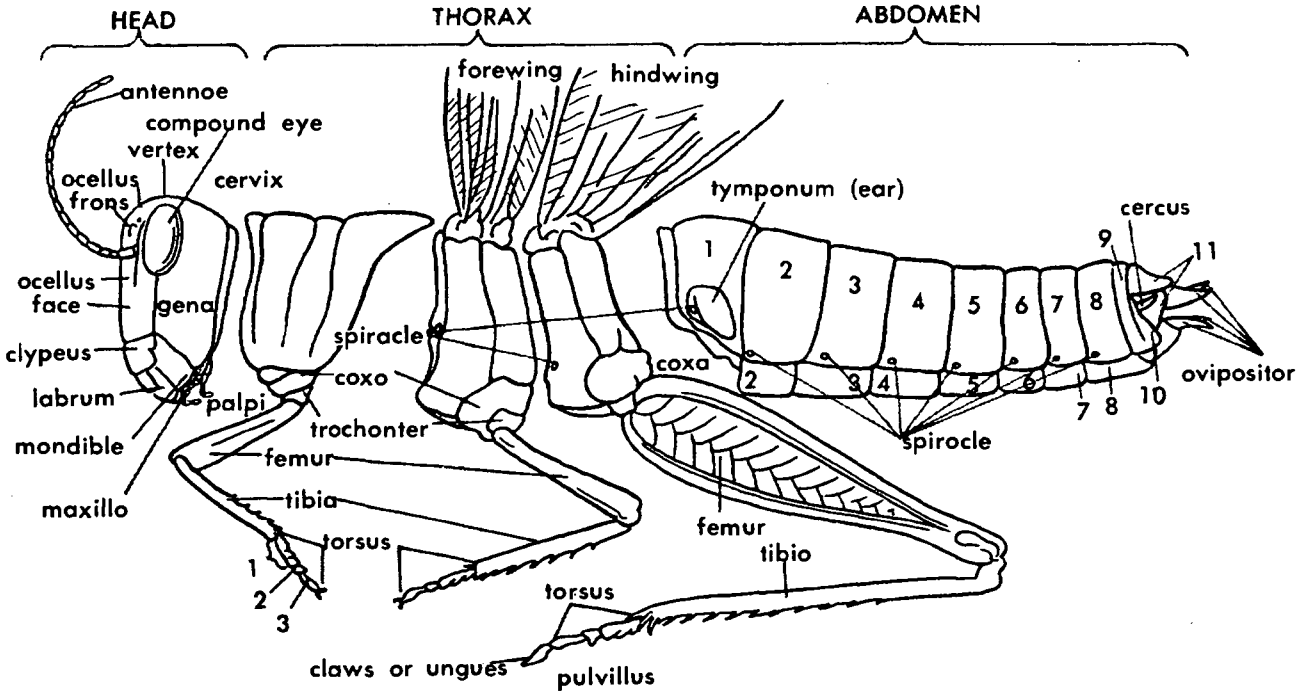
An insect is a small animal that has...

...a skeleton (shell) on the outside of its body called an exoskeleton. Most animals you know have skeletons (bones) inside their bodies. The insect skeleton is made of a material similar to that of your fingernails. This gives insects protection.

...three body regions. The head is the part which holds the eyes, mouthparts, and antennae. The thorax is the middle part where the legs and wings are attached. The abdomen is the part behind the thorax that contains the organs of digestion and reproduction.

...six legs (three pairs) on the thorax.

...two antennae. The antennae are on the front of the head. These serve as organs of touch and possibly taste, smell, and hearing.



Typical insect parts

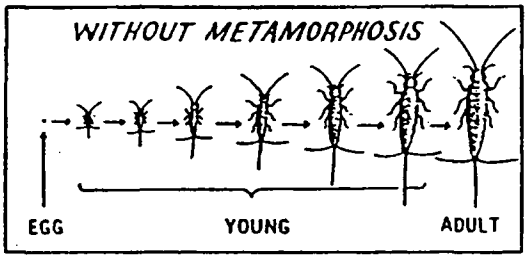
Insect Growth and Metamorphosis

Insect growth is accompanied by a series of *molts* necessary because the exoskeleton is incapable of expanding. The number of molts varies in different groups of insects.

Most insects hatch from eggs and go through several stages of life. Most insects change shape (form) as they grow and develop. This process of changing from egg to adult is called *metamorphosis* (met'-a-mor-pho-sis). Insects are divided into four groups, depending on their method of metamorphosis. Knowing the type of metamorphosis for each group (order) of insects is very important for successful identification, rearing, or pest control.

Drawings below illustrate examples of metamorphosis.

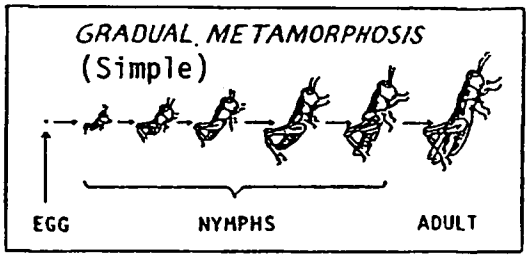
In **Group 1** the insect that comes from the egg looks exactly like it will when grown, except it will then be larger.



Orders

Thysanura (Silverfish)
Collembola (Springtails)

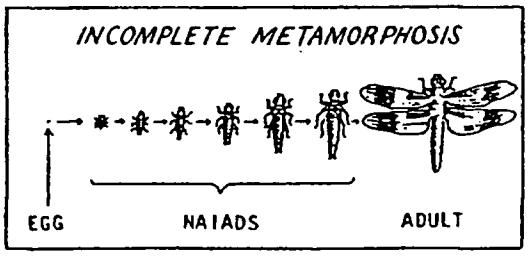
Insects in **Group 2** change shape gradually. There are three stages of growth: egg, nymph, and adult. Nymphs are miniature copies of their parents, but without wings.



Orders

Orthoptera (Grasshopper)
Isoptera (Termite)
Psocoptera (Book and bark lice)
Thysanoptera (Thrips)
Hemiptera (True bugs)
Homoptera (Aphids, leafhoppers, cicadas)
Dermaptera (Earwigs)
Mallophaga (Biting lice)
Anoplura (Sucking lice)

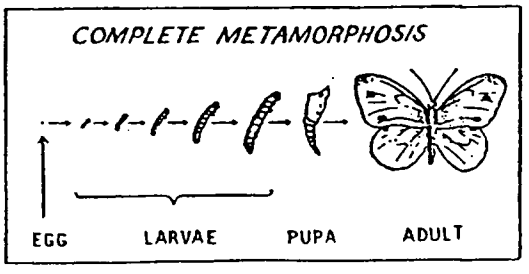
The young insects in **Group 3** change size gradually. They do not look like adults until shedding their last skin. Then there is a dramatic change.



Orders

Ephemeroptera (Mayflies)
Odonata (Dragonflies)
Plecoptera (Stoneflies)

All insects in **Group 4** go through four stages of growth. None of the young looks like the adult. There is a great change in shape when the adult emerges from the pupa stage.



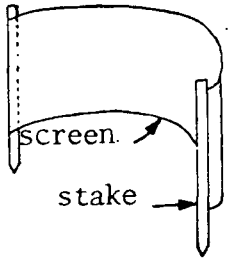
Orders

Neuroptera (Lacewings)
Coleoptera (Beetles)
Mecoptera (Scorpionflies)
Trichoptera (Caddisflies)
Lepidoptera (Moths, butterflies)
Diptera (Flies)
Siphonaptera (Fleas)
Hymenoptera (Bees, wasps)

Collecting: Insects are Where You Find Them

Insects may be collected in a great variety of locations. Generally they are found in, on, or near their food supply. Many species are closely associated with specific host plants or animals. Others may feed on a large number of related plants.

Aquatic insects spend at least a portion of their lives in water. Certain species are restricted to stagnant ponds; others are able to exist only in cold, highly oxygenated water. The types of insects found in an aquatic habitat can indicate the health of that ecosystem. Aquatic insects can be collected using an aquatic screen.



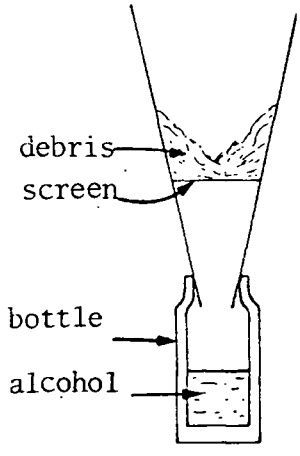
Aquatic screen

Insects may be predatory, feeding on other animals. There are many species that live on decaying plant or animal material. Some are parasitic, laying eggs on or in host species. You may notice tiny white eggs attached to caterpillars, or you may find that a caterpillar does not pupate but one or more small wasps or flies emerge from it. These are parasites.

For general collecting, visit as many habitats as possible throughout the year. Hatches occur during which one or more species will be extremely abundant for a short time. Mayflies, stoneflies, cicadas, and winged termites are examples of insects showing sudden emergence or appearance.

Many insects are *crepuscular*, that is, they become active only during dimly lit periods. Others are *nocturnal*, active at night.

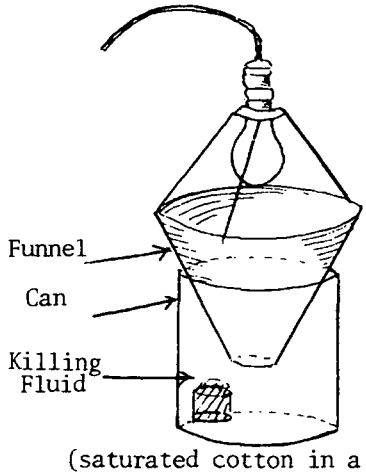
Insects are common in sheltered spots under rocks or boards, or in rotting logs. Sifting through forest litter (moss or top soil) will expose many species seldom seen otherwise. Small insects should not be overlooked. Size is not very important, in fact, some of the most important insects are the smallest—e.g., aphids, and mosquitoes. Insects may be collected from leaf litter or birds' nests using a Berlese Funnel.



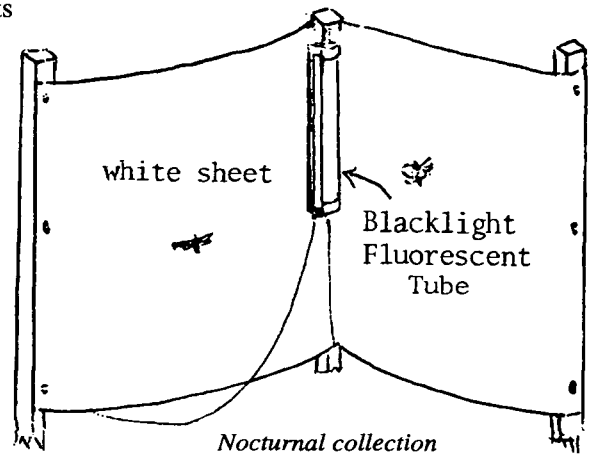
Berlese-type funnel

Since insects are cold-blooded; they are limited in activity by the temperature surrounding them. Therefore, most insects seek protective shelter and hibernate in winter. Some may estivate during very hot summer periods. Estivation is a dormant state used to slow down the body processes to survive the stresses of summer. There is marked variation among insects. Some may be active in winter months e.g., some moths and stoneflies.

Many insects are attracted to lights, but they see yellow light poorly, if at all. They see ultraviolet (or so-called blacklight) best. Collecting on warm summer nights from twilight until it begins to cool off can be very rewarding. A lantern or ultraviolet fluorescent tube (most stores dealing in lighting equipment can supply these) used with an old bed sheet to act as a reflector will attract hundreds of specimens in a single evening. These can be picked off the sheet or scooped up in a net as they arrive.



Light traps



Nocturnal collection

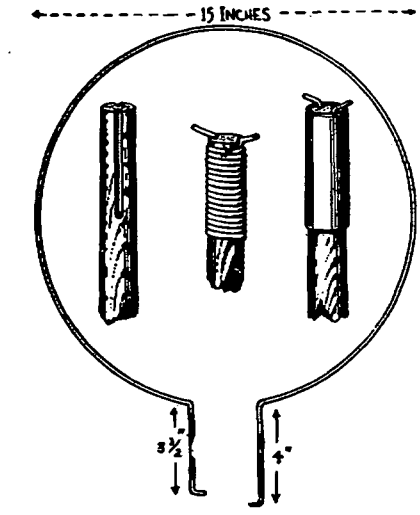
Insects are abundant, so beginners should not find collecting difficult. The collector should use a variety of collecting techniques and be persistent. Collecting will soon prove so easy that the problem will be to find time to preserve the collection.

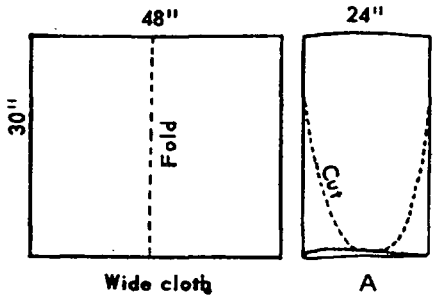
The Insect Net

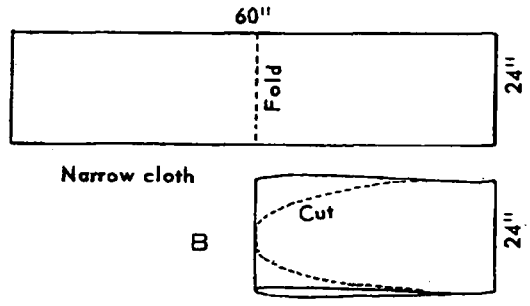
Most insects will be caught with a net. Two kinds of nets are used. One is called a butterfly or aerial net. It has a bag made of mosquito netting, or similar porous material, permitting it to be swung freely through the air. The other kind of net, called a beating or sweeping net, has a bag made of unbleached muslin. It is swung back and forth, scraping grass, weeds, and foliage as you walk along.

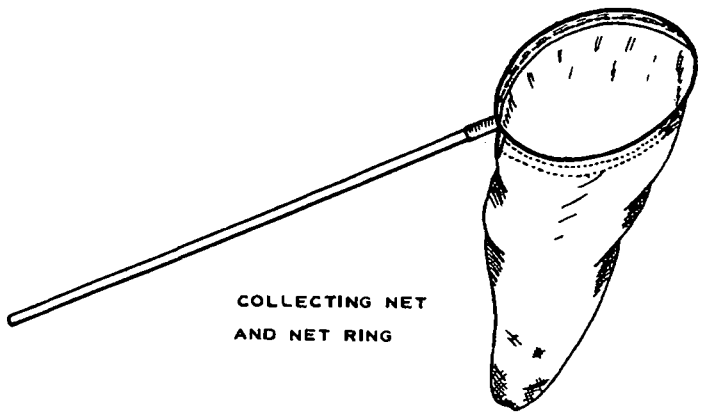
Make your net this way:

1. Bend a 54-inch piece of No. 12 steel wire into a 15-inch loop, as shown in the diagram.
2. Make the bag from a single piece of cloth. If cloth is wide, fold and cut as in Figure A. If narrow, fold as in Figure B. Feed sacks, unbleached muslin, or sheeting can be used.
3. The shape should taper toward a rounded bottom. The top edge of the bag should measure 48 inches. The bag can be about 30 inches in depth.
4. Cut the cloth to shape. Pin the edges together to hold them while you sew. Make a flat or fell seam. Fasten the open end of the bag to the wire loop by folding over the wire and sewing with heavy thread. Turn under the edge of the fabric so you have a smooth, flat seam.
5. Attach the ends of the wire loop to a 3-foot broom handle with fine wire or heavy cord, or with a ferrule.









Insect Killing Jar

A. Safety Precautions

Any substance poisonous enough to kill insects could be hazardous to your health if not handled carefully. Do not get any of the killing fluid on your hands or clothing. **If you do come into contact with the killing fluid, wash immediately**. Do not inhale fumes. Use only jars that can be tightly sealed. **Pour the killing fluid into the killing jar outside, where you are least likely to inhale fumes**. This is called *charging the killing jar.*

Label the killing jar:

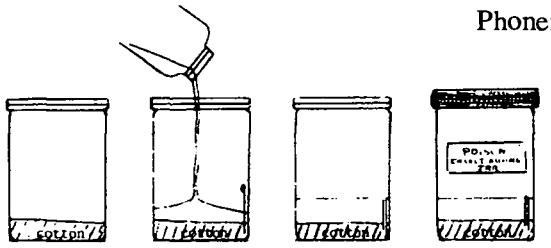
POISON
INSECT KILLING JAR

B. Materials

1. Clear, wide-mouth jars with tight-fitting lids. Small olive, pickle, or baby-food jars are good
2. Plaster of Paris available at hardware or paint stores
3. Cotton, water, spoon, matchstick
4. Ethyl acetate

C. Procedures

1. Pack cotton into bottom of jar.
2. Mix plaster of Paris into a thick but pourable paste and add 1/2 to 1 inch of this over the cotton.



Step 1 Step 2 Step 3 Step 4

Insect killing jar

Push a matchstick or similar small object along the plaster into the cotton and leave it there until the plaster hardens.

3. Allow plaster to dry thoroughly.
4. Add ethyl acetate* to the killing jar until the cotton and plaster are saturated. Attach poison label and tight lid.

Crumble pieces of paper toweling or tissue in the killing jar. This will absorb moisture and keep insects separated.

You may purchase collecting supplies from:

Bio Quip
17803 LaSalle Ave.
Gardena, CA 90248-3602
Phone: 310-324-7931

**Note: Ethyl acetate is volatile. Killing jars should have tight-fitting lids. The lid should not be removed for more than a few seconds. Do not use plastic bottles.*

Insect Relaxing Methods

Insects that have dried after being killed must be relaxed or made limber before they can be mounted. Two methods are given; the most common is the relaxing jar.

1. Relaxing Jar

Materials needed:

a. Wide-mouthed jar or can
b. A cup of sand
c. Small piece of cardboard or screen

How to make:

a. Pour an inch of sand into container and moisten with water.
b. Cut screen or cardboard to fit over the sand.

How to use

a. Place insects to be relaxed gently on screen or cardboard and close the lid.
b. Check in 6–12 hours to determine degree of relaxing completed.
c. Do not permit specimens to become wet or remain in the jar for long periods. They may form mold.
d. Replace cardboard if it becomes water soaked.

2. Quick Relaxing

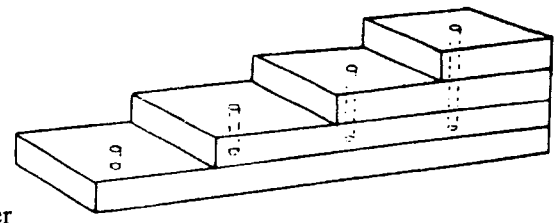
On the stove, bring a pot of water to a slow boil. Over the top of the pot place a fine screen (like window screen). Place insects on the screen in the steam for 15–20 minutes. Turn the insects so that steam penetrates all the body parts.

Insects may be patted dry as necessary with absorbent tissue, then mounted.

Pinning Block

Your collection will look neater if labels on all the pins are at the same height. A mounting block or pinning box will be helpful. To make it you need the following materials:

1. Four pieces of soft wood 1/4 inch thick; 1 inch wide; and 1, 2, 3, and 4 inches long.
2. Small carpenter's drill or small nail
3. Glue for gluing small pieces of wood together



Drill (or use a nail to make) a small hole in the center of each step as shown in the drawing. The holes should be only slightly larger than the diameter of an insect pin.

Pinning Insects

Insects should be pinned in a uniform manner using pins made especially for this purpose. Do not use pins designed for sewing. You may order insect mounting pins from a biological supply company, or you may contact your county Extension agent.

The body part through which the pin is placed differs in some orders of insects. In the absence of specific information, pin them through the thorax just to the right of center.

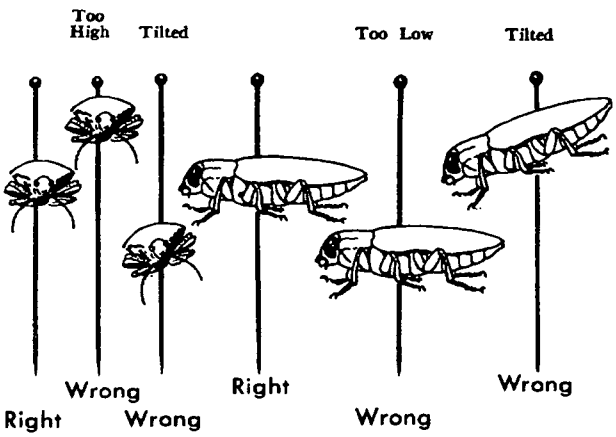
All insects should be at the same height on the pins—that is, about 1/2 inch of pin should be visible above the insect.

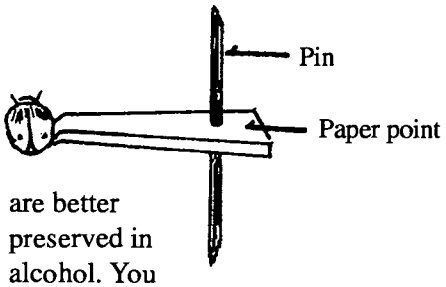
The insect should be horizontal on the pin, perpendicular to the pin itself. It should not be tilted from side to side. The pinning block is a valuable aid in getting the insect in good position on the pin.

Soft-bodied insects may tend to droop on the pin. Legs, wings, and antennae may be in disorder. It's important to straighten the body parts in a way that permits future study. If the insect needs this attention, move the legs, etc. with forceps or a pin. To counteract body or leg droop, add a heavy paper support under the pinned insect and leave it there until the insect dries.

Small specimens should be glued to triangular paper points as illustrated at above right.

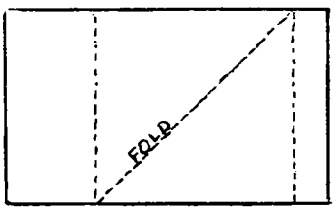
Note in the illustration that the insect is glued to the point on its right side with its head facing to the right. Point-mount any insect if you think the pin would damage it. Points can be cut from heavy paper or file-card stock, or may be obtained from the Extension office. Some soft-bodied insects, such as aphids, springtails, silverfish, and mayflies, and larvae should not be pinned at all but should be preserved in small vials of 70% rubbing alcohol or 70% ethyl alcohol. These vials can be displayed in collection boxes if firmly held in place with pins, glue, or wire fasteners.



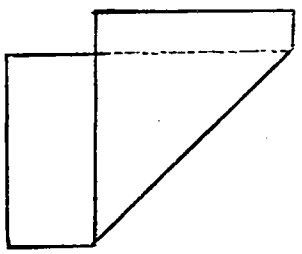


Very fragile insects such as craneflies, mosquitoes, etc. also are better preserved in alcohol. You may use rubbing alcohol for this purpose.

Lepidoptera (butterflies and moths) may be "papered" for storage prior to spreading. The steps in making a paper triangle are illustrated. These papered specimens must be thoroughly relaxed before spreading is attempted.



STEP 1



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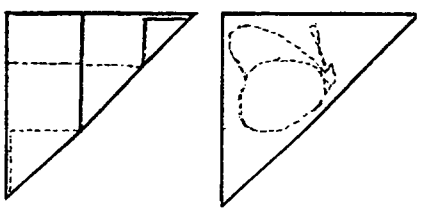


3 4

An Insect Spreading Board

Lepidoptera (butterflies and moths) must be properly mounted to look their best in an insect collection. This spreading board will enable you to prepare your specimens when they are freshly killed, or relaxed, so their wings will remain in the desired position when dry. The groove is wider at one end than the other so you can put small specimens at one end and large ones at the other.

Materials needed:

a. One piece of 3/8" or 1/2" thick fiber board or balsa wood 5 1/2" x 12"

b. Two pieces of 3/4" by 2 5/8" softwood 12" long (called "1 by 3s")

c. Six small shingle nails

d. Two 1/4" thick wood or cardboard strips 1/2" x 12"

Tools needed:

Hammer, saw, knife

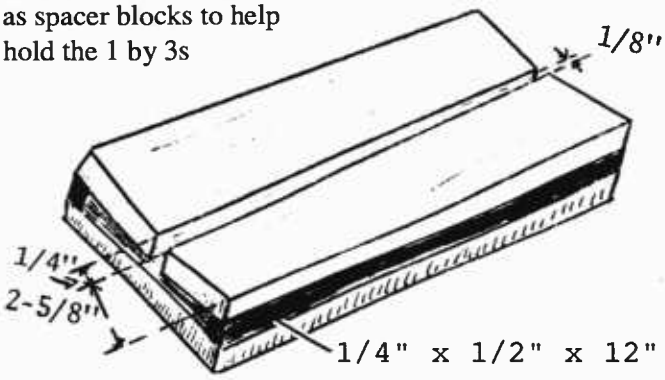
Making the Board

Place the 5 1/2" x 12" fiber board on your work surface. Place the two 1/2" x 12" pieces of wood or cardboard on the long outer edges.

Place the two 12" long 1 by 3s on the fiber board with the outside edge resting on top of the 1/2" x 12" strips. This will produce the angle needed for the board where the butterfly's wings will rest.

Use small blocks 1/4" and 1/8" wide at opposite ends of the board as spacer blocks to help hold the 1 by 3s the correct distance apart at each end of the board.

Nail the 1 by 3s at the four corners and the center edges. Remove the spacer blocks.



Spreading Lepidoptera

Your moth or butterfly must be freshly killed or well relaxed so it won't be stiff when you put it on your spreading board.

Pin the insect through the middle segment of the thorax and place it in the groove on the board.

Place a strip of paper 1/8" wide over the wing and pin down on one end. Slowly pull the wing into position, using the point of a pin to push against the veins on the wing. When the wing is in the correct position, push the strip down on the board and pin. If you have kept the strip of paper tight enough, the wing will remain in place. As you work with the wings, take care not to bump off the wing scales which give each specimen its distinctive color pattern.

Repeat on the other side and the insect will look as shown.

Adding a wide piece of paper will keep the wing flat until it dries. An average-size specimen will dry in a couple of days during the summer.

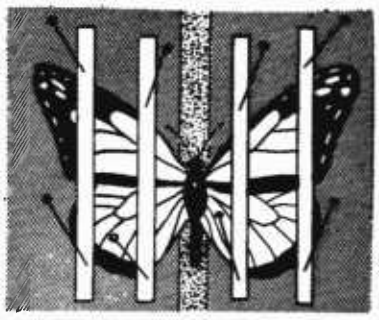
Suggestions

Put your locality label on the spreading board with the insect.

Place the board out of reach of your smaller brothers and sisters.

Do not place the board in the sun, as colors of some insects fade.

As soon as the insect is dry, place it in your collection. Otherwise it may get damaged.



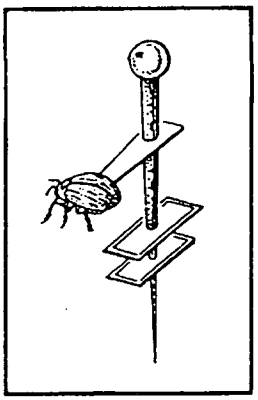
Butterfly properly spread

How to Label Insects

While labeling is not a glamorous job, it is important! Having insects accurately labeled and neatly displayed increases both the scientific and aesthetic value of a collection.

1. Finished label size should 13/16" x 7/16". Label sheet masters are in the Leader Guide (4-H 3221L). *Hint*: Copy a master, record the necessary information (either hand-printed with pencil or typed) reduce the label by 50% on a copier machine to equal the required size, glue the sheet to heavier paper, cut out the correctly sized labels, and pin.
2. The top label should include the following information: state where collected, county where collected, site where collected (or nearest town), the date collected, and collector's name.

3. The bottom label should include scientific order name and common insect name.
4. When positioned on the pin, the labels lie parallel to the long axis of the insect. The order in which to pin is: (1) the insect, (2) top label, (3) bottom label. (See illustration below.)
5. Use a pinning block to position all labels at a uniform height below the insects.
6. Labels for pointed insects lie parallel to the long axis of the **point**, not the insect. (See illustration at right.)
7. For insects preserved in alcohol, labels, printed in pencil or waterproof ink, should be placed inside the vial.



Labels are Parallel to the Point

Actual Size

Top Label

Sample

STATE COUNTY CLOSEST TOWN DATE COLLECTOR

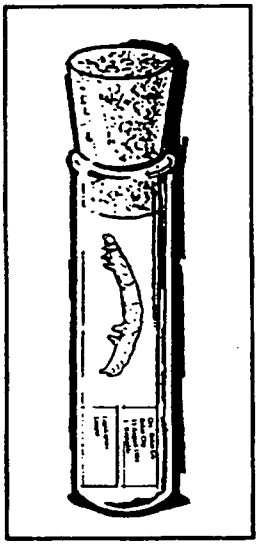
ORE. BAKER CO. BAKER CITY 15 AUGUST 1994 J. REYNOLDS

Bottom Label

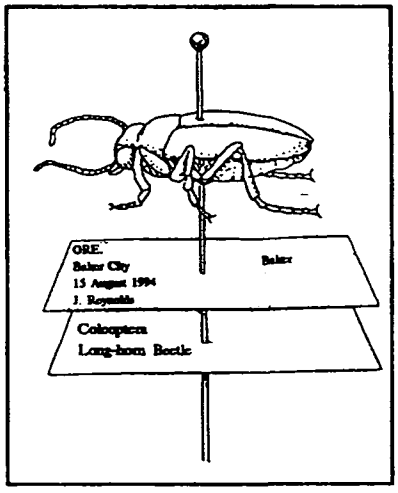
Sample

Order Common Name

COLEOPTERA LONG-HORN BEETLE



Vial with Insect and Labels



Labels are Parallel to the Insect

Collection or Display Box

Collections should be kept in sturdy cardboard or wooden boxes. Size is not too important, but moderate sizes are better than unwieldy heavy cases.

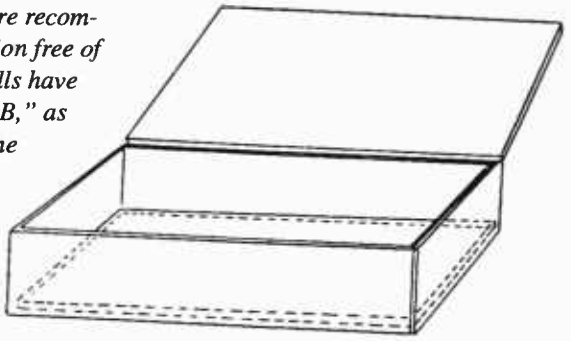
The pinning material in the bottom of the box should be soft enough to permit easy insertion of pins. Celotex, balsa, cork, or corrugated cardboard are recommended.

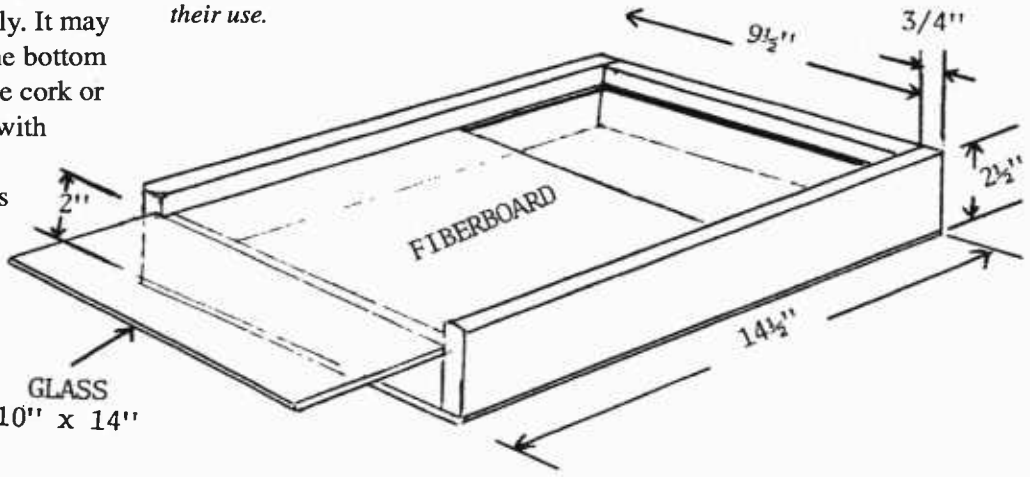
Pinning material should be cut to fit box bottoms snugly. It may be glued or tacked to the bottom of the box. Covering the cork or other pinning material with heavy white paper may add to the attractiveness of the display.

Two illustrations of acceptable boxes are shown—the first a cigar box; the second a larger box for advanced collectors.

Formerly, mothballs were recommended to keep the collection free of living insect pests. Mothballs have paradichlorobenzene, "PDB," as their active ingredient. Some tests have shown PDB to cause cancer in laboratory animals.

All currently available materials used to prevent insect damage in collections are hazardous and we therefore do not recommend their use.





Riker Mounts

A Riker mount is a type of display case made of heavy cardboard with a transparent top. Insects placed inside rest on a layer of cotton that fills the box and holds the specimens snugly in place. Life histories of large butterflies or moths make attractive Riker mounts. Host plant material and labels can be placed inside, and all the materials may be displayed in life-like poses.

Riker mounts may be purchased from biological supply houses, but they are easy to make. Here's how:

Select boxes of adequate size to hold your display. Many gift boxes such as shirt, necktie, or candy boxes are excellent for this use. The box should not be more than 2 inches deep. Deeper boxes can be cut to that depth.

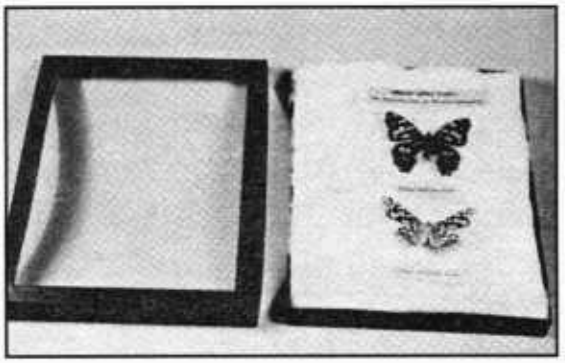
Step 1—Carefully cut out the interior portion of the box lid, leaving about a 1/2-inch margin.

Step 2—Cut glass or heavy-gauge transparent acetate to size and tape to the inside of the lid.

Step 3—Fill the bottom of the box with a layer of cotton.

Arrange previously prepared display material and labels in desired position on the cotton.

Bind the box top and bottom with plastic tape.

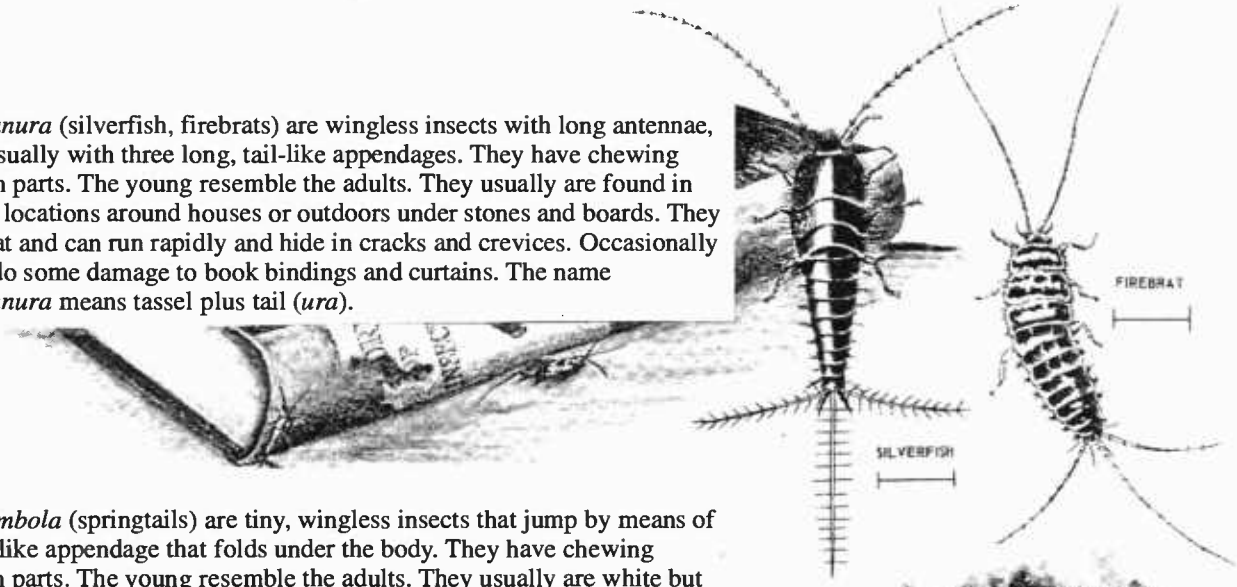


Riker mount in preparation

Riker mount

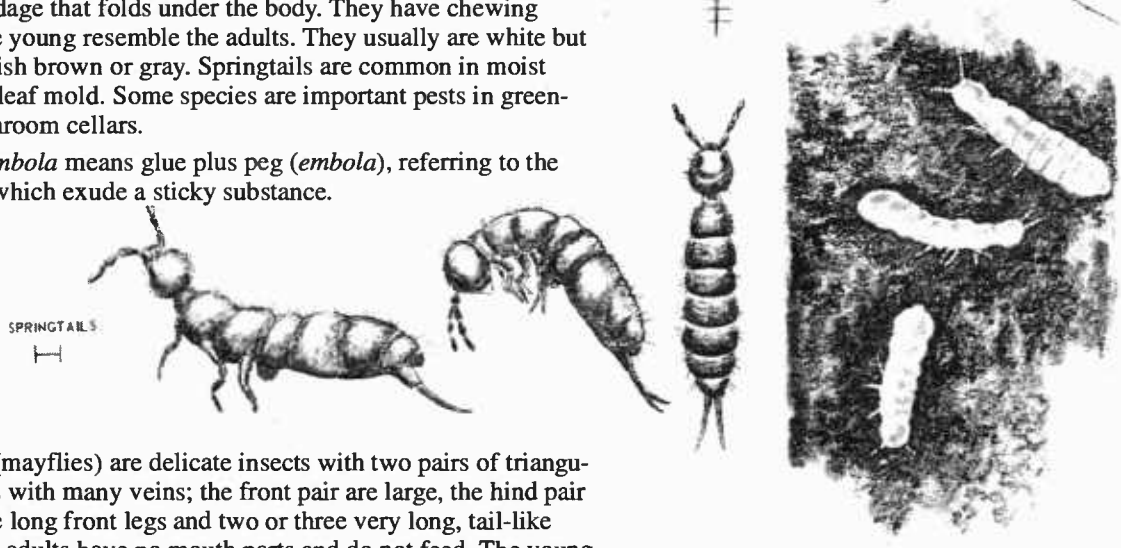
Identification of Insects by Order

Thysanura (silverfish, firebrats) are wingless insects with long antennae, and usually with three long, tail-like appendages. They have chewing mouth parts. The young resemble the adults. They usually are found in moist locations around houses or outdoors under stones and boards. They are flat and can run rapidly and hide in cracks and crevices. Occasionally they do some damage to book bindings and curtains. The name *Thysanura* means tassel plus tail (*ura*).

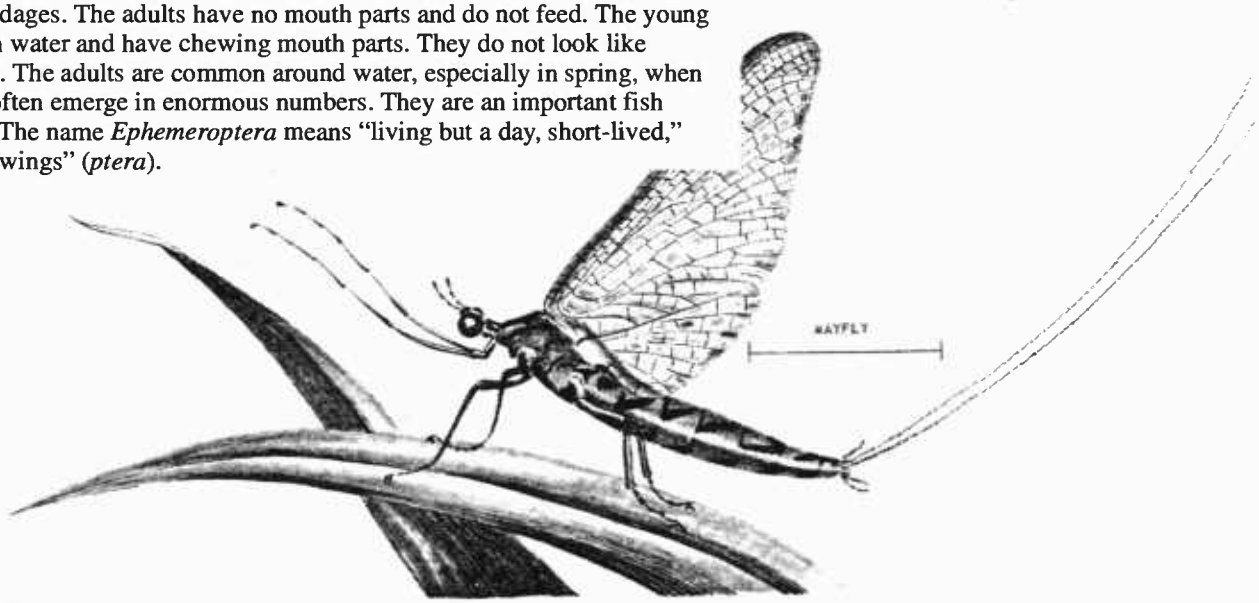


Collembola (springtails) are tiny, wingless insects that jump by means of a tail-like appendage that folds under the body. They have chewing mouth parts. The young resemble the adults. They usually are white but some are yellowish brown or gray. Springtails are common in moist locations and in leaf mold. Some species are important pests in greenhouses and mushroom cellars.

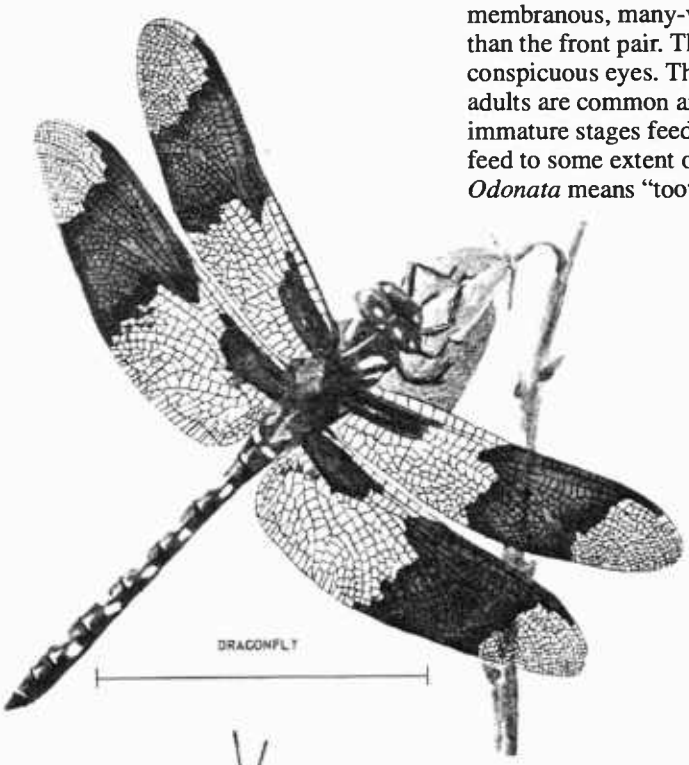
The name *Collembola* means glue plus peg (*embola*), referring to the ventricle tubes, which exude a sticky substance.

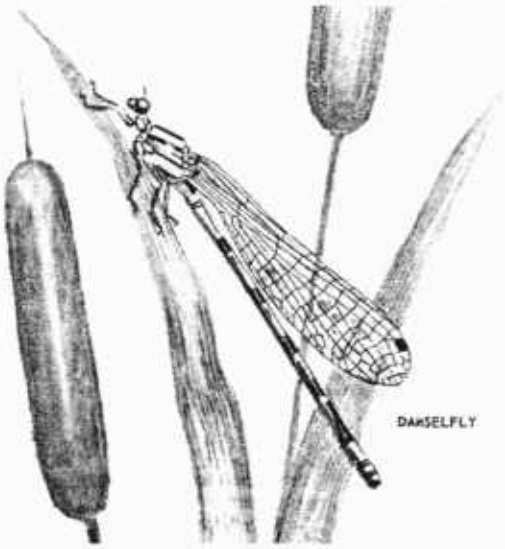


Ephemeroptera (mayflies) are delicate insects with two pairs of triangular-shaped wings with many veins; the front pair are large, the hind pair small. They have long front legs and two or three very long, tail-like appendages. The adults have no mouth parts and do not feed. The young live in water and have chewing mouth parts. They do not look like adults. The adults are common around water, especially in spring, when they often emerge in enormous numbers. They are an important fish food. The name *Ephemeroptera* means "living but a day, short-lived," plus "wings" (*ptera*).

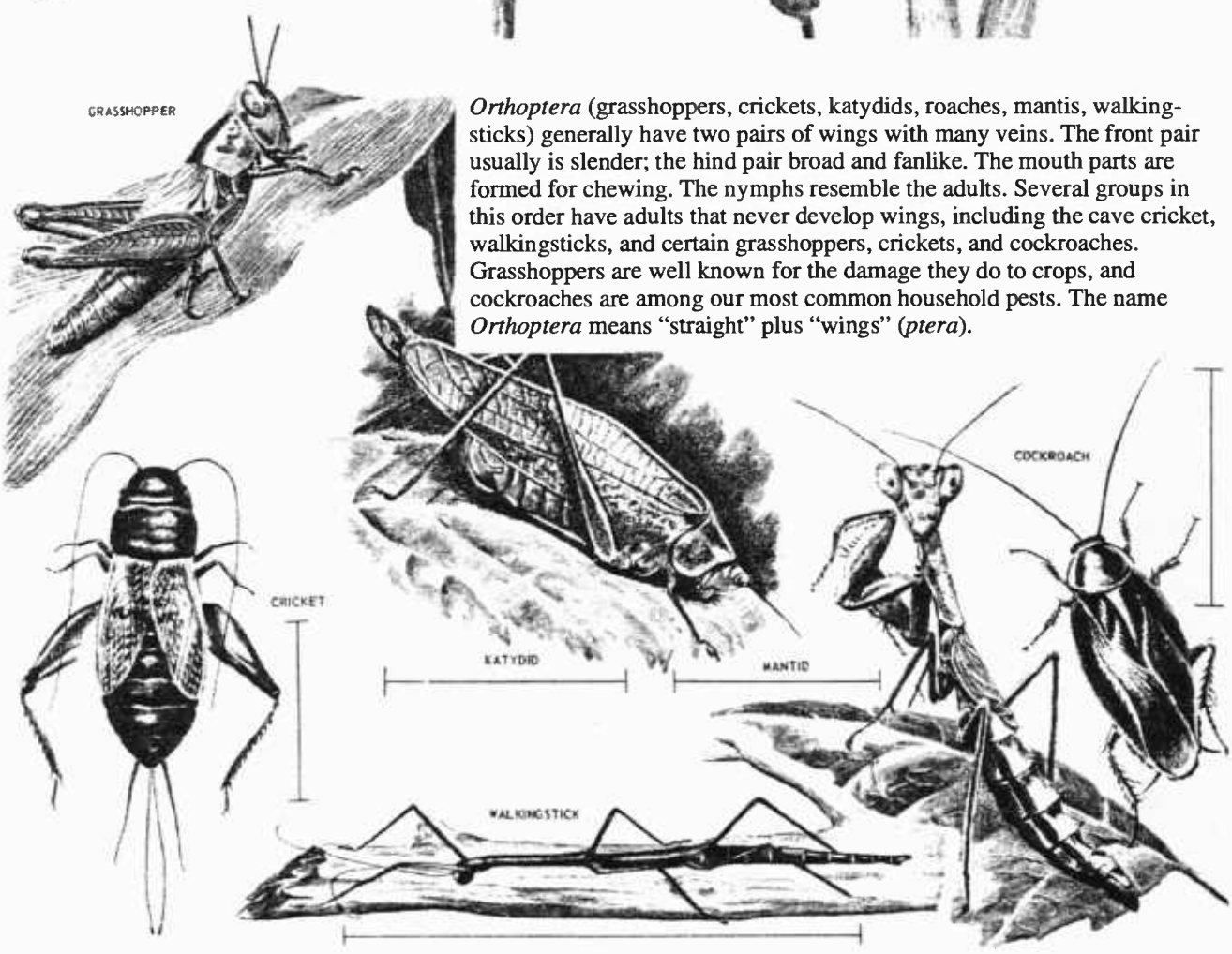


Odonata (dragonflies, damselflies) are large insects with two pair of membranous, many-veined wings; the hind pair are as large as or larger than the front pair. They have chewing mouth parts. They have large, conspicuous eyes. The young live in water and are not like the adults. The adults are common around ponds, lakes, and streams. Both adults and the immature stages feed on other insects. They are beneficial because they feed to some extent on mosquitoes and other small flies. The name *Odonata* means "toothed."

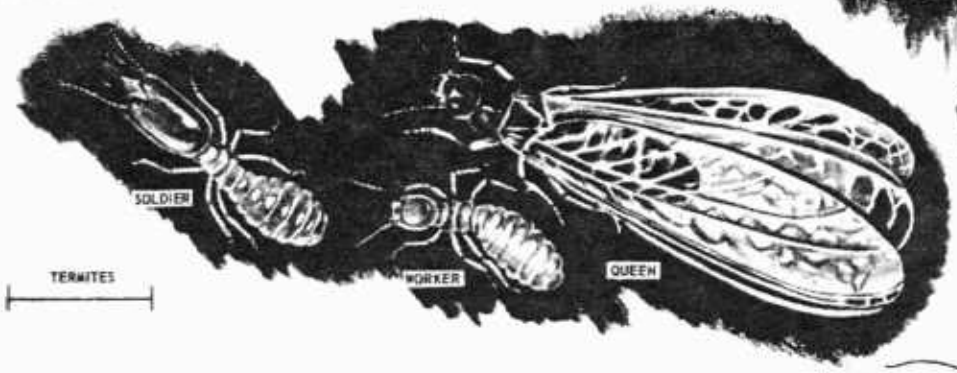




Orthoptera (grasshoppers, crickets, katydids, roaches, mantis, walking-sticks) generally have two pairs of wings with many veins. The front pair usually is slender; the hind pair broad and fanlike. The mouth parts are formed for chewing. The nymphs resemble the adults. Several groups in this order have adults that never develop wings, including the cave cricket, walkingsticks, and certain grasshoppers, crickets, and cockroaches. Grasshoppers are well known for the damage they do to crops, and cockroaches are among our most common household pests. The name *Orthoptera* means "straight" plus "wings" (*ptera*).



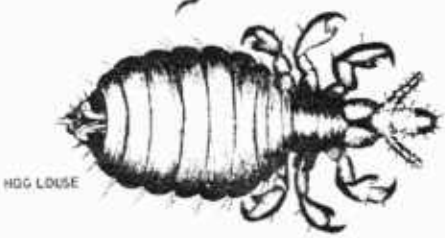
Isoptera (termites) are small, soft-bodied, yellowish or whitish insects that live in colonies in wood. Colonies consist of three classes—workers, soldiers, and swarmers. The workers and soldiers are wingless and never leave the colony. The swarmers are reproductive forms with dark bodies and four long, many-veined wings. They leave the colonies on sunny days to mate and start new colonies. Termites have chewing mouth parts and feed upon wood. They destroy many structures every year. The name *Isoptera* means "equal" plus "wings" (*ptera*), referring to the four equal wings of the swarmers.



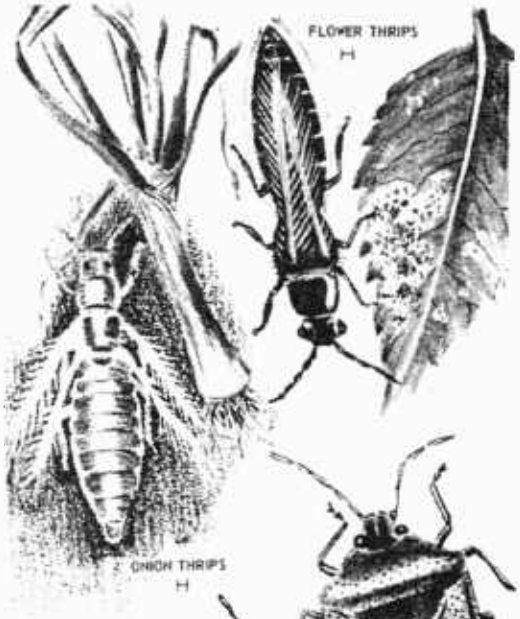
Plecoptera (stoneflies) are large, soft-bodied insects ½ to 2 inches long. They have four wings that fold flat over the back; the hind pair fold like a fan and are much larger than the front wings. The antennae are long, and there are two long tail-like appendages at the tip of the abdomen. They have chewing mouth parts, but many of the adults do not feed. The young or nymphs live in rapidly running streams under stones. The adults are found on stones or plants near streams. *Plecoptera* means "plaited" plus "wings" (*ptera*), referring to the wings overlapping the sides of the body.

Dermaptera (earwigs) are medium-sized insects, usually with four wings. The front pair are short, leaving the abdomen exposed. The hind wings are folded under these. A pair of nonpoisonous pinchers are found at the end of the abdomen. They have chewing mouth parts. The nymphs go through a gradual metamorphosis to reach their adult form. Usually they are found outdoors hiding under leaves or boards, or in cracks during the day. The name *Dermaptera* means "skin" plus "wings" (*ptera*), referring to the texture of the front wings.

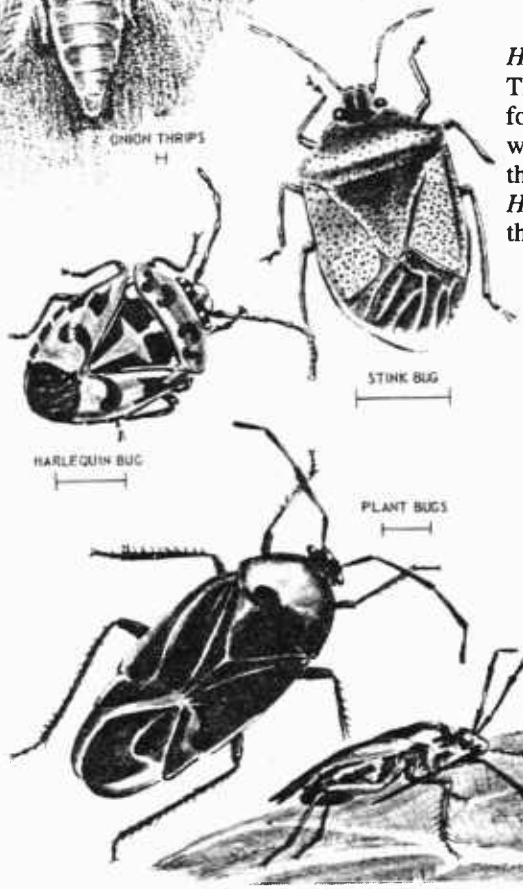
Mallophaga (biting lice or bird lice) are small, flat, wingless, parasitic insects with chewing mouth parts. The legs and antennae are short. The immature stages resemble the adults. They feed upon feathers, hair, wool, and skin scales. They frequently are important pests of domestic fowl and animals. They do not live on humans. The name *Mallophaga* means "wool" (*mallos*) plus "to eat."



Anoplura (true lice or sucking lice) are small, flat, wingless, parasitic insects with mouth parts formed for piercing and sucking. The legs and antennae are short. The immature stages resemble the adults. These insects are found on human and domestic animals, but not on fowl. They feed by sucking blood. The common cootie, or body louse, is a vector of epidemic typhus in humans. The name *Anoplura* means "unarmed, without a tail" (*ura*).

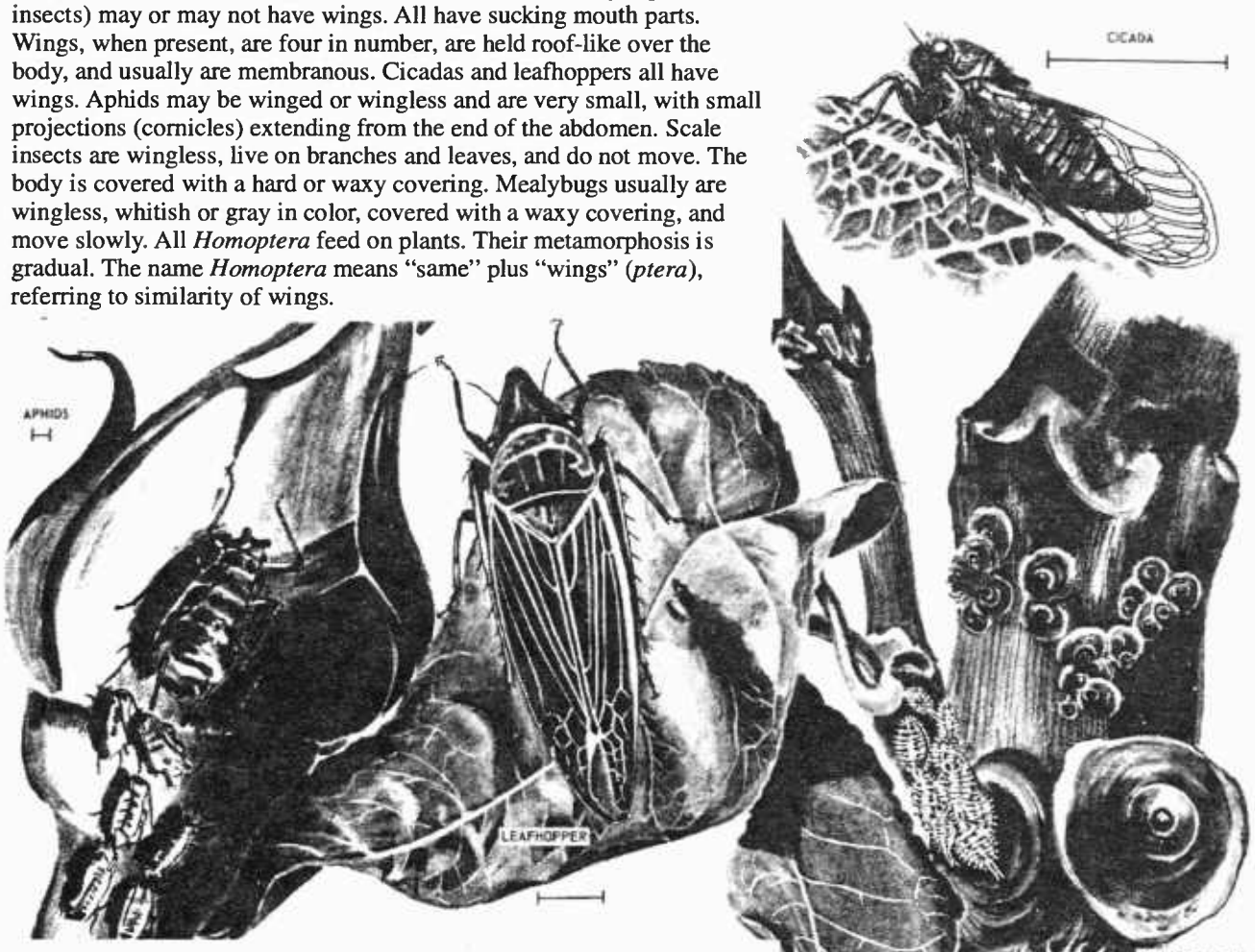


Thysanoptera (thrips) are mostly very small insects about 1/8 inch long, usually with two pairs of slender wings with few veins but fringed with long hairs. The legs and antennae are short. The mouth parts are formed for piercing and sucking. The immature stages resemble the adults. Some of these insects feed on plants; others prey on small insects. Those that feed on plants are frequently very injurious in greenhouses or on vegetable crops. The name *Thysanoptera* means "a tassel" plus "wings" (*ptera*), referring to the marginal hairs on the wings.

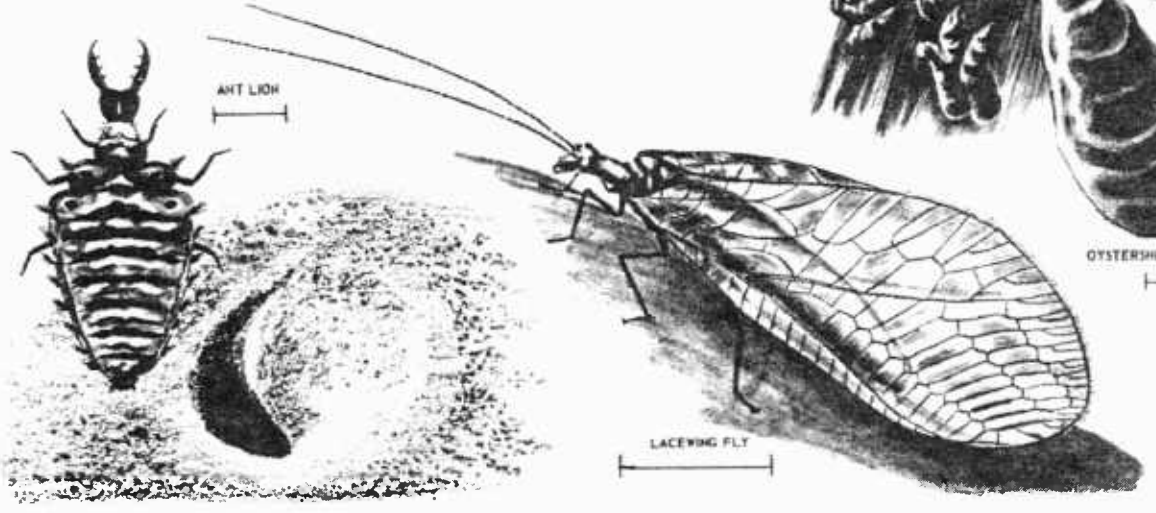


Hemiptera (true bugs) usually have four wings folded flat over the body. The front pair are thickened with membranous tips. The mouth parts are for sucking and are prolonged into a beak. The insects are found in water, on plants, and on animals, and cause considerable damage by their feeding. They go through a gradual metamorphosis. The name *Hemiptera* means "half" plus "wings" (*ptera*), referring to the partly thickened, partly membranous front wings.

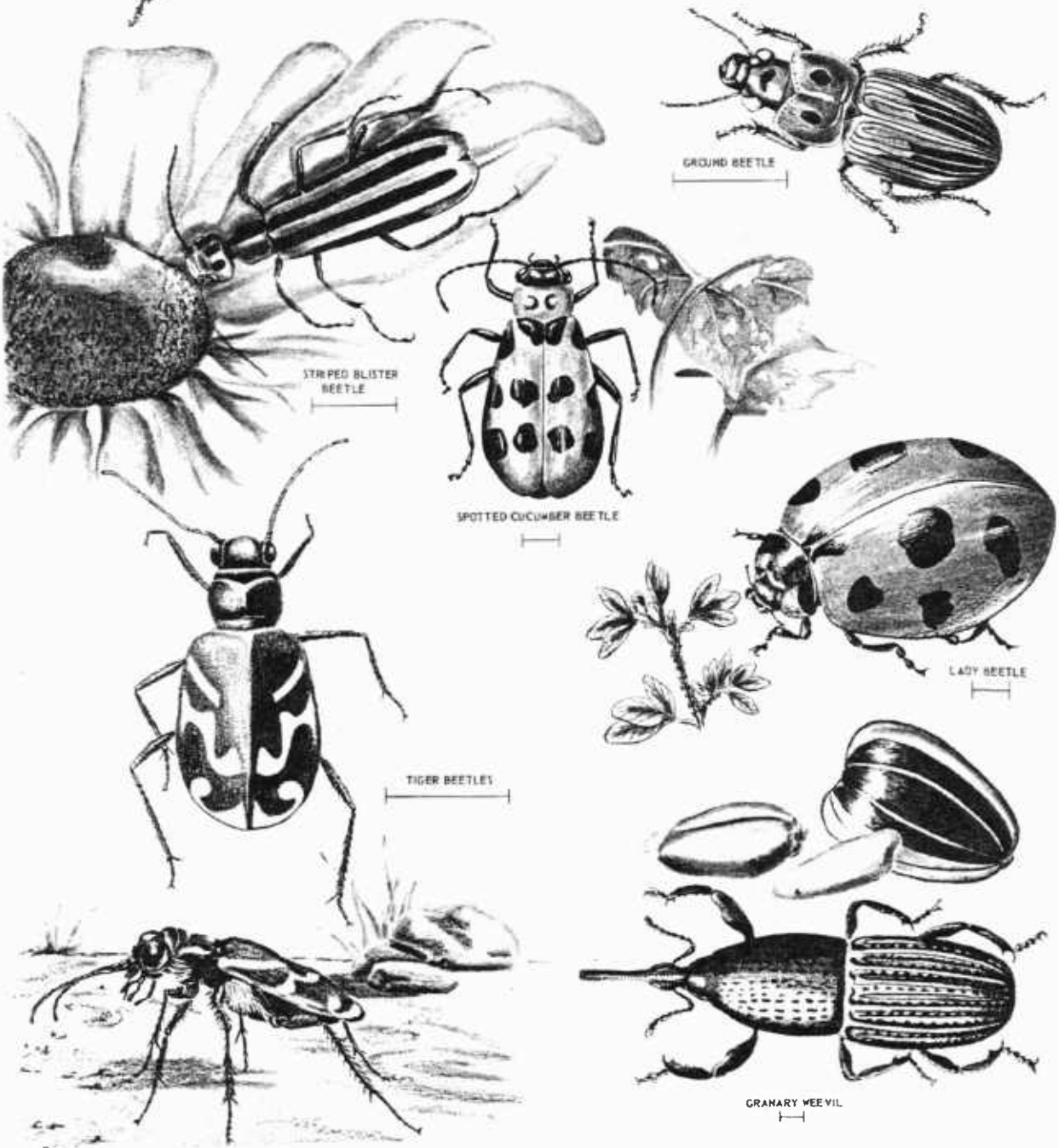
Homoptera (aphids, leafhoppers, cicadas, whiteflies, mealybugs, scale insects) may or may not have wings. All have sucking mouth parts. Wings, when present, are four in number, are held roof-like over the body, and usually are membranous. Cicadas and leafhoppers all have wings. Aphids may be winged or wingless and are very small, with small projections (cornicles) extending from the end of the abdomen. Scale insects are wingless, live on branches and leaves, and do not move. The body is covered with a hard or waxy covering. Mealybugs usually are wingless, whitish or gray in color, covered with a waxy covering, and move slowly. All *Homoptera* feed on plants. Their metamorphosis is gradual. The name *Homoptera* means "same" plus "wings" (*ptera*), referring to similarity of wings.



Neuroptera (lacewings, flies, ant lions, and their allies) are rather fragile insects with two pairs of many-veined wings of about the same size. The antennae are long. The mouth parts are formed for chewing. The immature stages are predaceous. These insects undergo complete metamorphosis. The most common ones are the aphid lion and the doodlebug (or ant lion) which forms pits in dry, dusty places. They are beneficial because they feed on insect pests. The name *Neuroptera* means "nerve" plus "wings" (*ptera*), referring to the many veins in the wings.

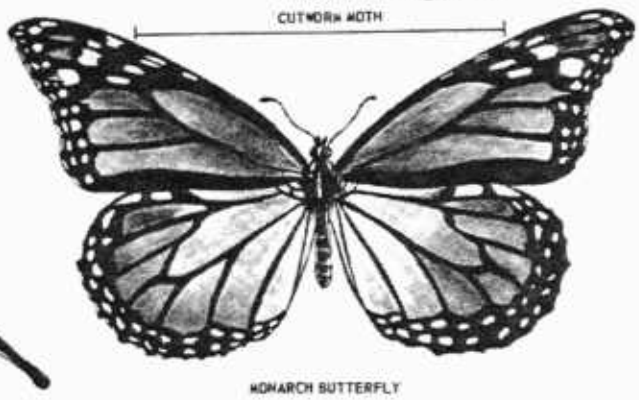


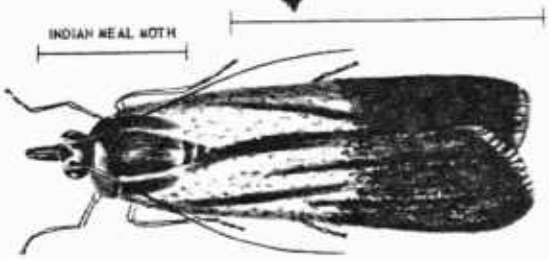
Coleoptera (beetles and weevils) usually are winged, with two pair of wings. The front pair are thick, forming a hard shell and meeting in a straight line down the middle of the back. The hind wings are membranous and are folded under the front wings when at rest. They have chewing mouth parts. The immature stages are grub-like or worm-like, and the insects pass through a pupal stage before becoming adults. Their food habits vary. Some feed on living plants, some are predaceous, some are scavengers, and some bore in wood. This order includes some of the best known and most important insect pests. Most of the members are terrestrial but a few are aquatic. The name *Coleoptera* means "sheath" plus "wings" (*ptera*), referring to the thickened front wings.



Trichoptera (caddisflies) are soft-bodied insects with two pairs of wings clothed with silky hairs and having a medium number of veins. The antennae are long. The mouth parts of the adult are reduced except for the palps. The immature stages are worm-like and live in water. Most of them build cases about their bodies. The adults are common around streams. The name *Trichoptera* means hair plus wings (*ptera*).

Lepidoptera (butterflies, moths) usually are winged. The winged members have two pair of wings covered with overlapping scales. Adults have sucking mouth parts. The immature stages are worm-like and have chewing mouth parts. Some immature forms are known as caterpillars, cutworms, and hornworms. In the immature stages, most of the species feed on leaves of plants; others bore in plant stems, and some are leaf miners. This is one of the best known orders of insects and contains some of our most important pests, such as the codling moth, the armyworm, clothes moth, and the cabbageworm. The name *Leipidoptera* means "scale" plus "wings" (*ptera*).





HOUSEFLY

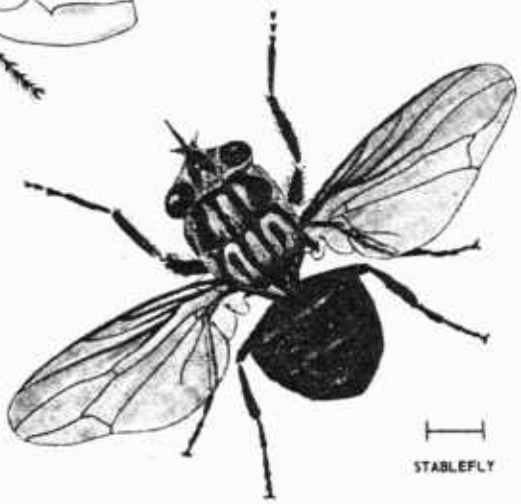
Diptera (flies, mosquitoes, gnats, and their allies) usually are winged, but have only one pair of wings without many veins. The hindwings are represented by a pair of slender, knobbed structures called halteres. The mouth parts are formed for sucking, or piercing and sucking. The immature stages are worm-like and are known as maggots. They do not resemble the adults. The order includes some forms that are parasitic, others that are predaceous, and some that live on either living or dead plant material. Some plant-eating members of the order cause a great amount of damage to crops. Because many of the species carry diseases, this is one of the most important orders from the standpoint of human health. The name *Diptera* means "two" plus "wings" (*ptera*), referring to the single pair of wings.

MOSQUITO

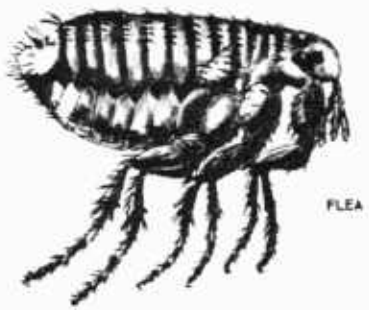
STRIPED HORSEFLY

FLESHFLY

WESTERN HORSEFLY



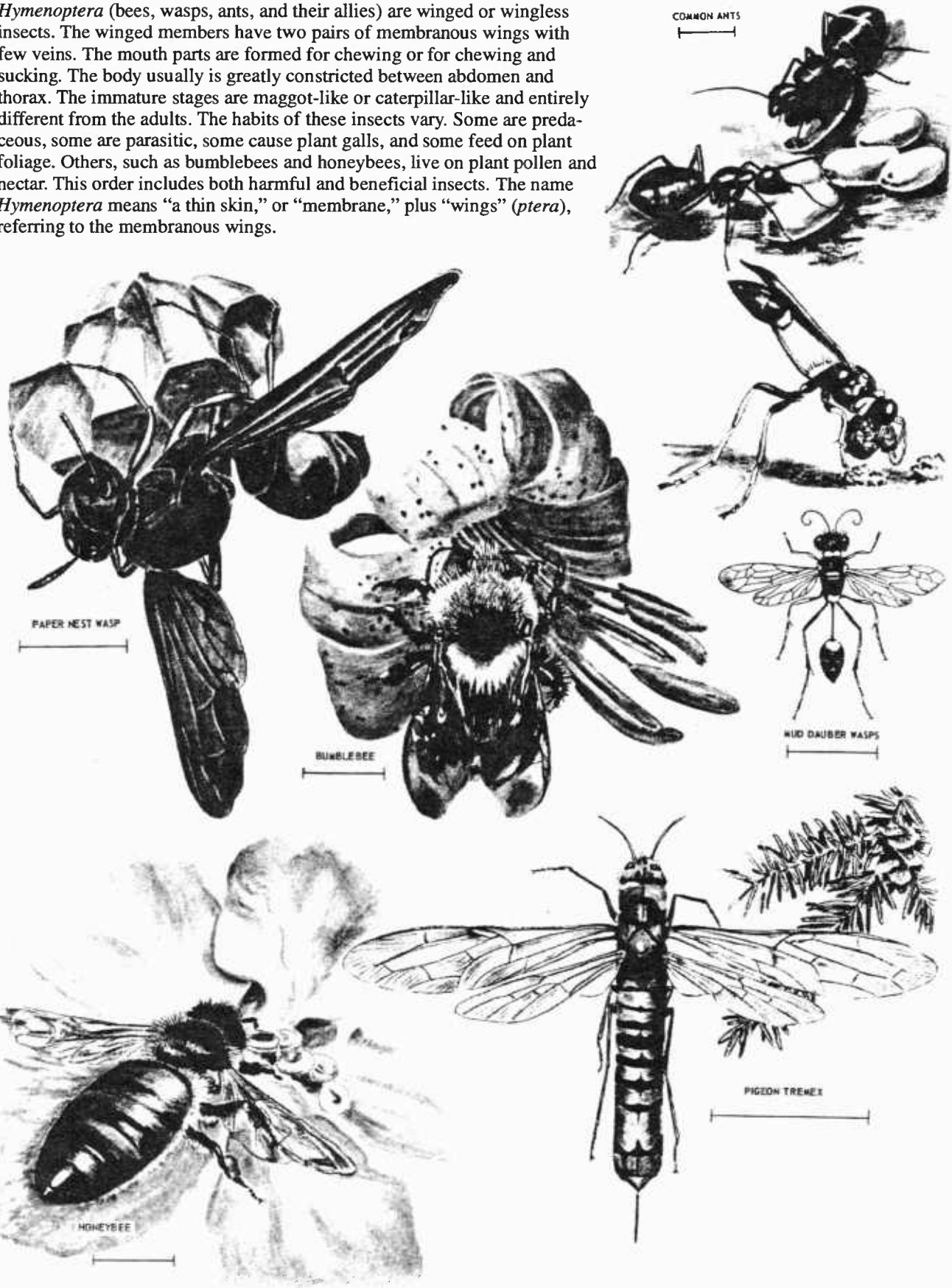
STABLEFLY



FLEA

Siphonaptera (fleas) are small, wingless insects with laterally compressed bodies. The legs are comparatively long. The body has numerous short bristles directed backward. The mouth parts are formed for piercing and sucking. The immature stages are worm-like, quite different from the adults, and are found in the nests of various animals. The adults are well known as pests of domestic animals and people. One species transmits bubonic plague from rodents to humans. The name *Siphonaptera* means "tube" plus "without wing" (*aptera*).

Hymenoptera (bees, wasps, ants, and their allies) are winged or wingless insects. The winged members have two pairs of membranous wings with few veins. The mouth parts are formed for chewing or for chewing and sucking. The body usually is greatly constricted between abdomen and thorax. The immature stages are maggot-like or caterpillar-like and entirely different from the adults. The habits of these insects vary. Some are predaceous, some are parasitic, some cause plant galls, and some feed on plant foliage. Others, such as bumblebees and honeybees, live on plant pollen and nectar. This order includes both harmful and beneficial insects. The name *Hymenoptera* means "a thin skin," or "membrane," plus "wings" (*ptera*), referring to the membranous wings.



A Partial List of Common Oregon Insects

Order *Thysanura*—the bristletails, found in rotten wood. Examples: silverfish and firebrats—both found in homes.

Order *Collembola*—the springtails, most have a jumping organ, are very small, found under bark, in moist situations.

Order *Ephemeroptera*—the mayflies, elongate soft-bodied with two or three threadlike tails. Aquatic, emerging in huge numbers at times.

Order *Odonata*—dragonflies and damselflies.

Order *Orthoptera*—Examples: grasshoppers, cockroaches (American, Oriental, and brown banded), katydids, mantids, walking sticks.

Order *Isoptera*—the termites. Examples: dampwood, subterranean.

Order *Plecoptera*—the stoneflies. Examples: giant stoneflies, roach-like stoneflies, winter stoneflies, spring stoneflies, green wing stoneflies.

Order *Dermaptera*—the earwigs (European earwig).

Order *Mallophaga*—biting or chewing lice. Examples: chicken louse, dog-biting louse, horse-biting louse, chicken-head louse, shaft louse, cattle-biting louse, turkey louse; many other biting lice on birds and mammals.

Order *Anaplura*—sucking lice. Parasites of mammals, including species: horses, cattle, hogs, sheep, and man. Examples: head louse, body louse.

Order *Thysanoptera*—thrips. Examples: Flower thrips, pear thrips, gladiolus thrips, onion thrips, prune thrips, greenhouse thrips.

Order *Hemiptera*—true bugs. Examples:
Aquatic bugs—water boatmen, backswimmers, giant water bugs, toad bugs, water striders, water measurers.
Terrestrial pests—bed bugs, plant bugs, flower bugs, lace bugs, chinch bugs, grass bugs, stink bugs, squash bugs, stainers.
Terrestrial beneficial—ambush bugs, assassin bugs, damsal bugs.

Order *Homoptera*—Examples: cicadas, spittlebugs, white flies, treehoppers, psylla, scales, leafhoppers, aphids, mealybugs.

Order *Neuroptera*—Examples: fishflies, alderflies, lacewings, dobsonflies, snakeflies, mantidflies, antlion.

Order *Coleoptera*—the beetles. Examples: tiger beetles, ground beetles, grain beetles, ant-like flower beetles, blister beetles, spider beetles, stag beetles, long-horned wood borers, predaceous diving beetles, rove beetles, fireflies, bark beetles, whirligig beetles, sap beetles, ladybird beetles, hairy fungus beetles, darkling beetles, powder-post beetles, scarab beetles, crawling water beetles, water scavenger beetles, soldier beetles, ambrosia beetles, strawberry root weevils, bean weevils, hister beetles, fungus beetles, checkered beetles, metallic wood-borers, pea leaf weevils, seed beetles, pea weevils, carrion beetles, flower beetles, click beetles, flat bark beetles, wireworms, leaf beetles (asparagus beetles, spotted cucumber beetles), potato beetles (Colorado potato beetles), flea beetles (tuber beetles, cabbage beetles, potato beetles).

Order *Trichoptera*—caddisflies (aquatic). Examples: primitive caddisflies, finger-net caddisflies, net-spinning caddisflies, snail-case caddisflies.

Order *Lepidoptera*—butterflies, moths, skippers. Examples: Parnassians, cabbage, sulfurs, orange-tips, monarch, wood nymphs, variegated cutworm, Western bean cutworm, corn earworm, clothes moth, tiger moth, cabbage looper, noctuids, brush-footed butterflies, blues, coppers, hair-streaks, cutworm, fritillaries, swallowtails, tussock, checker-spots, sphinx, measuringworm, hawk moth, angel-wings, mourning cloaks, saddle back, admirals, hornworm, clear-wing, beet armyworm, black cutworm, ctenuchas, owlet, tent caterpillar, underwing, cankerworm.

Order *Diptera*—the flies. Examples: craneflies, horse flies, bee flies, mosquitoes, syrphid flies, fruit flies, gall midges, house flies, face flies, blow flies, flesh flies, leaf miners, biting midges, march flies, robber flies, deer flies, tachinid flies, picture-winged flies, stable flies, horn flies, bot flies.

Order *Siphonaptera*—the fleas. Examples: rodent fleas, bat fleas, cat fleas, dog fleas.

Order *Hymenoptera*—the bees, ants, wasps, etc. Examples: sawflies, spider wasps, cuckoo wasps, ichneumons, leafcutting bees, ants, gall wasps, bumblebees, paper wasps, velvet ants, horntails, honeybees, vespid wasps, chalcids, carpenter bees, yellow jackets.

How to Use the Key to Orders of Insects

Beginning at Step 1, read the first two lines of the key. You'll see that you are given two choices or descriptions of parts of an insect.

Look at the insect you wish to identify to an order. If it has wings that are well developed, refer to Step 2 as indicated in the second column. If the insect to be identified is wingless, or with small, undeveloped wings, refer to Step 22, as indicated.

Continue through the key in this manner, reading the two descriptions provided for each number to which you have been referred, and comparing them with the insect to be identified. Use the illustrations to aid your identification.

When you reach a description that fits the insect to be identified, it will be followed by a word printed in capital letters. This is the name of the order to which that insect belongs. For further information about the insect, turn to the pages where insect orders are described.

Words Used in the Key

Abdomen—the last of the three body regions of insects.

Antenna (pl., antennae)—one of a pair of horns or feelers on the heads of insects.

Beak—the mouth parts of a sucking insect.

Cells—the areas in the wings of insects that are between or bounded by veins.

Cercus (pl., cerci)—the thread-like or sometimes forceps-like tails near the tip of the insect abdomen (usually a pair).

Conspicuous—easy to see.

Cornicle—one of a pair of short, blunt tubular structures (sometimes button-like) on the top and near the end of the aphid abdomen. They give off a waxy liquid that helps protect against predators.

Elytron (pl., elytra)—the leathery or hard front wings of beetles. They usually cover the hind wings when at rest and sometimes are called "wing covers."

Furcula—a forked "tail" on the underside of the abdomen of *Collembola* (springtails), used for jumping.

Halteres—small, knob-like organs (sometimes shaped like a baseball bat or bowling pin) located on the thorax of *Diptera*. They take the place of the hind wings and are used to help balance the insect in flight.

Mandibles—the first pair of jaws in insects; stout and tooth-like in chewing insects, needle- or sword-shaped in sucking insects; the lateral upper jaws of biting insects.

Membranous—thin like a membrane. Clear or almost clear enough to see through, like cellophane or clear plastic sheeting.

Mesothorax—the second or middle segment of the thorax that bears the middle pair of legs and the first pair of wings.

Metathorax—the third or last thoracic segment. Joins to the abdomen. Bears the hind pair of legs and second pair of wings or rudiments of these wings, such as the halteres found on flies (*Diptera*).

Palpus (pl., palpi)—small "feelers" near the mouths of insects, probably used to help select food when eating.

Parasite—any animal that lives in or on another living animal.

Predator—an animal that attacks and feeds on other animals.

Pronotum—the top or upper side of the prothorax.

Prothorax—the first thoracic ring or segment; bears the first pair of legs but has no wings.

Scales—small, powder-like structures covering the wings of lepidoptera that provide the wing's color markings.

Segments—subdivisions of the insect body, leg, or antenna. Between joints.

Segmented—jointed or divided into sections.

Stylet—tubular or needlelike structure, sucking mouth parts of sucking lice or other sucking insects.

Tarsus (pl., tarsi)—the "feet" of insects. The last small segments near the end of the insect leg. The number may vary from one to five.

Thorax—the second or intermediate region of the insect body, found between the head and abdomen; bears the legs and wings when present; made up of three rings or segments: first, prothorax; second, mesothorax; and third, metathorax.

Veins—the rod-like or vein-like stiffening or supporting "frame" of the insect wing.

Key to Orders of Insects

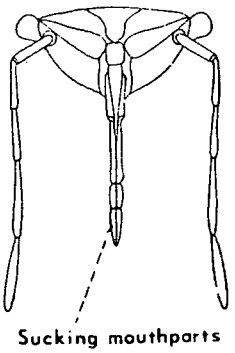


Figure 1

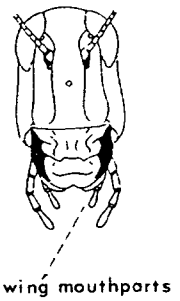


Figure 2

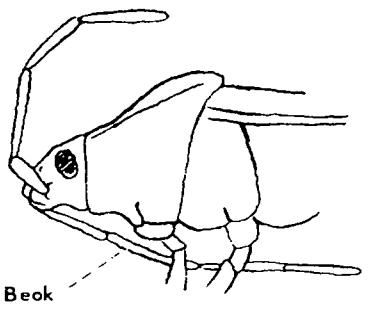


Figure 3

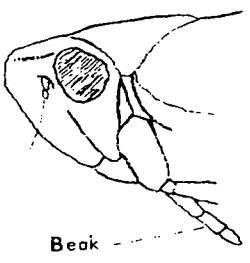


Figure 4

Steps	Refer to Step No.	Insect Order	Refer to Page No.
1. Wings well developed	2		
Wingless, or with small, undeveloped wings	22		
2. Front wings (elytra) hard, leathery, at least at base; hind wings, if present, membranous	3		
Wings entirely membranous	7		
3. Sucking mouthparts, with beak longer than wide, and usually jointed (Figure 1)	4		
Chewing mouth parts (Figure 2)	5		
4. Beak arising from front part of head (Figure 3); front wings usually leathery at base and membranous (skin-like) at tip; tips generally overlapping when at rest (true bugs)		*Hemiptera*	18
Beak arising from rear underside part of head, often appearing to arise at base of front legs (Figure 4); front wings of uniform texture throughout; tips not overlapping or only slightly overlapping when at rest (leafhoppers, cicadas, aphids, treehoppers)		*Homoptera*	19

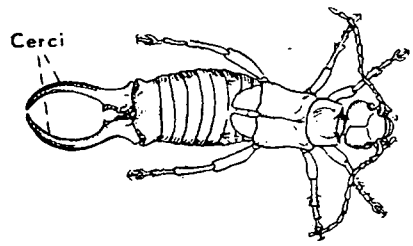


Figure 5

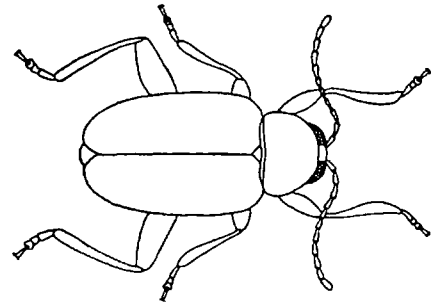


Figure 6

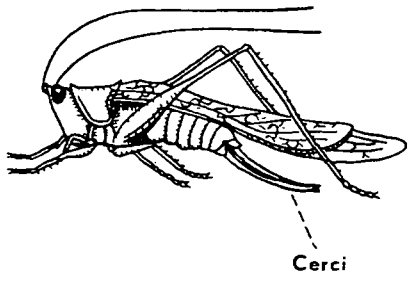


Figure 7

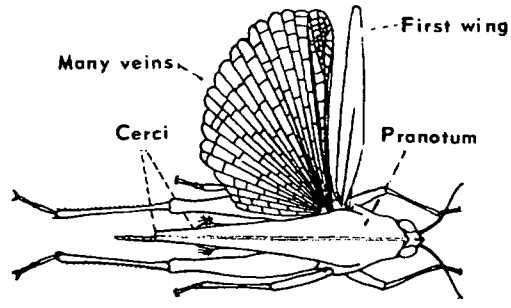


Figure 8

Steps	Refer to Step No.	Insect Order	Refer to Page No.
5. Abdomen with forceps-like cerci (Figure 5); elytra short, leaving most of the abdomen exposed (earwigs)		*Dermaptera*	17
Abdomen without forceps-like cerci, or if cerci appear forceps-like, then wings cover most of abdomen	6		
6. Front wings without veins, usually meeting in a straight line down middle of back (Figure 6); antennae with 11 or fewer segments; hind wings narrow, usually longer than front wings when unfolded, and with few veins (beetles)		*Coleoptera*	20
Front wings with veins, either held roof-like over abdomen or overlapping over abdomen when at rest (Figure 7); antennae usually with more than 12 segments; hind wings broad, usually shorter than front wings, and with many veins (Figure 8) (grasshoppers, crickets, roaches, mantis)		*Orthoptera*	16
7. With two wings	8		
With four wings	11		

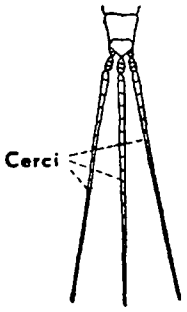


Figure 9

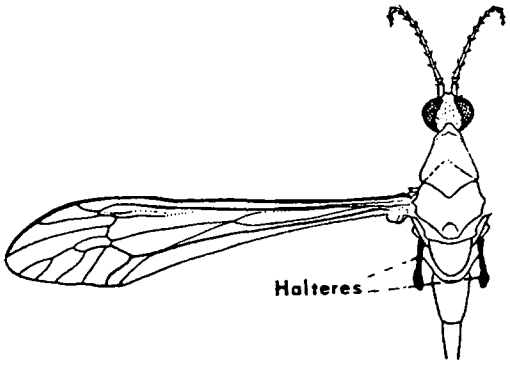


Figure 10

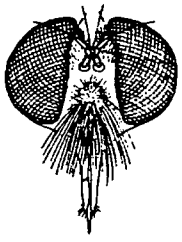


Figure 11

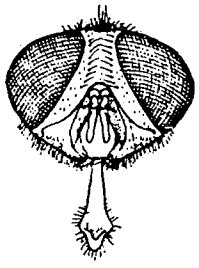


Figure 12

Figure 13

Steps	Refer to Step No.	Insect Order	Refer to Page No.
8. Body grasshopper-like; pronotum extending back over abdomen, pointed at tip (Figure 8); hind legs enlarged (grouse or pigmy locusts, family *Tetrigidae*)		*Orthoptera*	16
Body not grasshopper-like; pronotum not as above; hind legs not so enlarged	9		
9. Abdomen with threadlike or spine-like cerci (Figure 9); mouth parts small or undeveloped; halteres (Figure 10) may be present or absent	10		
Abdomen without thread-like or spine-like cerci; mouth parts usually well developed, forming a sucking beak (Figure 11) or tongue (Figure 12); halteres present (true flies, mosquitoes, gnats, midges)		*Diptera*	22
10. Halteres (Figure 10) present and hook-like; wings with only one forked vein (Figure 13); antennae long and conspicuous; very small insects, usually less than 3/8 inch long (male scale insects, family coccidae)		*Homoptera*	19
Halteres absent; wings with many veins and crossveins; antennae short, bristlelike, small; usually over 1/8 inch long (mayflies)		*Ephemeroptera*	15

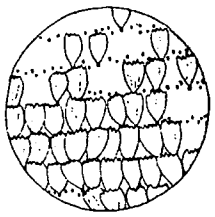


Figure 14

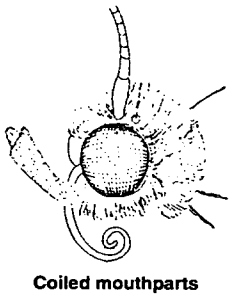


Figure 15

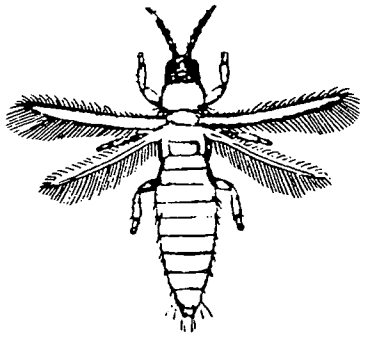


Figure 16

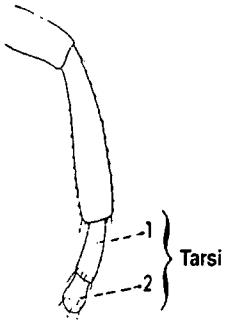


Figure 17

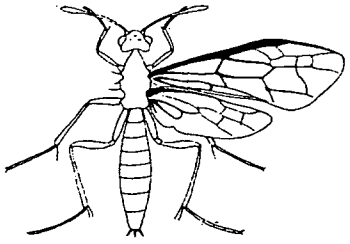


Figure 18

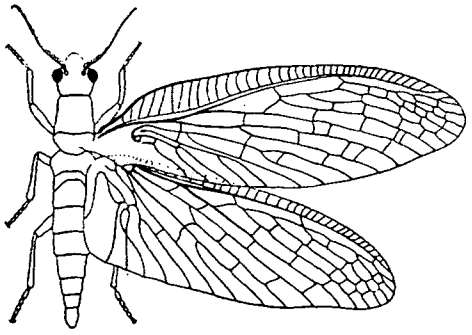


Figure 19

Steps	Refer to Step No.	Insect Order	Refer to Page No.
11. Wings completely or almost completely covered with microscopic powder-like scales (Figure 14); mouthparts usually in the form of a long, coiled, tube-like beak or tongue (Figure 15); antennae many-segmented (butterflies and moths)		*Lepidoptera*	21
Wings not covered with scales, though they may be hairy (Figure 16); mouth parts not in the form of a coiled tube-like tongue; antennae of various kinds.	12		
12. Wings long and narrow, veinless or with only one or two veins, fringed with long hairs (Figure 16); tarsi (Figure 17) with only one or two segments, the last segment swollen; very small insects, usually less than 1/8 inch long (thrips)		*Thysanoptera*	18
Wings not as above; if wings are somewhat long and narrow, then the tarsi have more than two segments.	13		
13. Hindwings smaller than front wings (Figure 18), usually with fewer veins	14		
Hind wings as large as or larger than front wings, with as many or more veins (Figure 19)	18		

Figure 20

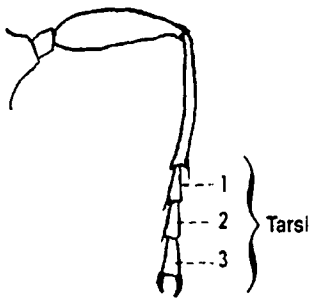


Figure 21

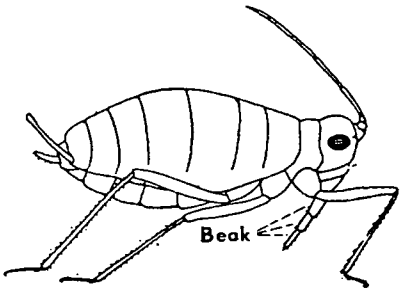


Figure 22

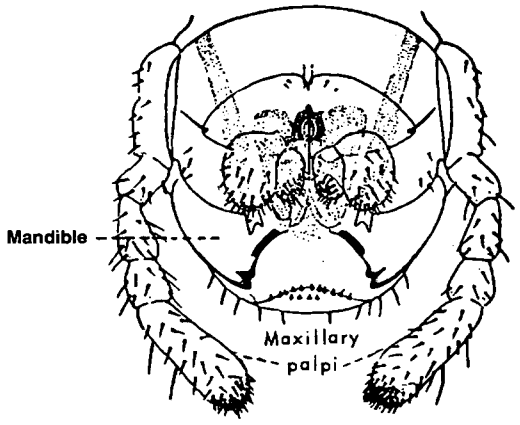


Figure 23

Steps	Refer to Step No.	Insect Order	Refer to Page No.
14. Front wings with many cross-veins and cells; antennae short, bristle-like, small; abdomen with two or three long, threadlike cerci (Figure 9); delicate, soft-bodied insects (mayflies)		*Ephemeroptera*	15
Front wings with few cross-veins and cells (Figure 20); antennae fairly long, or if short and bristle-like, then there are no thread-like cerci	15		
15. Tarsi two- or three-segmented (Figure 21)	16		
Tarsi four- or five-segmented	17		
16. Mouthparts sucking, the beak rising at rear of head (Figures 4 and 22) (leafhoppers, cicadas, aphids, treehoppers)		*Homoptera*	19
Mouthparts chewing (Figure 23), very small insects (booklice, barklice, psocids)		*Psocoptera*	

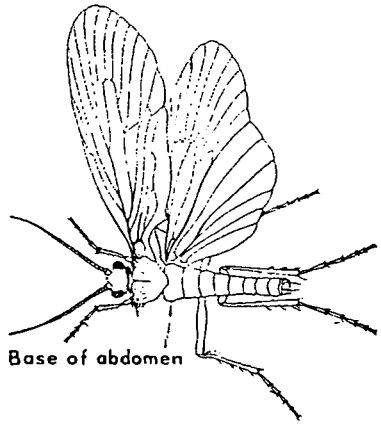


Figure 24

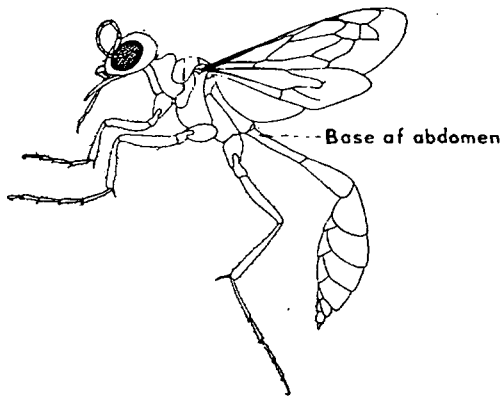


Figure 25

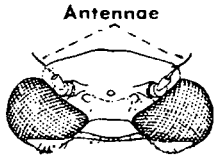


Figure 26

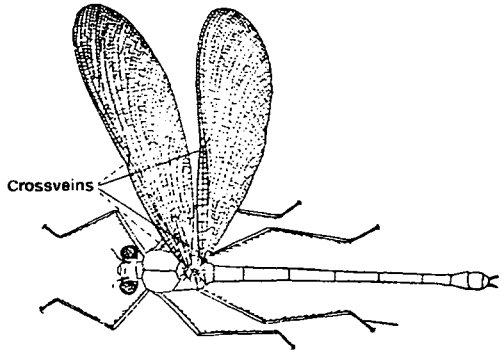


Figure 27

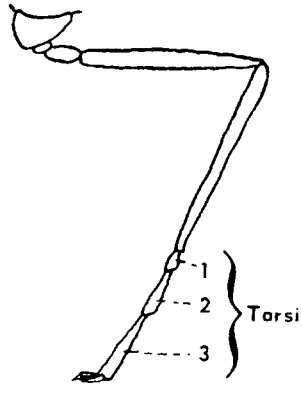


Figure 28

Steps	Refer to Step No.	Insect Order	Refer to Page No.
17. Wings noticeably hairy; mouthparts usually very small except for the palpi; antennae usually as long as the body or longer; veins in front and hind wings similar; abdomen not narrow at the base; rather soft-bodied insects, not wasp-like (Figure 24) (caddisflies)		*Trichoptera*	21
Wings apparently not hairy; mandibles well developed; antennae shorter than the body; fewer veins in hind wings than in front wings; abdomen usually narrow at base (Figure 25); rather hard-bodied, wasp-like insects (sawflies, ichneumon flies, ants, wasps, and bees)		*Hymenoptera*	23
18. Tarsi three- or four-segmented (Figure 21)	19		
Tarsi five-segmented	21		
19. Antennae short, bristle-like and small (Figure 26); wings with many cross-veins, never held flat over the abdomen when at rest (Figure 27); tarsi three-segmented (Figure 28); body long and slender, 3/4 to 3 1/2 inches long (dragonflies and damselflies)		*Odonata*	16
Antennae long and conspicuous; wing veins variable, usually held flat over abdomen when at rest; 1 1/2 inches long or less	20		

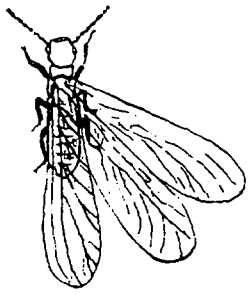


Figure 29

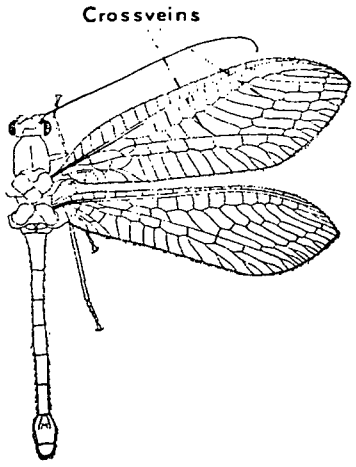


Figure 30

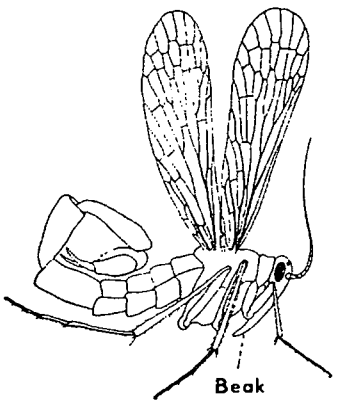


Figure 31

Steps	Refer to Step No.	Insect Order	Refer to Page No.
20. Front and hindwings similar in shape, size, and number of veins, reaching well beyond the tip of the abdomen when at rest (Figure 29); no cerci; body 5/16 inch long or less (termites)		*Isoptera*	17
Hindwings with the rear area much enlarged and folded fanlike when at rest; cerci present; bodies mostly 5/8 to 2 inches long (stoneflies)		*Plecoptera*	17
21. Front edge of front wings with many cross-veins (Figure 30); mouthparts not formed into a beak (as in figure 31) (fishflies, dobsonflies, lacewings, ant lions)		*Neuroptera*	19
Front edge of front wings with not more than one or two cross-veins; mouth parts extended downward to form a "beak" (Figure 31) (scorpion flies)		*Mecoptera*	
22. Usually parasites; body more or less leathery, and flattened from the upper to lower sides of body or from side to side	23		
Free-living, not parasites; body usually not flattened or leathery	28		

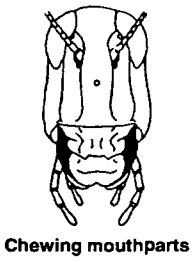


Figure 32

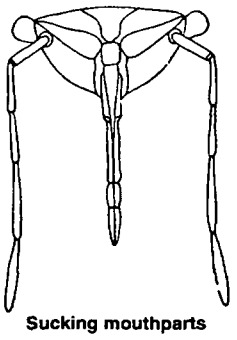


Figure 33

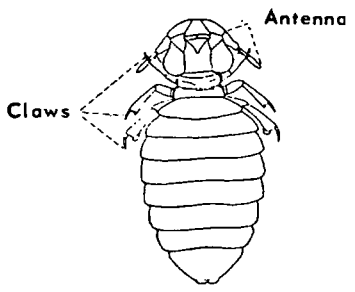


Figure 34

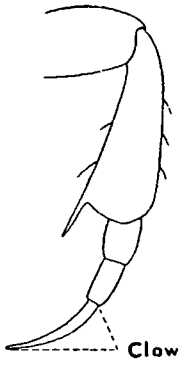


Figure 35

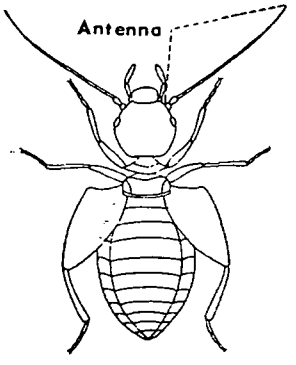


Figure 36

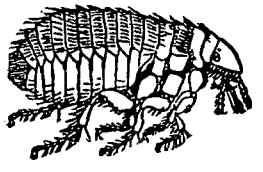


Figure 37

Steps	Refer to Step No.	Insect Order	Refer to Page No.
23. Mouthparts chewing (Figure 32)	24		
Mouthparts sucking (Figure 33), sometimes beak or stylet is drawn up into the head and cannot be seen	25		
24. Antennae with five or fewer segments (Figure 34); tarsi with one claw (Figure 35), parasites of animals, or with two claws, parasites of birds (chewing lice)		*Mallophaga*	18
Antennae with more than five segments (Figure 36); not parasitic (booklice, barklice, psocids)		*Psocoptera*	
25. Body flattened on the sides (Figure 37); jumping insects (fleas)		*Siphonaptera*	22
Body flattened from upper to lower sides; not jumping insects	26		

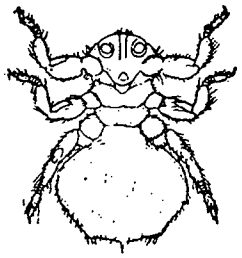


Figure 38

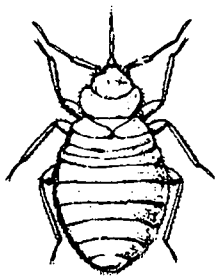


Figure 39

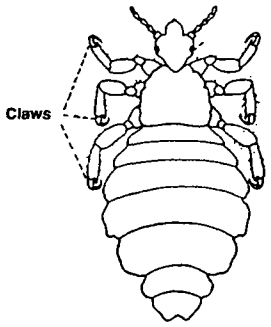


Figure 40

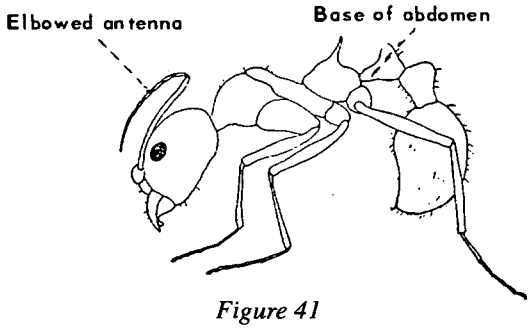


Figure 41

Steps	Refer to Step No.	Insect Order	Refer to Page No.
26. Antennae hidden in grooves beneath the head (Figure 38) (louse flies)		*Diptera*	22
Antennae not hidden, usually easy to see	27		
27. Beak longer than wide, four segments (Figure 33), extending back beneath the body; tarsi with two small claws (Figure 39) (wingless bugs)		*Hemiptera*	18
Head with only a short snout in front, the stylet pulled back into the head when not in use; tarsi with one very large claw (Figures 35 & 40) (sucking lice)		*Anoplura*	18
28. Abdomen very thin, small, or narrow at base (Figure 41); antennae usually elbowed (Figure 41); hard-bodied, ant-like insects (ants and wingless wasps, velvet ants)		*Hymenoptera*	23
Abdomen not particularly thin at base; antennae not elbowed	29		

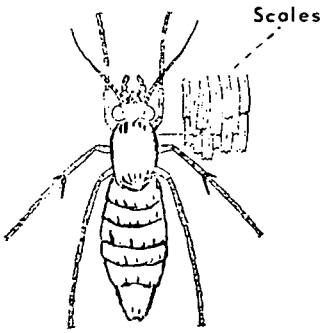


Figure 42

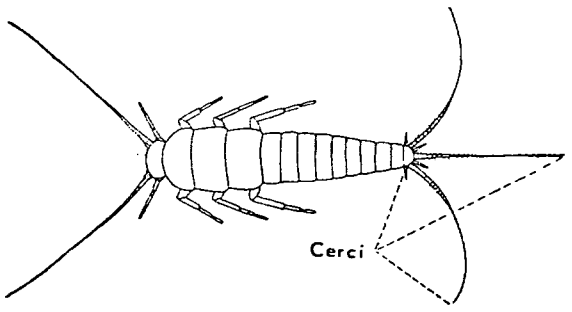


Figure 43

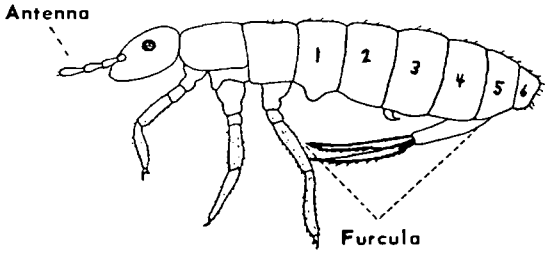


Figure 44

Steps	Refer to Step No.	Insect Order	Refer to Page No.
29. Body covered with scales (Figure 42)	30		
Body not covered with scales	31		
30. Abdomen with three long, threadlike cerci (Figure 43), and with spine-like hairs or spikes on some abdominal segments; mouth parts chewing (silverfish, bristletails, firebrats)		*Thysanura*	15
Abdomen without tails or spine-like hairs (Figure 42); mouthparts sucking, usually in the form of a long, coiled, threadlike tube or tongue (Figure 15) (wingless moths)		*Lepidoptera*	21
31. Mouthparts hidden within the head; abdomen with spine-like hairs on some segments, or with a furcula near the end of the abdomen (Figure 44); usually less than 1/4 inch long	32		
Mouth parts not as above, easily seen, and either sucking or chewing; size variable	33		

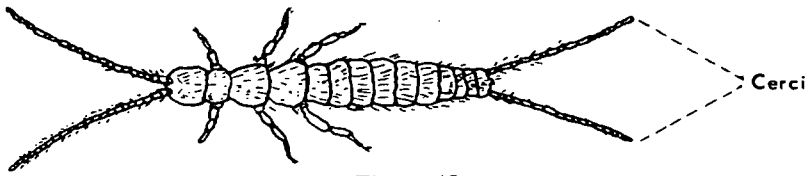


Figure 45

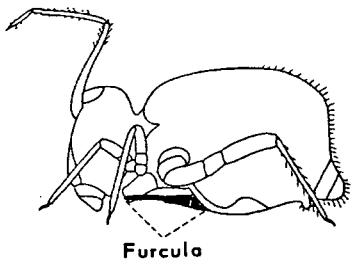


Figure 46

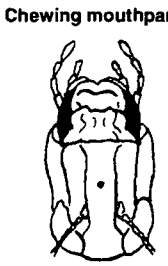


Figure 47

Steps	Refer to Step No.	Insect Order	Refer to Page No.
32. Antennae long and with many segments; abdomen with at least nine segments, with spine-like hairs on some segments; without a furcula near the end of abdomen, but with two, short to long, forceps-like cerci at the end of the abdomen (Figure 45) (japygids, campodeids, projapygids). These insects are light-colored, about 1/4 inch or less, and are found in damp places under bark, stones, or fallen trees, in rotting wood, etc.		*Thysanura*	15
Antennae short, with six or fewer segments; abdomen with six or fewer segments (Figure 44), usually with a furcula beneath and near the end of the abdomen (Figures 44 and 46) (Springtails)		*Collembola*	15
33. Mouthparts sucking, with beak long and pointing backward from the head, or cone-shaped and pointing downward (Figure 33)	34		
Mouthparts chewing (Figure 47); if beak-like, then the beak is fairly long and pointed downward (Figure 50)	36		

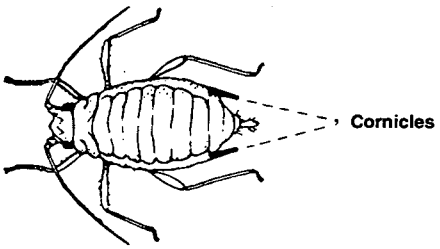


Figure 48

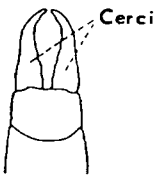


Figure 49

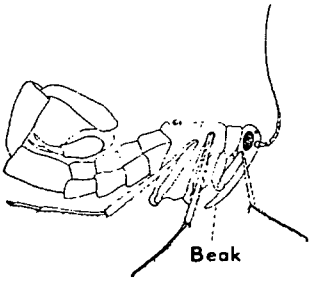


Figure 50

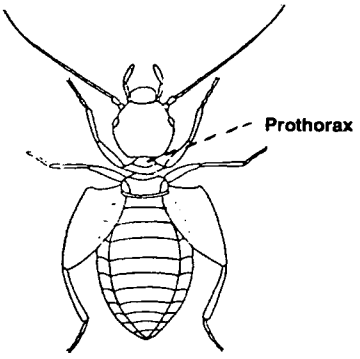


Figure 51

Steps	Refer to Step No.	Insect Order	Refer to Page No.
34. Body long and narrow; tarsi with one or two segments and often without claws (Figure 17); beak cone-shaped; very small insects, usually less than 1/8 inch long (Figure 16) (thrips)		*Thysanoptera*	15
Body usually more or less oval; tarsi usually three-segmented (Figure 28), with well-developed claws, size variable	35		
35. Beak arising from rear under part of head (Figures 4 and 22); abdomen often with a pair of cornicles (Figure 48) (aphids)		*Homoptera*	19
Beak arising from front part of head (Figures 1 and 3); abdomen without cornicles (wingless bugs)		*Hemiptera*	18
36. Cerci forceps-like (Figure 49) (earwigs)		*Dermaptera*	17
Cerci absent, or if present, then not forceps-like (Figure 52)	37		
37. Mouthparts in the form of a beak pointing downward (Figure 50); tarsi five-segmented (Figure 54); insect usually less than 5/16 inch long (Figure 50) (wingless scorpion flies)		*Mecoptera*	
Mouthparts not as above; tarsi and size of insect variable	38		

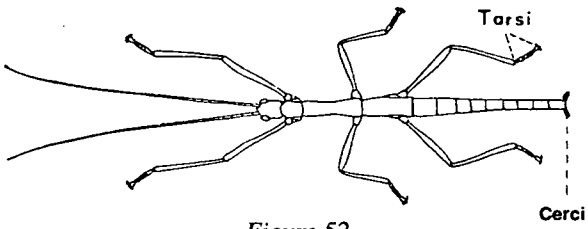


Figure 52

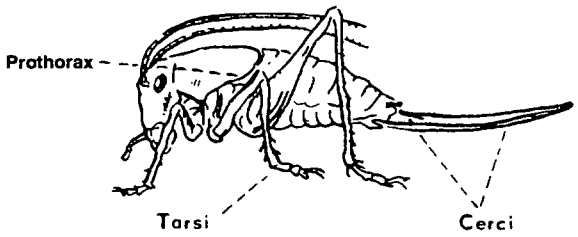


Figure 53

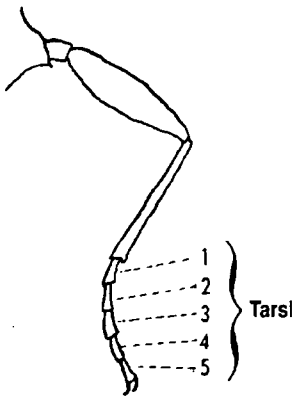


Figure 54

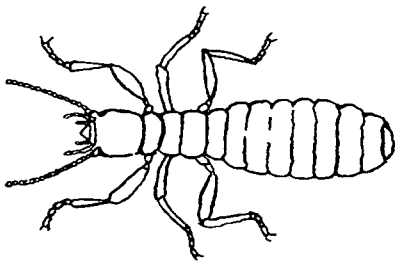


Figure 55

Steps	Refer to Step No.	Insect Order	Refer to Page No.
38. Small louse-like insects (Figure 51) less than 3/16 inch long; no cerci; tarsi two- or three-segmented; prothorax (Figure 51) very small (booklice, barklice)		*Psocoptera*	
Not louselike, insect usually more than 3/16 inch long; tarsi three to five-segmented; cerci present (Figures 52 and 53); prothorax large (Figure 53)	39		
39. Hindlegs large, fitted for jumping (Figure 53); tarsi four- or five-segmented. (Crickets and grasshoppers)		*Orthoptera*	16
Hindlegs not large, not fitted for jumping (Figure 52); tarsi four- or five-segmented	40		
40. Tarsi four-segmented; whitish, soft-bodied, living in wood or ground; insect 5/16 inch long or less (Figure 55) (termites)		*Isoptera*	17
Tarsi five-segmented; appearance not as above (Figure 52) (roaches, mantis, walkingsticks)		*Orthoptera*	16

Insect Survey

To survey is to examine for a specific purpose. Insect surveys may be undertaken to determine occurrence, emergence, population levels, or need for control.

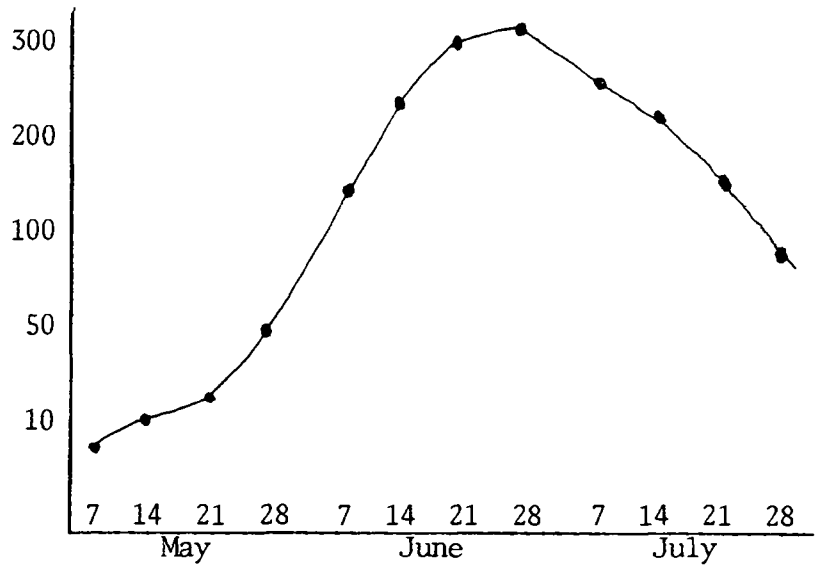
Survey methods vary dependent on the insect, its habits, and the kind of information needed. Food or sex attractants or light traps may be used to establish occurrence or emergence.

Population levels usually are determined by actually counting insects on leaves or in sweeps of a net. The sample size is important in such surveys. For example, 100 sweeps of a net taken at random over a field will give more accurate information than 10 sweeps taken at a corner of the field. Weekly sampling of a host plant through a season will give useful information of population changes.

This type of survey lends itself to 4-H investigation. Sample populations of aphids on beans, birch, or walnut; weevils on peas; lygus bugs on alfalfa; leafhoppers on beets; or psylla on pear trees.

Hundreds of insects may be surveyed and the information gained can be used to effectively control pests or to establish just when certain insects are flying.

EXAMPLE OF TABULATING SURVEY DATA



Embedding Insects in Plastic

Embedding insects in plastic is not new but is an interesting as well as useful technique. Insects in clear plastic blocks can be handled without fear of breakage and last indefinitely.

This process is not easy but if you use care in preparation of specimens and follow directions, you can make very striking displays or ornamental embedments.

Purchase clear plastic resin and catalyst from a hobby shop. The procedure varies with different resin so no exact procedures will be given here. Be sure to get a sheet of directions with your purchase.

Selection and Preparation of Specimens

Insects for embedding should be in perfect condition, and should be as dry as possible, and free of waxy coatings. For many insects a thorough washing in a vial of solvent such as acetone will remove the wax or dirt particles. Moisture on or in the insects will result in a milky off-color appearance. Very shiny, smooth surfaces, especially in some beetles, often will appear silvery where the plastic has failed to adhere properly. True bugs, flies, termites, stoneflies, caddisflies, and mayflies take embedment well.

Unpinned insects look best in plastic. Kill insects and place those that will not be damaged by it into a shallow dish of alcohol. Ideally the more concentrated the alcohol the better. Arrange the insect parts, using insect pins or forceps, into the position you'll want them to have in the plastic block. You may want to maintain the position of the insect parts with bits of glass or other weights.

Lepidoptera or other large insects such as Odonata should be spread and dried on spreading boards.

Physical Preparations

Prepare for embedment in a clean, dust-free room. The fumes are strong, so make sure there is ventilation, but avoid strong wind blowing on the work area. Use disposable paper cups, spoons, and stirring rods. Cover the work area with several thicknesses of newspaper to catch spills and protect table or floor surfaces. You may use acetone or other strong solvents for cleanup, but it's best to avoid having to use them.

Molds to hold the plastic are numerous. The plastic will assume the shape of whatever container is used. Plastic ice-cube trays are excellent molds for small to moderate-size insects. They are flexible enough that finished embedments can pop right out of them. In addition, their smooth surface makes polishing unnecessary, or nearly so.

Embedding

After the insects to be embedded are ready and the work area prepared, mix a small amount of plastic resin with the catalyst following the manufacturer's directions. Start with enough for just a few castings, for the resin will harden in a short time. Pour the resin with extreme care and stir slowly into the catalyst to avoid getting bubbles into the mixture.

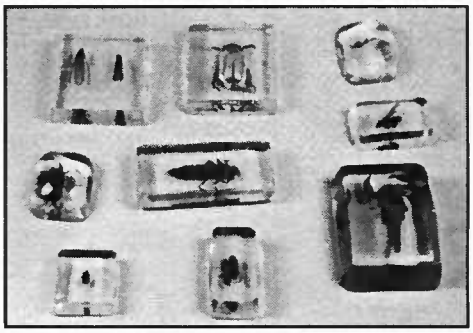
Pour 1/4 inch of catalyzed resin into each mold. Allow this to slightly thicken (become tacky). Test it with a toothpick. Now carefully place an insect, legs up, in the center of each mold. Don't move specimens around; the sticky plastic will break off fragile body parts.

If you want to include small printed or typed labels, prepare them in advance and place them in the plastic at this point. Do not use washable ink, as it will run.

After a few minutes, repeat the resin-catalyst mixing (use a clean paper cup), making enough to cover the insect with as much as 1/4 inch of plastic. If hurried, the insect will float to the top of this layer. If delayed for hours or more, the layers may fail to hold together. Allow plastic to "set up." This should take 6 to 24 hours dependent on the type of resin and temperature. Don't hurry this process.

When all prepared specimens are embedded, discard all stirring and measuring equipment and papers used to protect table and floor surfaces.

Embedments in ice-cube tray molds will pop out. Sand and polish with a very fine grit or jeweler's rouge dampened with water until a glass-like surface is obtained.



Examples of embedments—mature and immature insects, etc.

Typical embedments with ice cube tray and ceramic molds

Rearing Insects

Rearing insects means raising them under controlled conditions in a jar, bag, or screened cage. Why rear them? Insects move far and fast. Very often, immature specimens are found. What will they develop into? How long does it take?

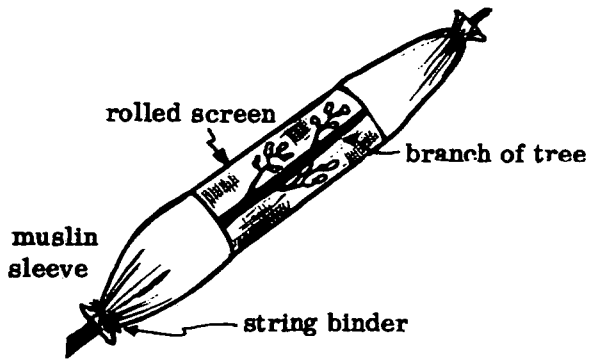
Perfect adult specimens only rarely can be caught in a net. A reared butterfly, for example, affords the experience of watching the caterpillar hatch from an egg...eat...molt...form a chrysalis...and emerge as an adult.

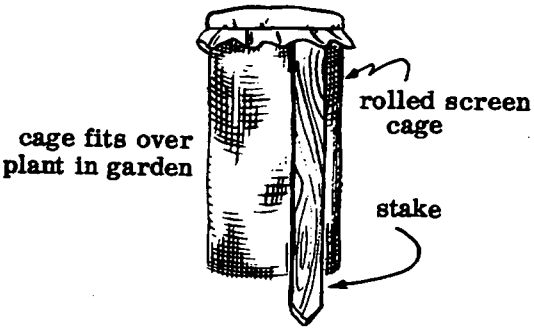
The larvae of insects are not nearly so well known as are the adults. Rearing larvae to the adult stage makes it possible to associate the two forms as being of the same species.

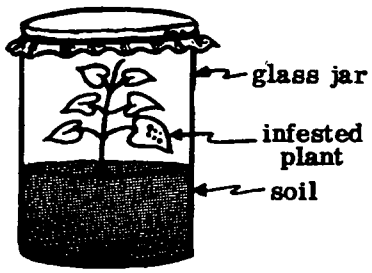
When collecting an insect for rearing, carefully observe the insect's food source so that you can feed it properly in a rearing container. Entomology books often give host plant data, which can be used if the preferred food is not known. A jar of pond water with mosquito "wriggler" is adequate for rearing mosquitoes to the adult state, but a tent caterpillar needs constant replenishment of fresh leaves until it spins a cocoon.

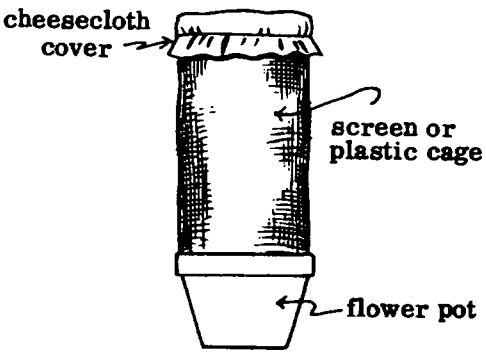
Simulate outdoor conditions in rearing most insects, but don't allow the hot sun to shine on rearing containers. Start with insects having a short life cycle of a few days or weeks. Many insects take a full year to develop from egg to adult; a large number take several years. Your reading and observations will soon give you ideas on where to begin.

The illustrations below are simple devices that you can make to confine, observe, and rear insects.









Presentations

Presentations provide a 4-H member the opportunity to show others the interesting and important things learned in a 4-H project.

As a 4-H'er, you know the facts. Your information will be appreciated by your friends, adult leaders, and organizations in your community.

It has often been said that if you want to learn, teach. Preparing a presentation allows the 4-H member to clarify ideas and really know the subject matter.

Presentations, to be effective, must be presented with skill. Extension publications on presentations will help the 4-H member develop effective methods, use of materials, and a degree of showmanship.

Presentation Topics

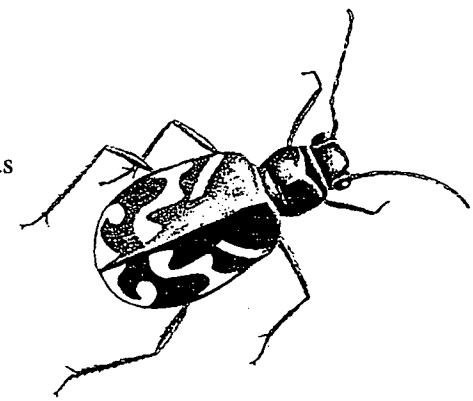
There is no limit to the insect collection and preservation methods, life histories, and control practices that lend themselves to 4-H presentations. Here are suggestions for topics that may be developed into presentations.

1. Making a collection net
2. Making a killing jar
3. Mounting insects
4. Making a spreading board
5. Making a Riker mount
6. Embedding insects in plastic
7. Insect control methods for a particular insect or group
8. Insect life histories
9. Insect ecology
10. Rearing insects

Entomology as a Career

Skilled entomologists are always in demand. A Bachelor of Science degree (B.S.) may lead to a job with industry in sales or as a technician. Federal and state government jobs also are available as inspectors and with public health organizations. Local governments sometimes hire entomologists for their mosquito control districts.

Those with a Master of Science degree (M.S.) or Doctorate (Ph.D.) in entomology may find employment with a college or university as teachers and researchers. The agricultural chemical industry often hires men and women for research and development positions. The federal government has openings in systematics, insect toxicology, insect physiology, ecology, and biological control. Both research and teaching positions are available at state universities and agricultural experiment stations. Finally, there are good opportunities, both with public and private organizations, for those interested in foreign service.



Welcome to 4-H Entomology

You will find the study of insects to be interesting and rewarding. This manual has been prepared to serve as a source of information concerning basic concepts in entomology. It will show you how to reach certain objectives and how to make and use equipment useful in learning about insects. The manual suggests activities 4-H members may engage in but is not intended to be limiting in any way.

As you venture into this world of entomology, your interest may lead you into experiences not visualized in this manual. In a sense, and this is particularly true in entomology, you may explore new areas of science, and discover information about insects never known before. Many amateur entomologists find species new to science or see previously unknown behavioral patterns of insects.

Remember, however, that everyone needs to learn certain basic information in entomology. Specialization or electives become more available as you develop your knowledge and skills.

Keep this manual as a reference throughout your participation in the 4-H Entomology Project.

This manual was revised by Virginia Thompson, Extension specialist, 4-H youth development; and reviewed by Jack DeAngelis, Extension entomology specialist, and Janice Cowan, Extension agent, Baker County; from original work by Joseph Capizzi, Jr., Extension entomology specialist emeritus, Oregon State University. Illustrations for core curriculum framework by David P. Cowan.

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