March 2015

4-H 26 Entomology Manual

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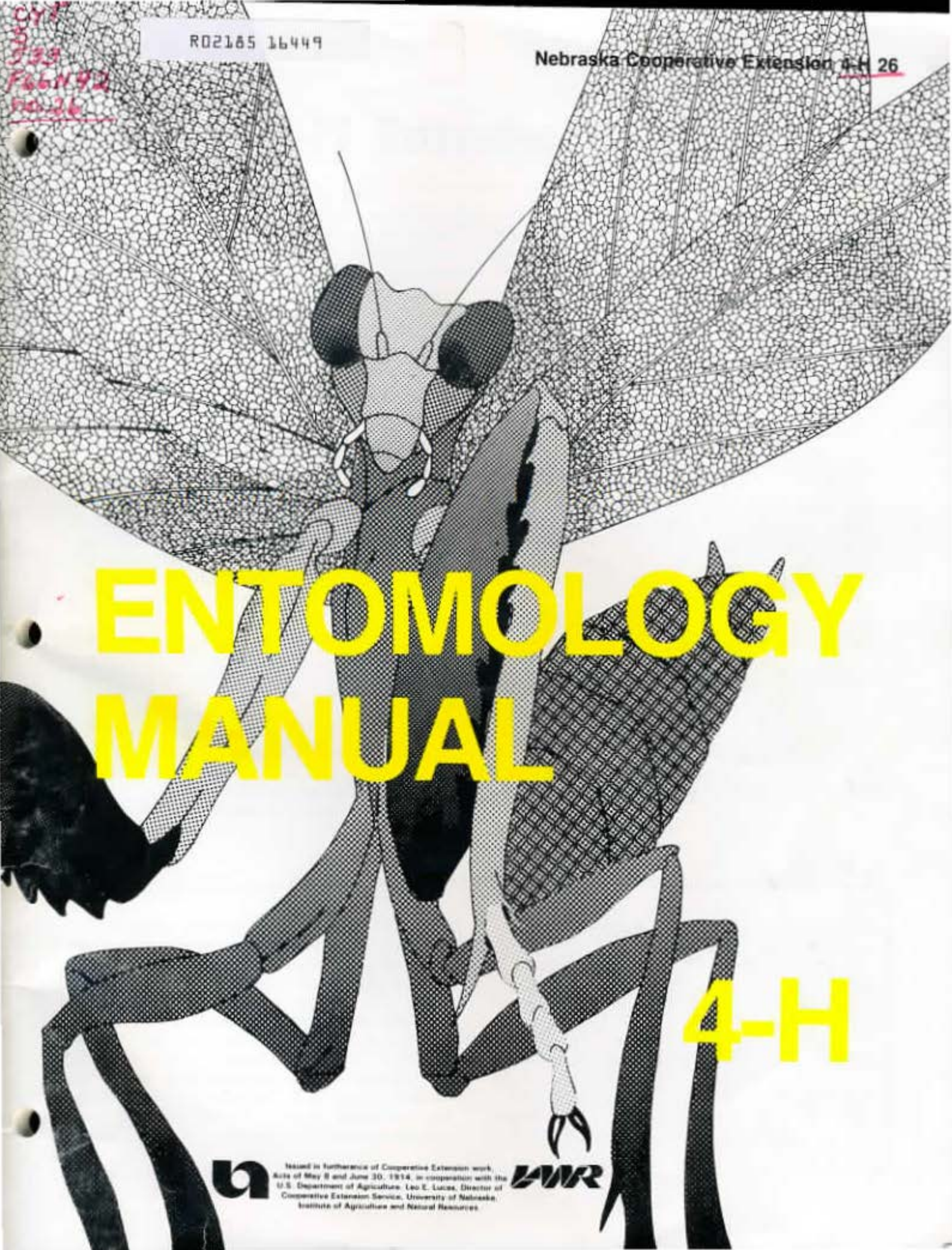
Nebraska Cooperative Extension 4-H 26



ENTOMOLOGY MANUAL

4-H

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Leo E. Lucas, Director of Cooperative Extension Service, University of Nebraska, Institute of Agriculture and Natural Resources.

4-H Entomology

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Acknowledgements

Many thoughtful comments, suggestions and ideas, received from several sources, have played prominent roles in the development of this 4-H manual. Special thanks must be extended to Robert Scriven, Buffalo County Extension Agent, whose encouragement led to the initial draft several years ago. Bob and his daughter Shauna (then a 4-H entomologist) read and commented extensively on the original manuscript. Since then, it has undergone numerous readings and modifications. The following have contributed their ideas and suggestions to the manual during some phase of its preparation:

M. Rethwisch, T. Miller, R. Roselle, R. Roselle, Jr.
L. Andersen, J. Wilson, K. Gast, L. Lane
J. A. Jones, J. Orr, W. Caldwell, L. Rudman

Acknowledgement must be given the following Cooperative Extension Services and to the National 4-H Service Committee, since their materials were drawn upon as sources of ideas and illustrations.

University of California
Louisiana State University
Pennsylvania State University
Virginia Polytechnic Institute
Kansas State University
University of Wyoming
University of Wisconsin
Washington State University

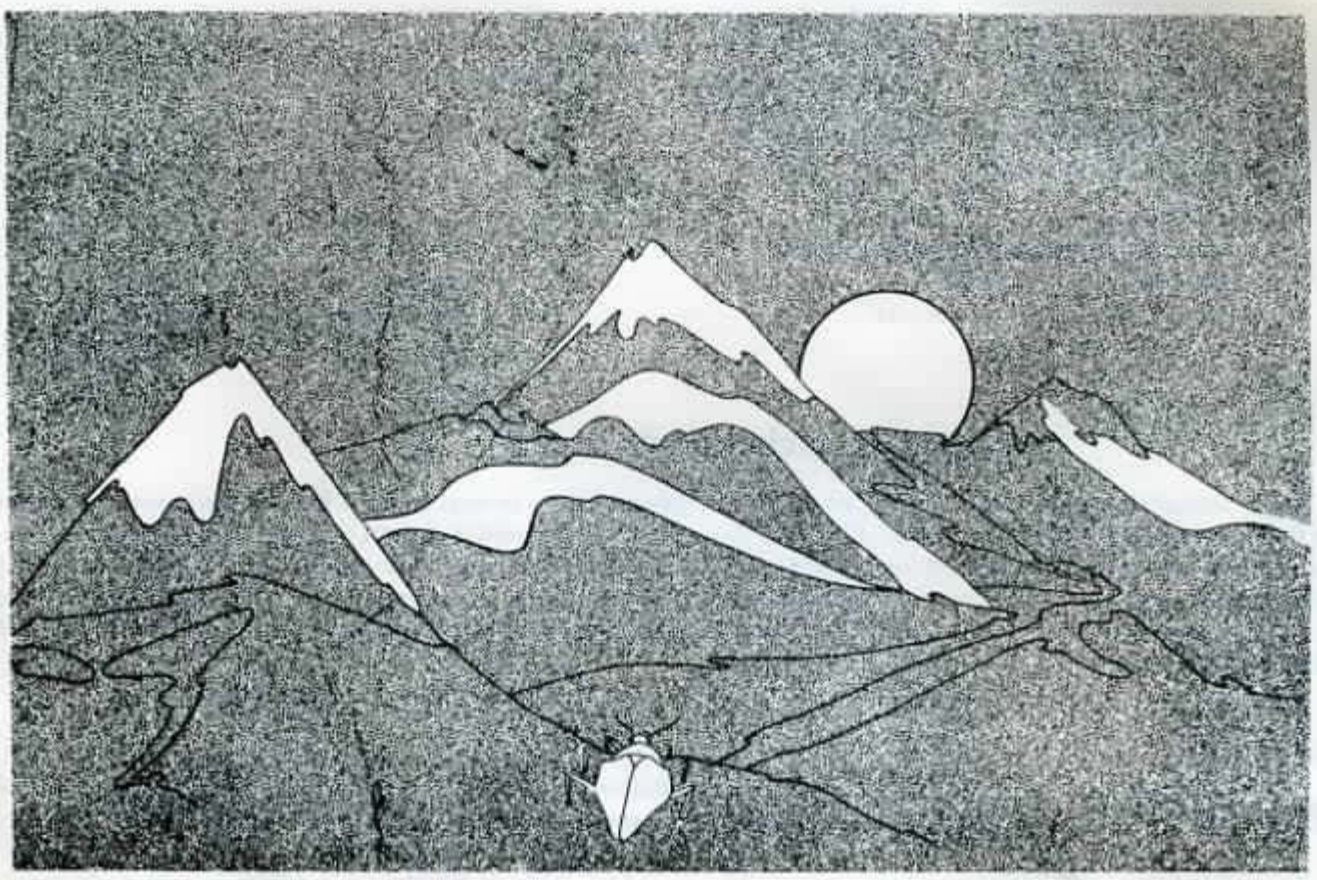
A special debt is owed Terry Meisenbach, IANR/UNL Department of Agricultural Communications, who edited the final draft and prepared it for publication.

A NOTE TO PARENTS AND 4-H LEADERS

The primary objective of the 4-H entomology project is to provide the 4-H youngster with an awareness of the world of insects. The member will develop scientific observation and study skills which will be valuable in the future.

Insects are the most abundant group of animals on earth and our daily lives are affected by their presence. For example, insects both benefit and damage our crops. Insects damage stored foods and fiber, and spread diseases to pets, livestock and humans. Pest insects must be controlled safely, effectively and economically. Because insect identification is essential before the proper selection of a control measure can be made, this project will stress the development of fundamental skills of insect identification. Emphasis will also be placed on developing knowledge of beneficial insects and complex inter-relationships that exist among insects of various types. A further objective of this project is to develop an appreciation for the beauty of insects and the tremendous variation encountered in insect life.

This project will provide a wide variety of entomological topics, allowing members to pursue their studies according to individual preferences.



When the moon shall have faded out from the sky, and the sun shall shine at noonday a dull cherry-red, and the seas shall be frozen over, and the ice-cap shall have crept downward to the equator from either pole, and no keels shall cut the waters, nor wheels turn in mills, when all cities shall have long been dead and crumbled into dust, and all life shall be on the very last verge of extinction on this globe; then, on a bit of lichen, growing on the bald rocks beside the eternal snows of Panama, shall be seated a tiny insect, preening its antennae in the glow of the worn-out sun, representing the sole survival of animal life on this our earth, a melancholy "bug".

W.J. Holland
Entomologist, 1903

TABLE OF CONTENTS

CHAPTER I

THE INSECT

INTRODUCTION

Nearly 75 percent of all known animals are insects. No one knows exactly how many species (kinds) of insects there are. Estimates range from 1 million to 10 million species. Only about 900,000 or so have been collected and described by insect classification experts. About 90,000 species are known from North America, excluding Mexico.

Most insects are quite small. Some beetles and wasps are so small they could crawl through the eye of a needle. Among the largest species are some tropical stick insects which can be 10 inches long and have a 10-inch wingspan. Certain tropical beetles may be 3 or 4 inches long and 2 to 3 inches wide. Because of great variation in size and habits, insects are able to adapt to many situations in nature.

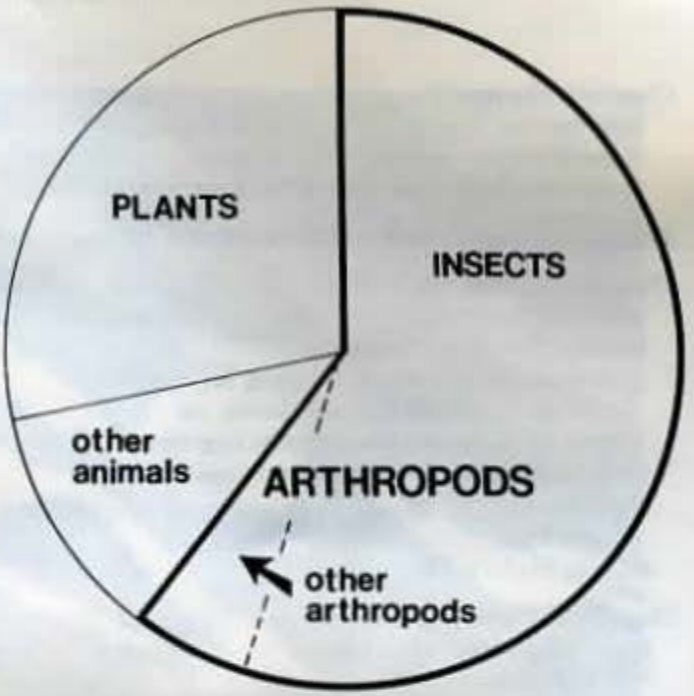
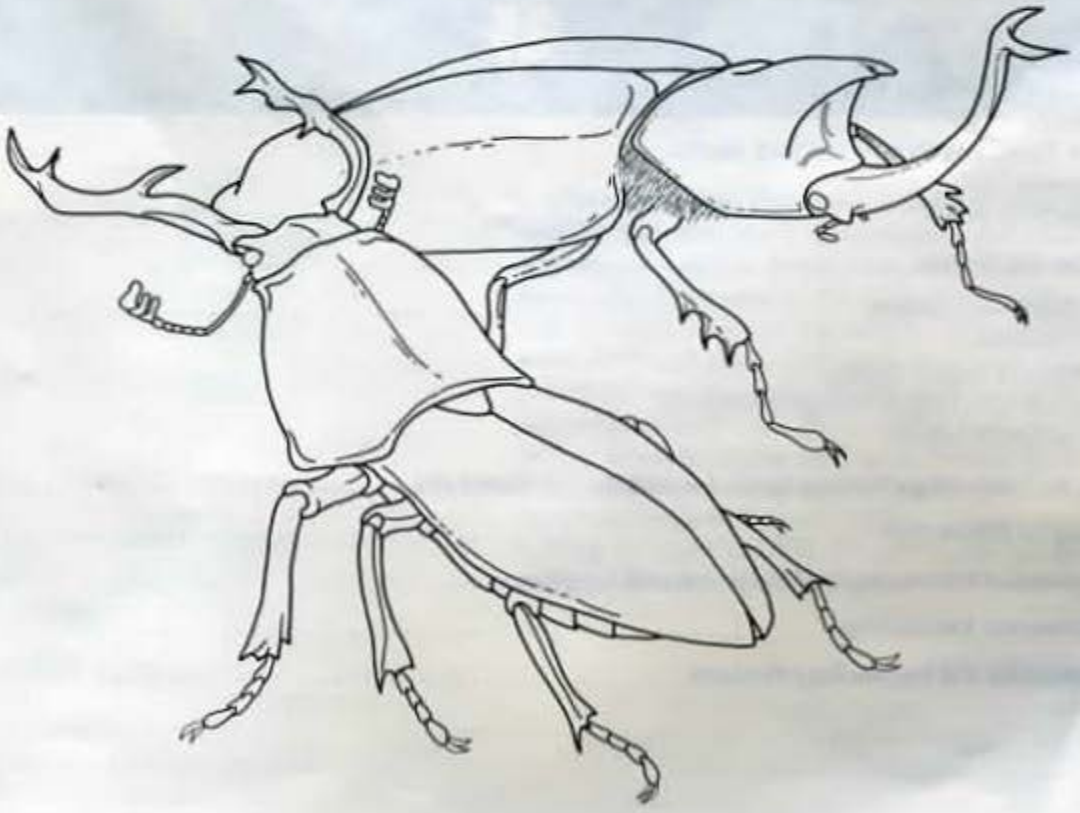


Figure A - Total kinds (or species) of insects compared to all other known animals and plants.



Insert B - Stag and Rhinoceros beetles

General Characteristics of Insects

In the adult stage, an insect has six legs and three distinct body parts (Fig. 1). In immature insects these parts may be hard to see (Fig. 2). Adult insects have two antennae and most have two pairs of wings.

The three main body parts are the **head, thorax** and **abdomen.** In certain stages of growth, these parts may not be clearly distinguishable. The **head** holds the eyes, mouthparts and antennae or "feelers". The **thorax** is the middle part of the insect to which the legs and wings (if present) are attached. The **abdomen**, which is just behind the thorax, contains the organs of digestion and reproduction. Leglike projections are also sometimes found on the abdomen. The abdomen and thorax contain tiny openings or pores, called **spiracles**, through which the insect breathes.

An insect has an **exoskeleton** (a skeleton located on the outside of the body). This exoskeleton is made of **chitin** (pronounced "ky-tin") which is similar to the substance our fingernails are made of. This external skeleton protects the internal organs from injury and loss of moisture.

The six **legs** (in three pairs) are attached to the thorax. One pair is attached to each segment of the thorax. In some insects, such as flies, the legs are not present in the immature stages (maggots), but appear when the insect matures into the adult fly.

Two **antennae**, located at the front of the insect's head, serve as organs of touch. In some insects, antennae are also used to taste, smell and hear.

Distinguishing Insects From Their Relatives

While most people recognize many kinds of insects, several other animals, including spiders, centipedes and ticks are often confused with them. However, if we are to study insects, we must be able to distinguish them from similar animals.

The animal kingdom is divided into large general groups of related animals called **phyla.** Insects belong to the phylum *Arthropoda*. The *Arthropoda* are further divided into classes which include the *Insecta* (insects), *Arachnida* (spiders), *Chilopoda* (centipedes), *Crustacea* (lobsters, crawdads, sowbugs) and *Diplopoda* (millipedes). All arthropods are alike in several ways. They all have an outer shell or **exoskeleton** which provides protection and which is periodically shed as the animal grows. Arthropods also have paired, segmented **appendages** (legs and antennae) and segmented bodies, usually grouped into two or three distinct body regions.

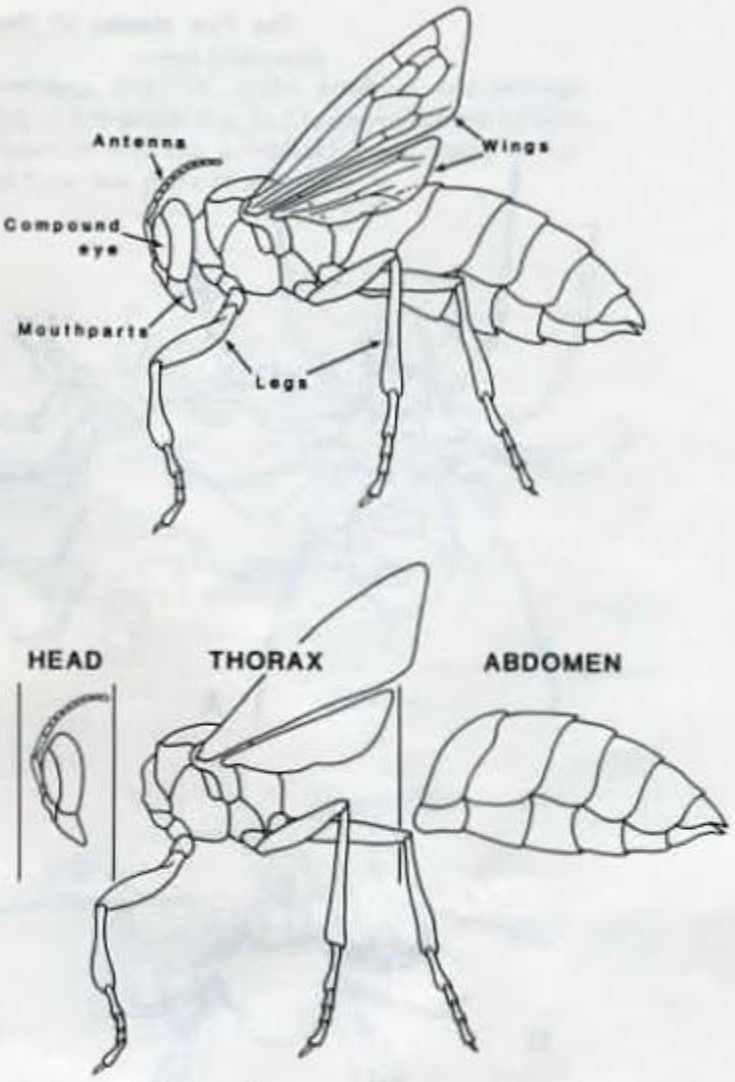


Figure 1 - The body parts of a mature (or adult) insect.

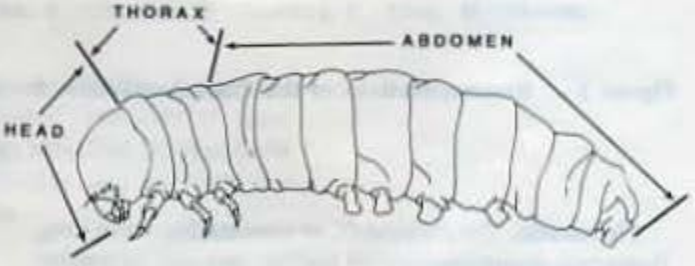


Figure 2 - The body parts of one type of immature insect.

The five **classes** of the phylum *Arthropoda* are described below.

Arachnida. Harvestmen, pseudoscorpions, scorpions, spiders, mites and ticks are arachnids (Fig. 3). They lack antennae, have four pairs of legs plus a head and thorax that are combined into one part called a **cephalothorax.**

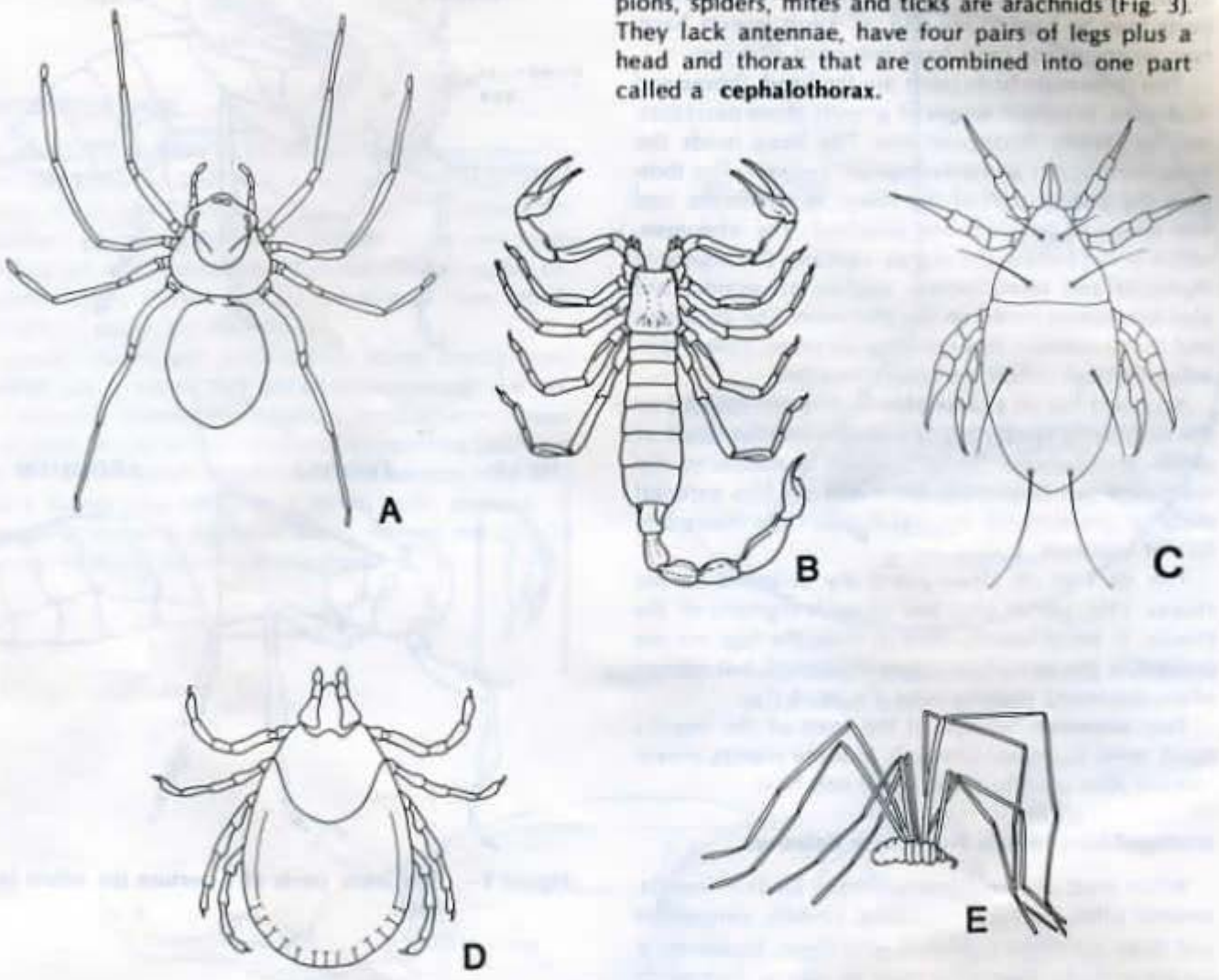


Figure 3 - Representatives of the Class Arachnida. A - Spider, B - Scorpion, C - Mite, D - Tick, E - Harvestman.

Chilopoda. The chilopods, or centipedes, have long, flattened, many-segmented bodies, one pair of moderately long antennae and one pair of legs attached to each body segment (Fig. 4). Members of this class live beneath litter or in the soil and are usually swift runners. Centipedes are predators on many small animals in the soil and some can inflict a painful bite.

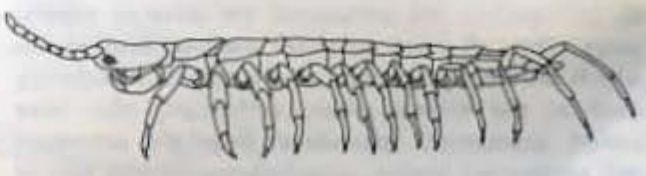


Figure 4 - Class Chilopoda. Centipede

Crustacea. Crayfish, crabs, sowbugs and shrimps belong to this group (Fig. 5). Crustaceans have at least five pairs of legs and a cephalothorax. Some crustaceans have two pairs of antennae.

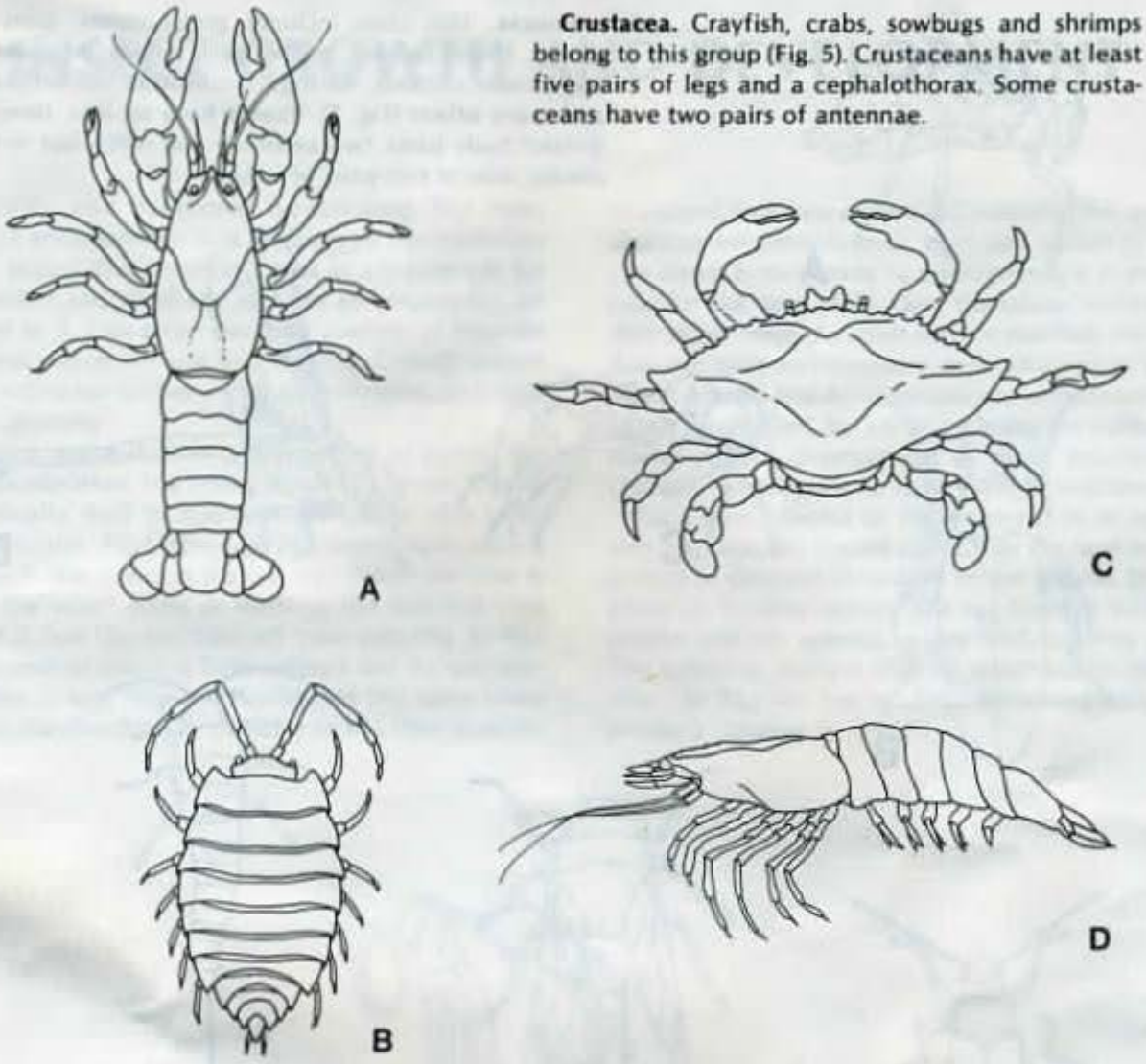


Figure 5 - Representatives of the Class Crustacea. A - Crayfish, B - Sowbug, C - Crab, D - Shrimp.

Diplopoda. The diplopods, or millipedes, have long, rounded, many-segmented bodies; one pair of short antennae; and two pairs of legs attached to most body segments (Fig. 6). Some millipedes curl up when disturbed. Millipedes do not bite.

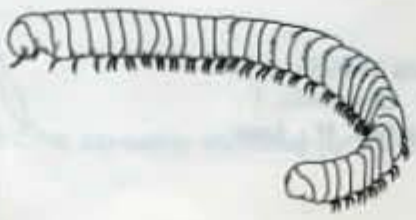


Figure 6 - Class Diplopoda. Millipede

Insecta. This class includes grasshoppers, armyworms, blister beetles, leafhoppers, aphids, boxelder bugs, mole crickets, earwigs, swallowtail butterflies and many others (Fig. 7). Insects have six legs, three distinct body parts, two antennae and often, but not always, one or two pairs of wings.

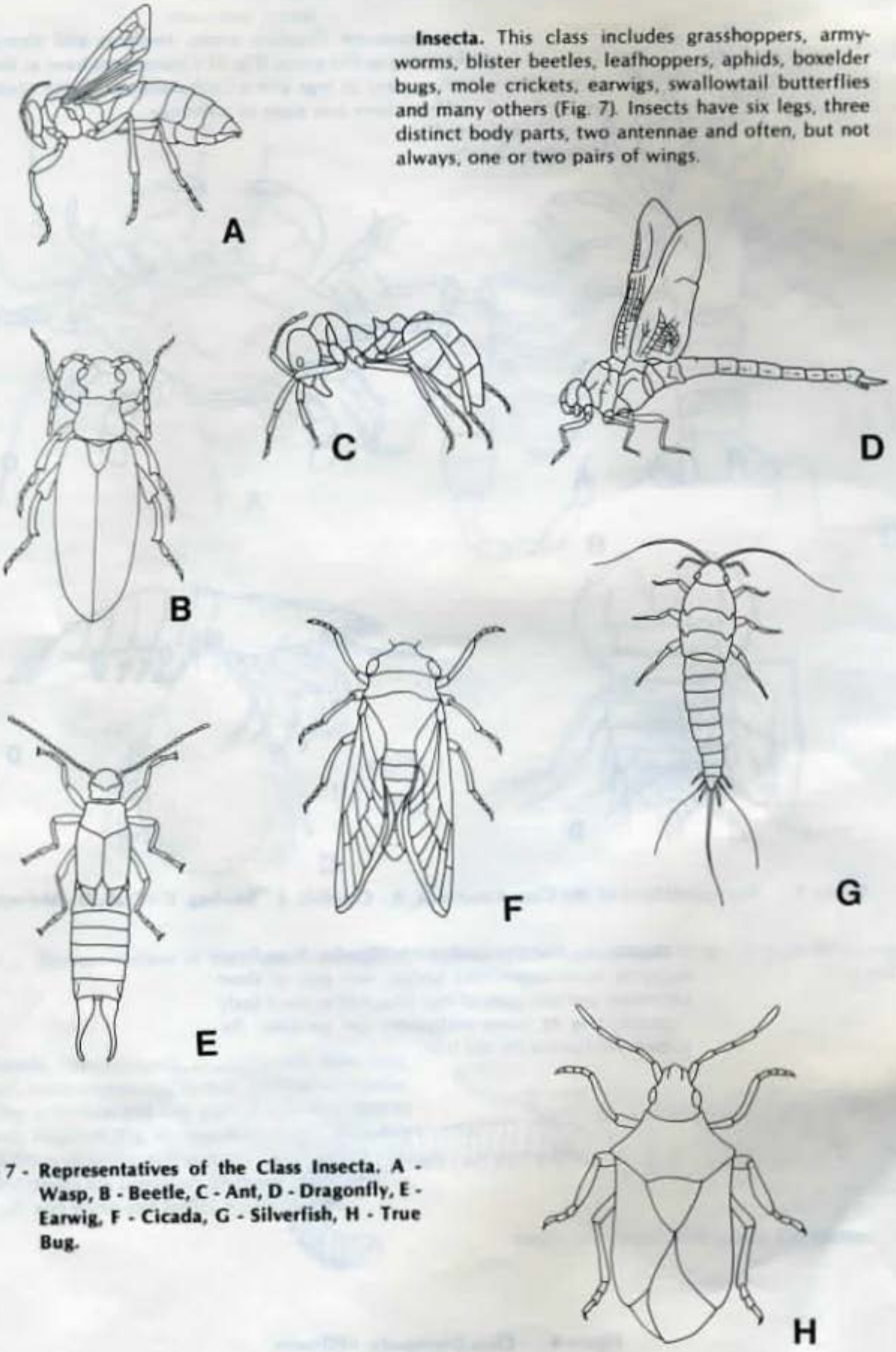


Figure 7 - Representatives of the Class Insecta. A - Wasp, B - Beetle, C - Ant, D - Dragonfly, E - Earwig, F - Cicada, G - Silverfish, H - True Bug.

CHAPTER II

INSECT GROWTH AND DEVELOPMENT

Animals with backbones (vertebrates), like man, have an **endoskeleton,** or a skeleton on the inside (endo = inside). Our skeleton serves as a framework for our bodies and all of our muscles and organs are attached to it. Our outer covering consists of muscles and skin which are soft and flexible. Growth occurs from within our bodies and is not restricted by a rigid outer covering.

Insects, however, live within a coat of armor, the hard **exoskeleton**. If a young insect is to grow, it must periodically shed its skin or it will not be able to increase in size. First, however, the insect must make a new, soft skin beneath the old one. When the time is right, the insect **molts** or sheds its old skin and slips out of it, just like you take off your coat (Fig. 8). The newly molted insect is light colored and its new exoskeleton is soft, thin and flexible. At this point some insects may swallow air or water or flex their muscles to expand their new covering. Gradually, the new exoskeleton becomes tanned, hard and darker in color. The insect is then ready to resume feeding in preparation for the next molt. Only immature insects shed their skins - once the adult stage is reached, the insect does not molt and therefore does not increase in size. Insect growth and development are complicated processes controlled by various chemicals called **hormones.** Insect development is often regulated by changes in temperature, light, food or moisture.

Each insect begins its development as an **egg.** Insect eggs may be placed directly on the host plant or animal or dropped at random on the ground. In some cases (as in some aphids), the egg hatches inside the mother and she appears to give birth to living young. The series of changes that an insect passes through after the egg hatches is called **metamorphosis** - this means a "change in form."

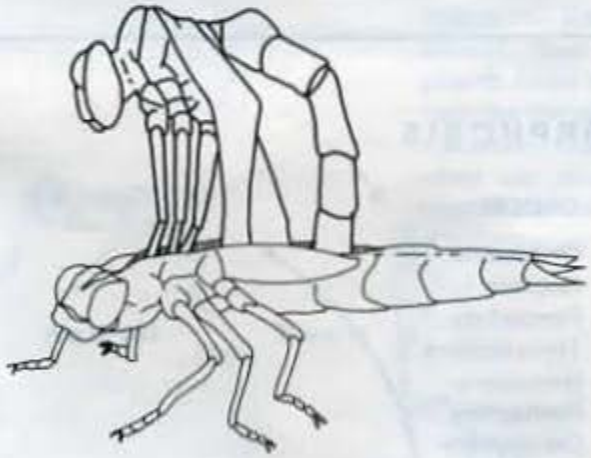
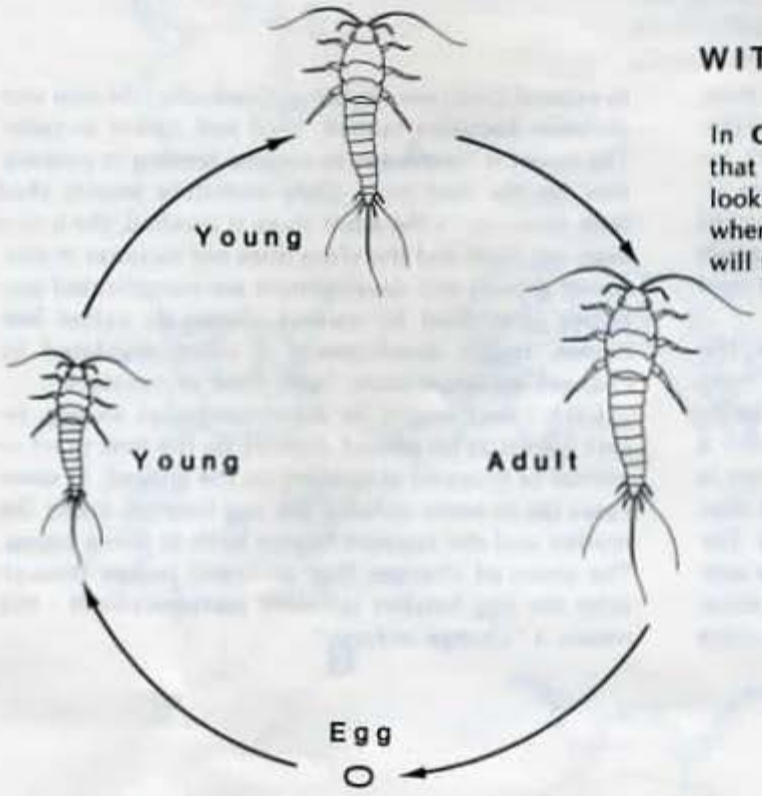


Figure 8 - A damselfly shedding (or molting) its skin.

The following illustrations show the four basic types of insect metamorphosis and list the insect orders that have each type of growth.



WITHOUT METAMORPHOSIS

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

ORDERS

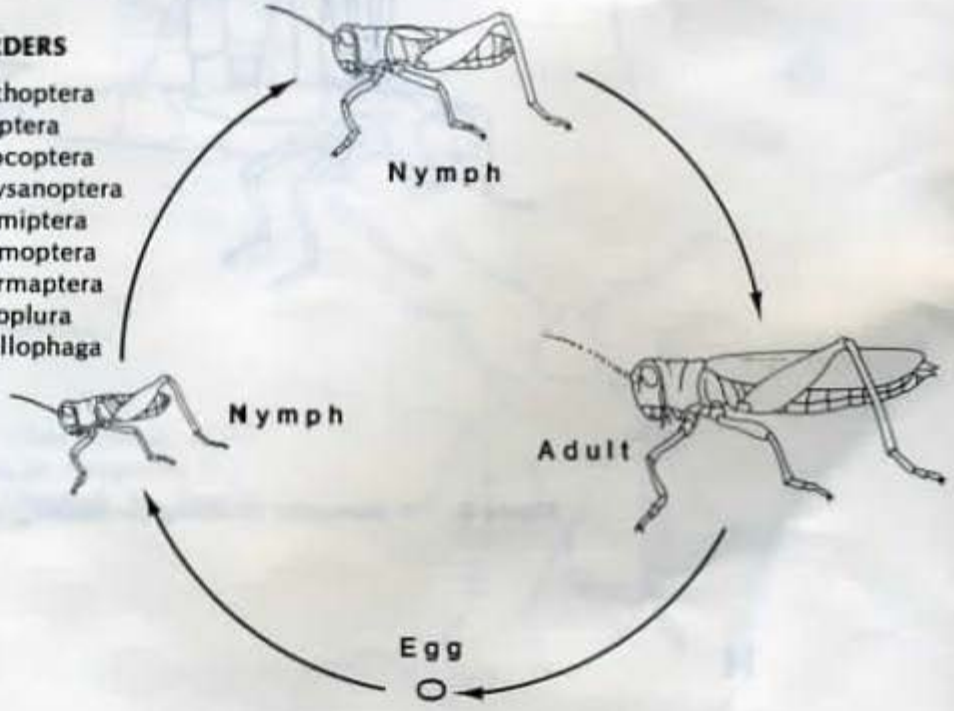
Collembola
Thysanura

GRADUAL METAMORPHOSIS

Insects in **GROUP 2** change shape gradually. There are three stages of growth, each looking more like an adult.

ORDERS

Orthoptera
Isoptera
Psocoptera
Thysanoptera
Hemiptera
Homoptera
Dermaptera
Anoplura
Mallophaga

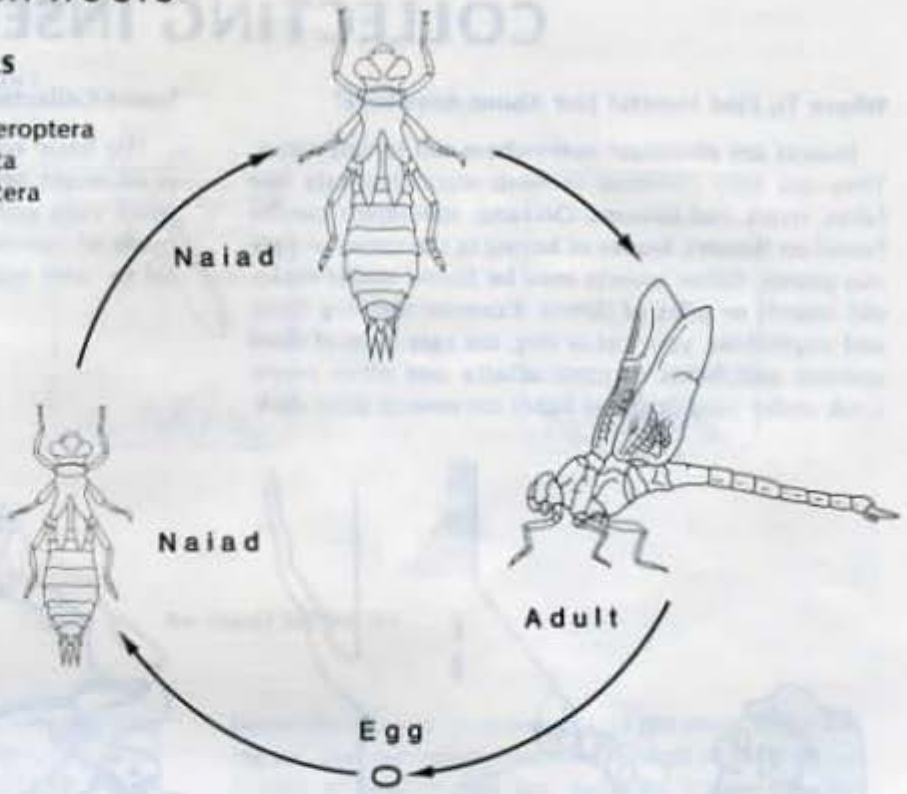


INCOMPLETE METAMORPHOSIS

The young insects in **GROUP 3** change shape gradually. They resemble their adults, somewhat, but not as much as do insects having gradual metamorphosis. These are all *aquatic* insects.

ORDERS

Ephemeroptera
Odonata
Plecoptera

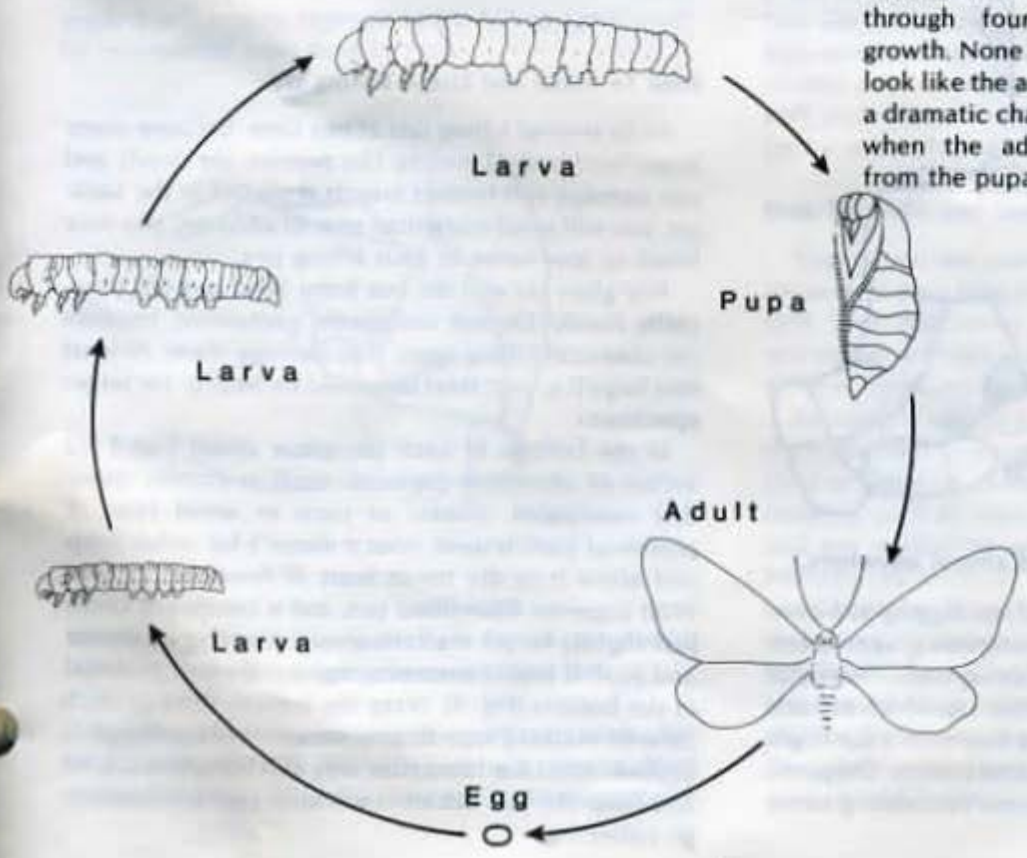


COMPLETE METAMORPHOSIS

Insects in **GROUP 4** go through four stages of growth. None of the young look like the adult. There is a dramatic change in shape when the adult emerges from the pupal stage.

ORDERS

Neuroptera
Coleoptera
Trichoptera
Lepidoptera
Diptera
Siphonaptera
Hymenoptera



CHAPTER III

COLLECTING INSECTS

Where To Find Insects? Just About Anywhere!

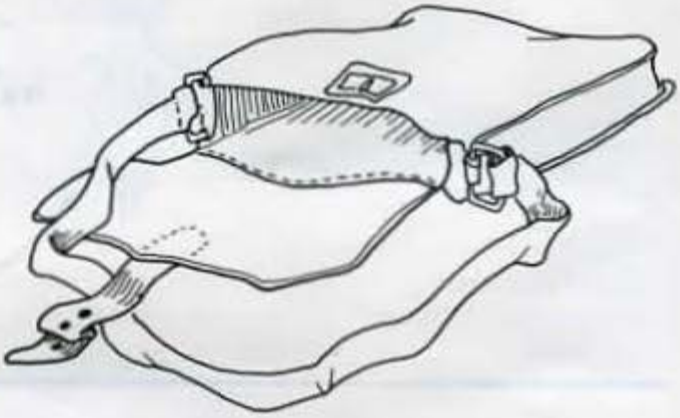
Insects are abundant everywhere but in salt water. They are very common in fresh water habitats like lakes, rivers and streams. On land, specimens can be found on flowers, leaves or boring in the stems of various plants. Other insects may be found under rocks, old boards or piles of debris. Examine spoiling fruits and vegetables, your cat or dog, the carcasses of dead animals and fields of corn, alfalfa and other crops. Look under yard or street lights for insects after dark.

Insert C - Insects can be found almost anywhere.

Many insects are found in soil, so digging in a compost pile is likely to turn up interesting specimens. Look under the bark of dead or dying trees. Trees that die of bacterial diseases often leak sap which attracts many insects. Examine the same tree with a flashlight at night for a totally different set of insects. Chop into an old rotten log to discover some fascinating specimens.

Insect Collecting Equipment

The basic equipment necessary for field collecting is an insect net, one or more killing jars and several small vials and assorted containers. A collecting bag made of canvas or other strong material is also helpful to carry equipment and insects when collecting.



Insert D - A bag to carry collecting equipment.

How To Make and Use A Killing Jar

Make several killing jars at one time. Because many large, hard-bodied insects, like beetles, die slowly and can damage soft-bodied insects if placed in the same jar, you will need more than one. In addition, you may break or lose some of your killing jars.

Any glass jar will do, but baby food jars are especially handy. Do not use plastic containers, because the chemical killing agent may damage them. At least one large (i.e. pint size) jar would be helpful for larger specimens.

In the bottom of each jar, place about 1 to 1 1/2 inches of absorbent material, such as cotton, shredded newspaper, plaster of paris or wood fiber. If plaster of paris is used, pour it about 1 1/2 inches deep and allow it to dry for at least 48 hours before use. With paper-or fiber-filled jars, cut a cardboard circle just slightly larger than the inside diameter of the jar and push it into the opening against the soft material in the bottom (Fig. 9). Wrap the bottom third of each jar with masking tape to prevent cuts in case the jar is broken. Attach a label that says POISON to each jar and keep the jars out of reach until you are ready to go collecting.

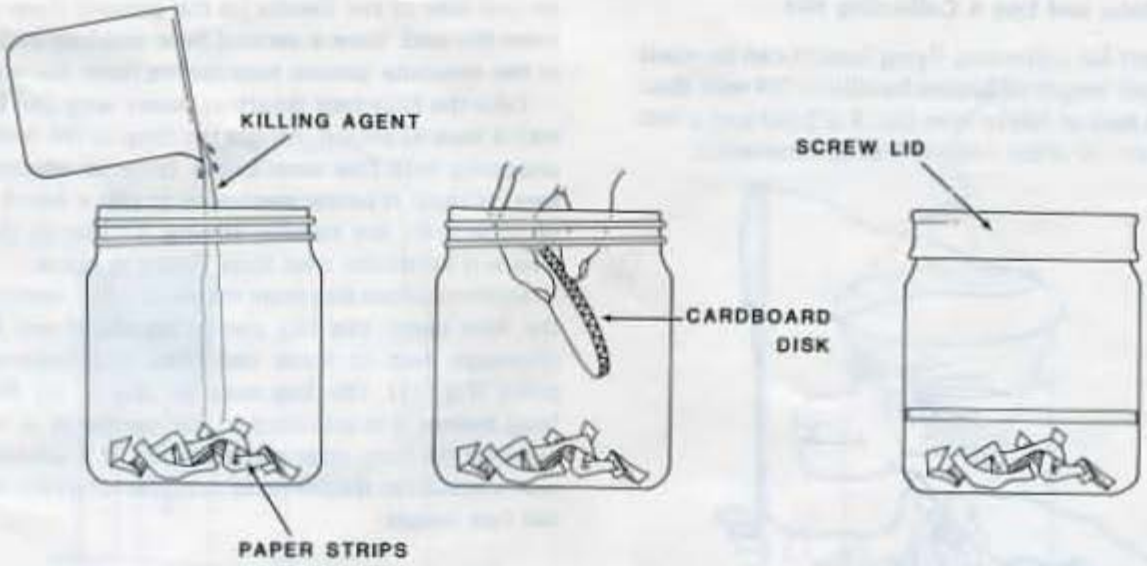


Figure 9 - An insect killing jar.

The killing jar is now ready to charge with a killing agent. The best material for killing insects is fingernail polish remover that contains ETHYL ACETATE. Polish removers containing acetone also will work but ethyl acetate is better. Pour enough into the killing jar to wet the absorbent material. **Do not use too much or you may damage insects that you collect.** Turn the lid on tightly to prevent loss of fumes. As the bottle is used, it will lose its strength so the killing agent must be replenished from time to time.

Insert E - Pinch the butterfly's thorax to stun it before placing in your killing jar.

Pinching the thorax of large butterflies or moths before placing them in the killing jar will prevent damage to the wings. Squeeze them for 20-30 seconds between thumb and index finger and put them in the killing jar. This procedure stuns the insects so they do not flutter around in the jar. Remove butterflies and moths from the killing jar so their wings do not become soaked with killing agent.

If a killing jar is not available, freezing is another way to kill insects. Simply place your specimens in a small jar and put them in the freezer for an hour or two. Do not handle them until they are thawed or legs and antennae may break. Insects left in the freezer for several days or weeks may dry out and become very stiff, even when thawed. If so, place them in a relaxing jar for a few days until they soften.

How To Make and Use A Relaxing Jar

Insects that are collected and left in the killing jar for several days tend to dry out and become hard and stiff. Such specimens are especially difficult to pin and mount without breaking. To restore their flexibility, it is necessary to relax them.

Relaxing is always a risky process and, if carelessly done, the specimens will be ruined. Use another baby food or larger jar as the relaxer. Place some absorbent material such as newspaper or cotton in the bottom and cut a blotting paper disk to fit tightly inside. Moisten the material with water and add a drop or two of Lysol or laundry bleach to prevent mold. Place insects on the paper, close the jar tightly and let it sit for about 2 days. Check the jar. If the insects are flexible, mount them immediately. If the specimens are still too stiff, keep them in the relaxer for a few more days, but watch them carefully. Insects will decompose if held in the relaxer too long.

How To Make and Use A Collecting Net

Aerial nets for collecting flying insects can be made from a 4-foot length of broom handle or 3/4 inch dowel, about 4 feet of heavy wire (no. 9 is best) and a half yard of nylon or orlon netting (curtain material).

As illustrated in Figure 10, cut grooves across one end of the handle, then bore a hole one-half inch deep on one side of the handle (in the groove) three inches from the end. Bore a second hole one-half inch deep in the opposite groove four inches from the end.

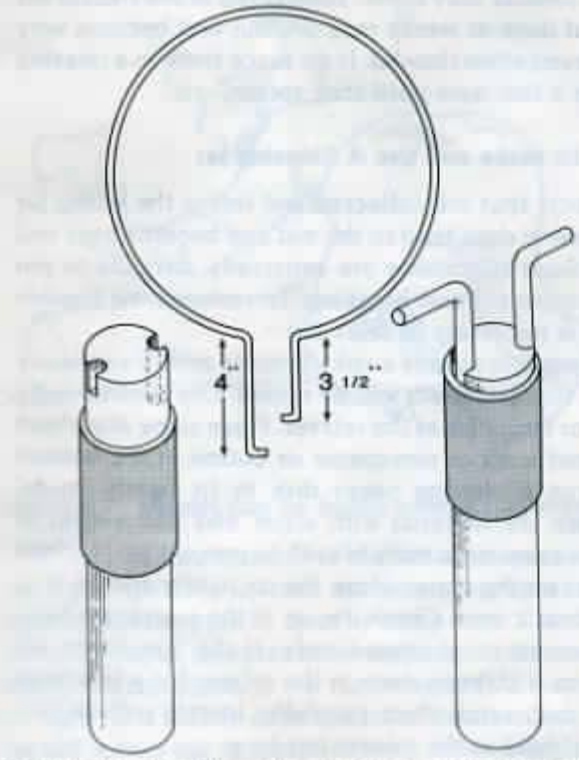


Figure 10 - How to make an insect collecting net.

Take the four foot length of heavy wire and bend it into a loop as shown. Attach the loop to the handle by wrapping with fine wire, heavy twine or electrical or freezer tape. A better method is to slip a 4-inch collar of pipe onto the handle, sliding it clear to the end where it holds the wire loop firmly in place.

Make your net bag from nylon or orlon netting to fit the wire hoop. The bag should be about one foot in diameter, two to three feet long and tapered to a point (Fig. 11). The bag may be placed on the wire loop before it is attached to the handle or it may be sewn to the loop after it is attached. It is advisable to sew a muslin or denim band over the loop to make the net last longer.

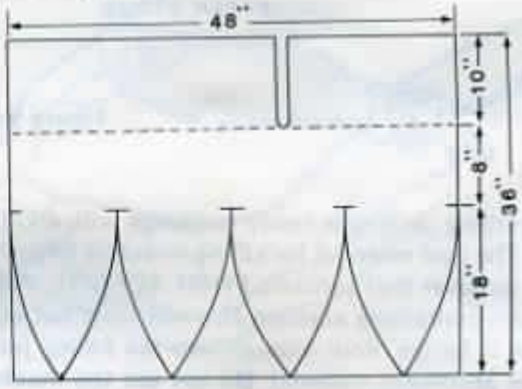


Figure 11 - How to make a collecting bag for your insect net.

Sweeping or beating nets can be made just like the aerial net. However, make the net bag of a strong muslin material instead of the lighter netting. These heavy duty nets are used to collect insects from grass, trees and shrubs by swinging the net through heavy foliage.

Other Collecting Equipment and How To Use It

Aspirator. The aspirator is a suction device for collecting small insects which are difficult (or hazardous) to capture with the fingers or an insect net (Fig. 12). Basically, it consists of a large glass or plastic vial, a length of flexible rubber tubing, some rigid plastic or metal tubing and a rubber stopper with 2 holes cut in it to receiving the tubing. You will also need a small piece of cheesecloth or fine metal screen.

Bend the two lengths of rigid tubing and fit the tubes into the rubber stopper as shown. The long tube should extend down to within about one inch of the bottom of the vial when it is in proper position. Attach the small piece of cheesecloth or metal screen to the short piece of tubing with solder, glue or a rubber band. (This is to prevent you from sucking several bugs or bits of dirt into your mouth when you are using the aspirator.) Now attach the rubber tube to the short piece of rigid tubing.

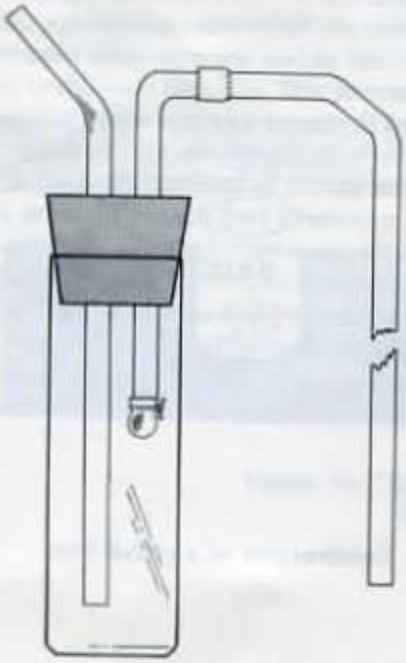


Figure 12 - An aspirator for collecting small insects.

To use the device, just place the long tube beside a small insect, put the rubber tube into your mouth and suck sharply. With a bit of practice, you will find that this is an excellent way to collect smaller insects with ease. Beware of collecting ants in your aspirator; they release formic acid after being collected—it doesn't taste very nice.

Light traps. Many types of insects are attracted to light and can be captured there by hand. A light trap offers the advantage that it will continue to trap specimens without being constantly watched by the collector.

Insects are quite sensitive to different types of light; therefore, more of certain types can be captured with black (or ultraviolet) light as opposed to the regular white light given off by most standard light bulbs. The difference in attractiveness of the two types of light is due to the wave lengths produced by the two kinds of bulbs. Black light consists mainly of the shorter wave lengths which are more attractive to night-flying moths. White light bulbs (producing mostly longer wave lengths) attract some moths, but not as many as a black light.

All that is needed to make a simple **white light trap** is an automobile trouble light, a 100-watt bulb, an old funnel and a wide mouth jar or a large tin fruit juice can (Fig. 13). Hang the light outdoors near a power

Figure 13 - A simple "white" light trap for collecting night-flying insects.

source, approximately 4 feet off the ground. Construct a wire framework to support the funnel and trap can. Cut the end from the funnel to allow larger insects to pass through. Place some crumpled newspaper in the bottom of the can (about 2 inches deep) and lightly wet it with nonflammable killing solution. Securely wire the trap can to the bottom of the funnel so it fits as snugly as possible. Start the trap at dusk and empty it and shut it off before you go to bed. **Do not operate this trap in the rain, because of electrical hazard.** It may be necessary to attach the trap to a post or other support if it is windy.

Blacklights are made in the same form as regular fluorescent tube lights and can be operated in similar types of fixtures (Fig. 14). Check your local hardware

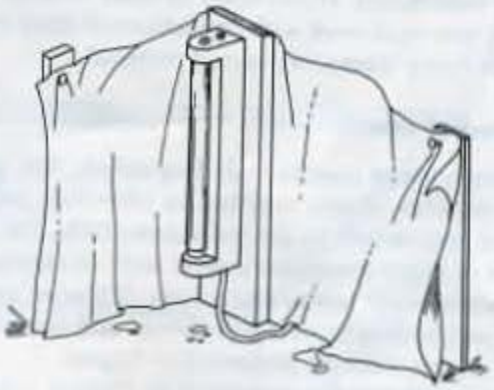


Figure 14 - A "blacklight" insect collector.

store for information. Hang the light on a pole or post and place a white sheet behind it to provide a reflecting surface. **Do not look directly at the blacklight bulb, because ultraviolet light can damage eyes.** Collect the insects attracted to the sheet as they land on the surface.

A **pitfall trap** will catch many ground beetles and other insects that live on or in the soil (Fig. 15). It consists of a trap can buried in the soil, level with the rim, so that insects attracted to it will fall in. Once inside, it is difficult for them to get out. An attractive bait in the bottom will increase the drawing power of the trap. Use pieces of spoiled fruit, vegetables, excrement or meat. Cover the trap with a board placed on small stones so insects can crawl under it and into the can. This arrangement will protect the trap from wind and rain, but allow access to the bugs you want to catch. It will also help to hold insects inside the trap once they are caught. Remove the insects you catch each morning.

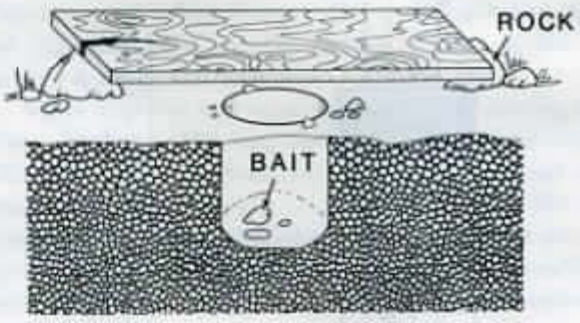


Figure 15 - Construction of a pitfall trap.

CHAPTER IV

PRESERVING INSECTS

Hard-Bodied Insects

Since insects have a hard exoskeleton and all of the soft parts are on the inside, they tend to keep rather well after drying, even for long periods of time. Only a small amount of maintenance is necessary to keep them in good condition. Many specimens in museums today are over one hundred years old and most look just as they did on the day they were collected. Certain types of insects may fade, but others hold their colors indefinitely. If you want to study insects in the winter, you must work with collections of dead insects or with living laboratory-reared material.

Soft-Bodied Insects

Many types of insects, including aphids, lice, springtails, termites, thrips, mayflies or silverfish, are soft-bodied and cannot be pinned successfully. The same is true of many immature insects such as caterpillars, beetle and wasp larvae and others. If placed on pins, most soft-bodied insects will shrivel and decompose. Such insects must be preserved in liquids.

Insects are readily preserved in alcohol solutions, usually of about 70 percent concentration (70% alcohol, 30% water). Either ethyl or isopropyl alcohol can be used with success, even if denatured to prevent human consumption. Alcohol (particularly isopropyl) can cause colors of specimens to darken and bodies to shrivel. These problems can be largely prevented in either of two ways. The best way is to kill the insects in boiling water (dip them in for about 30 seconds and then transfer them to 70 percent alcohol).

A second method, often used for caterpillars and other soft-bodied larvae, is to kill the insects in a special **fixing** solution called K.A.A. mixture. This solution is made by mixing one part of kerosene, two parts of glacial acetic acid (a weak acid, available at your local drug or photo supply store) and ten parts of 95 percent denatured alcohol. Vinegar can be substituted for the glacial acetic acid with reasonable success. A good feature of the K.A.A. solution is that it causes soft-bodied larvae to uncurl, distend and swell up, making them easier to examine and study. Leaving specimens in the solution too long can cause the bodies to burst, so watch them carefully. Small insects should not stay in the solution for more than 30 minutes while larger ones, such as caterpillars, might require 2 to 3 hours. After they are fixed in the solution, they should be transferred to 70 percent alcohol in tightly closed vials (use rubber stoppers).

A specimen label should accompany the insect (labeling will be discussed in detail later). With an insect pin placed against the interior of the vial, force the rubber stopper deep into the vial as the pin is simultaneously withdrawn (Fig. 16). This procedure forces surplus air out of the vial as a stream of tiny bubbles, thus helping to ensure an airtight fit.

Because the body contents of a large specimen may dilute the preservative it is best to replace the original alcohol with fresh alcohol after a day or two.

After this special treatment, colors should not fade much. Over the years, the alcohol may evaporate, so just add a bit more from time to time.

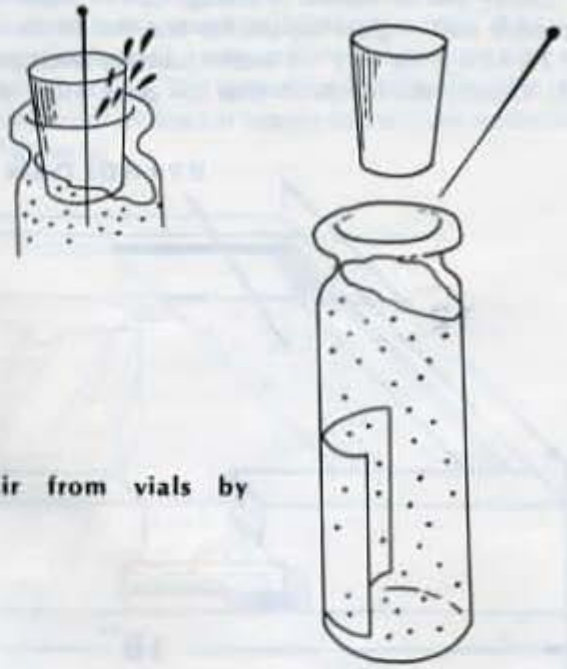


Figure 16 - Remove excess air from vials by "burping" them.

CHAPTER V

PINNING, MOUNTING AND DISPLAYING INSECTS

Temporary Storage Boxes

Cigar boxes make excellent containers for temporary storage of pinned insect specimens (Fig. 7). Ask your druggist or local restaurant owner to save boxes for you. Line the bottom of the boxes with styrofoam material, celotex, corkboard, balsa wood or cardboard to receive and hold the insect pins. While cigar boxes are fine for temporary storage, they are poor over long periods of time. For extended storage and for display, tighter containers are essential. If boxes are not tight, museum pests (dermestid beetles) can get in and destroy your collection.

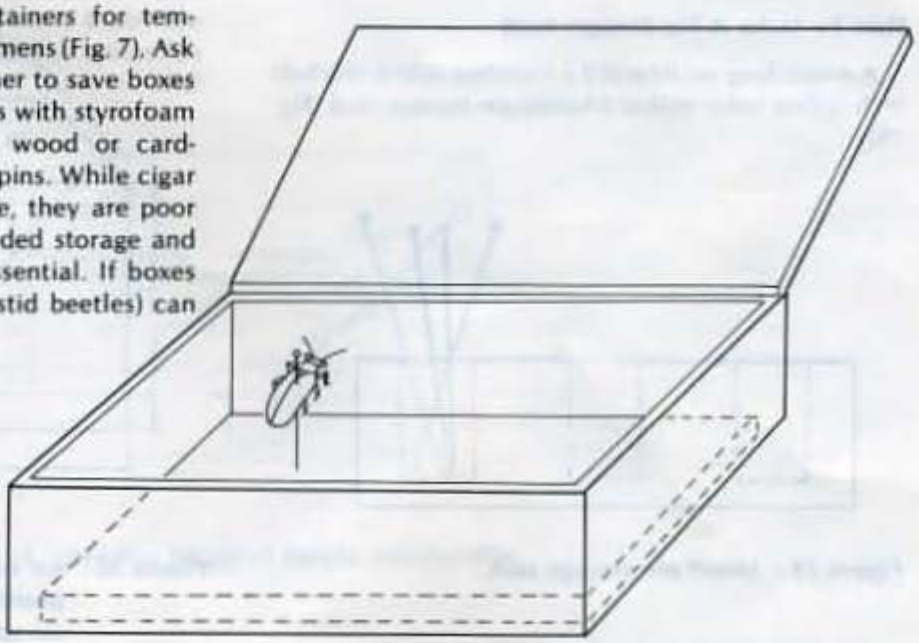


Figure 17 - Cigar boxes are satisfactory for temporary storage of insect specimens.

How To Make Display Cases

A display box for exhibit or storage can be made at reasonable cost. A glass top display box should measure 12 x 18 x 2 1/2 to 3 1/2 inches (outside measurement). Groove the inside so that the glass will slide out the narrow end of the box (Fig. 18). Attach a small hook or other device to hold the glass in place. Line the box with styrofoam, celotex, corkboard, or other soft, preferably light-colored material that can be easily penetrated by insect pins.

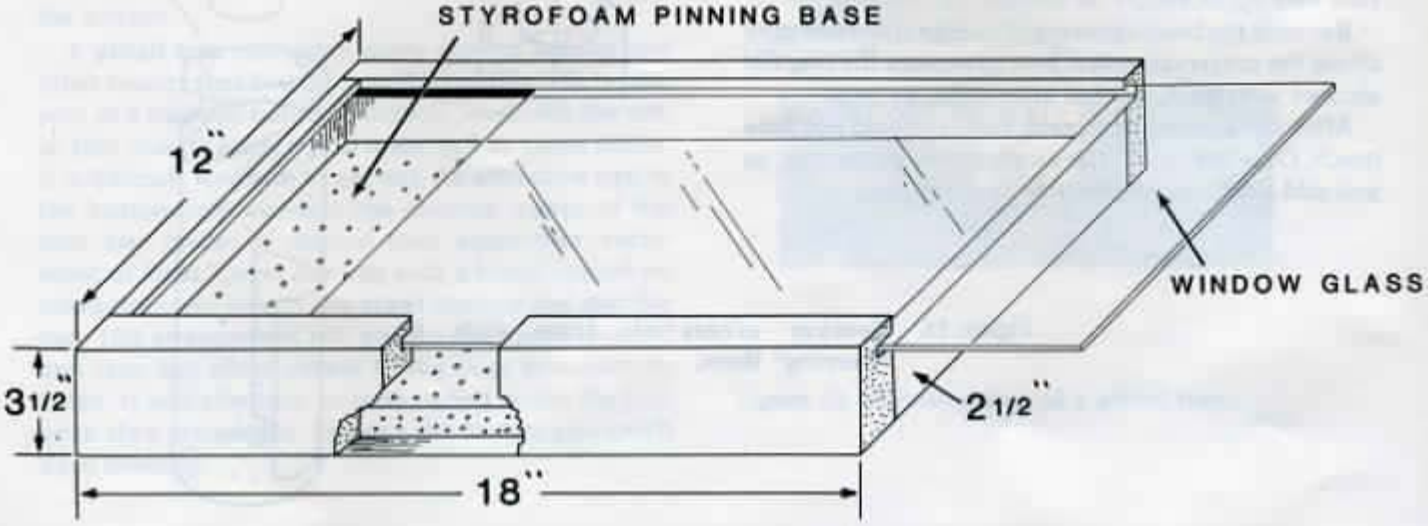


Figure 18 - Construction of an insect display box.

Insect Pins and Where To Obtain Them

Special pins are needed to pin insects. They come in several sizes from 00 through 7 (size of pin increases with number). Number 3 insect pins are the best for most purposes. Insect pins can be purchased from biological supply houses and from the State 4-H Office (see addresses in Chapter X).

How To Make A Pin Storage Rack

A 4-inch long section of 2 x 4 lumber with 6 one-half inch drilled holes makes a handy pin storage rack (Fig. 19).

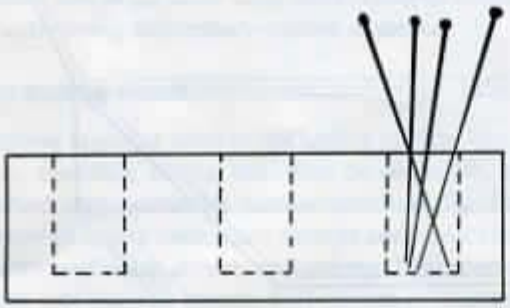


Figure 19 - Insect pin storage rack.

How To Make A Pinning Block

Larger insects should be mounted using a wooden pinning block, a simple, easily made piece of equipment. The dimensions are shown in Figure 20. Bore a very small hole almost through the bottom in the middle of each step. A simpler pinning block can be made by drilling three holes—1, 3/4, and 1/2 inch deep—into a small wooden block. Use of the pinning block will result in an attractive collection with the insect, collection and identification labels in uniform position.

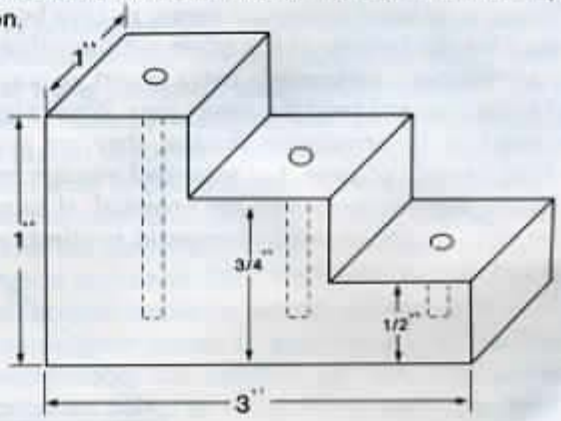


Figure 20 - An insect pinning block. Top step is to position the insect, the second and third for specimen labels.

How To Make A Spreading Board

Mounting butterflies is a special technique that requires a spreading board to do an attractive job. The measurements for a spreading board are given in Figure 21. It should be made of soft pine with a piece of balsa or cork underneath the center groove to receive insect pins. An acceptable spreading board can be made from balsa wood or cardboard strips, 2 heavy paper clasps, four corks and four common pins as shown in Figure 22. Spreading boards can also be ordered from biological supply houses (see addresses in Chapter X).

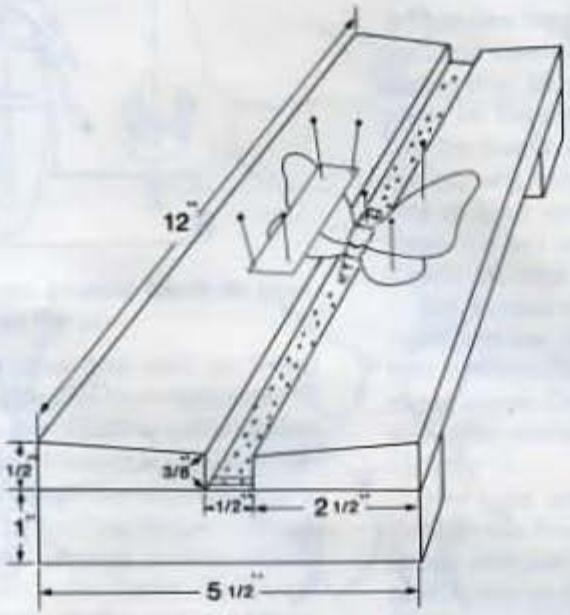


Figure 21 - A spreading board for butterflies, moths and other insects.

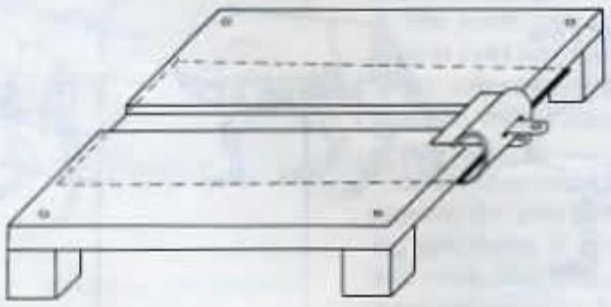


Figure 22 - A spreading board of simple construction.

Pinning Insects

The proper way to pin an insect depends on the type of insect that you have collected. Remember that soft-bodied insects such as caterpillars, mayflies, silverfish and some others cannot be pinned. The diagram in Figure 23 shows the proper way to pin various orders of insects. Note that the pin is usually just slightly to the right of the midline of the insect. Specimens should also be level and squarely mounted on the pin as shown (Fig. 24). The use of a pinning block will help in obtaining proper height and positioning.

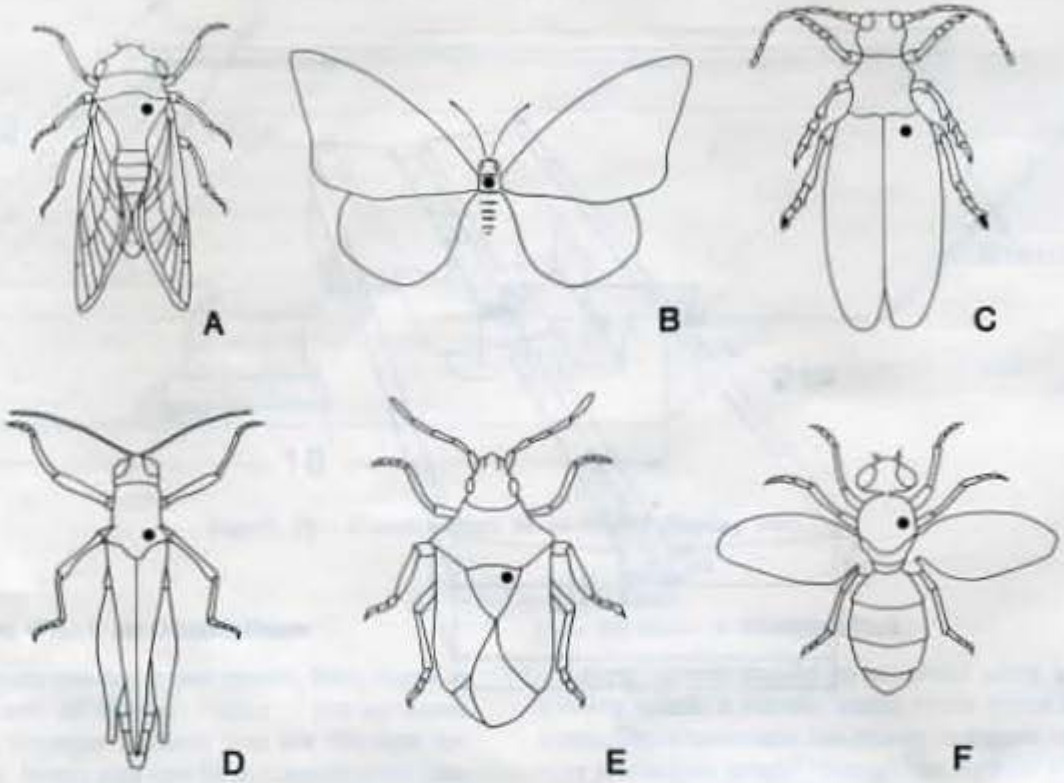


Figure 23 - The dot shows where pin should be placed for 6 orders of insects. A - Cicada (Homoptera), B - Butterfly (Lepidoptera), C - Beetle (Coleoptera), D - Grasshopper (Orthoptera), E - True Bug (Hemiptera), F - Fly (Diptera).

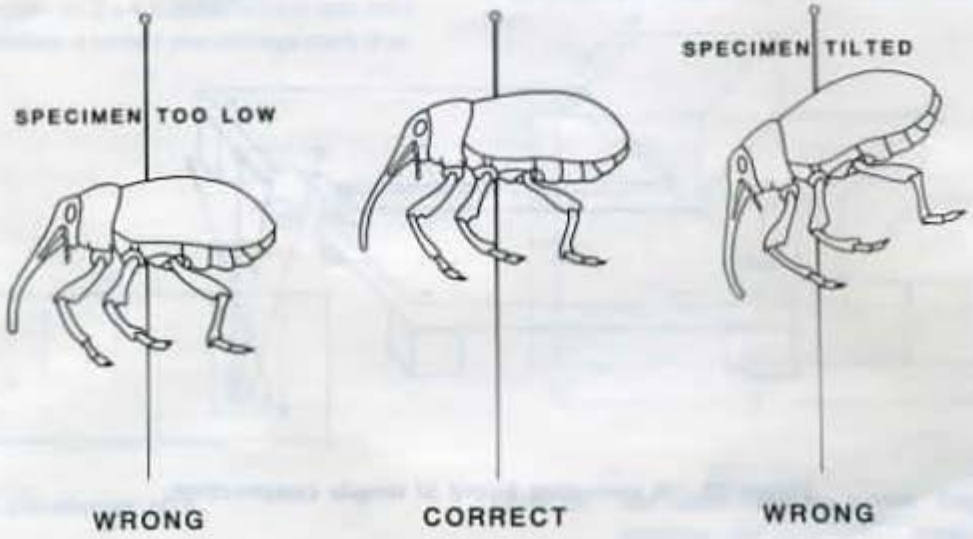


Figure 24 - How to mount a specimen on the insect pin.

First, place the pin in the insect in the proper position on the top step of the pinning block, pushing it in to about 1/4 inch of the pin head. Then, remove the pin from the top step, reverse it and place the head of the pin in the lowest step of the pinning block. Push it down as far as it will go (Fig. 25). This will result in positioning each insect about one-half inch from the pin head. The middle step on the block is to position the collection label. The lowest step is used to position the order identification label.

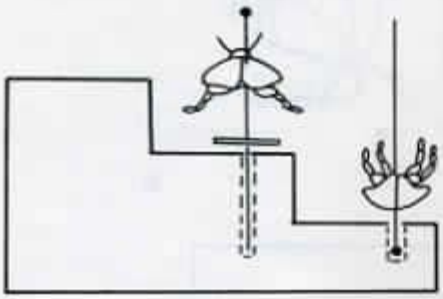


Figure 25 - Proper use of the pinning block to position an insect on the pin.

Very small insects (less than 3/16 inch or 1 cm) should not be pinned, but glued on their right sides to small paper triangles. This procedure is called **pointing.** A properly mounted (small) insect is shown in Figure 26. First, drive the pin through the large end of the triangle. Level the triangle by pushing the pin through the hole in the highest step of your pinning block. Bend the tip of the paper triangle slightly downward and touch it with a small drop of glue or clear fingernail polish. Pick up the small insect carefully with forceps and mount it by touching it on its right side to the drop of glue. Adjust the insect so it remains squarely in position. Allow the glue to dry.

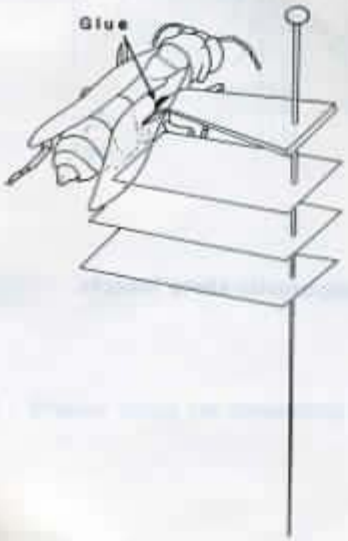


Figure 26 - A very small insect, correctly "pointed" and mounted.

Pinning and Spreading Butterflies and Moths

Insects with large wings, such as butterflies, moths and dragonflies, can be temporarily stored in paper triangles until you have time to pin and spread them. Fold pieces of paper as shown in Figure 27, placing the insect inside with the wings held together above the body. Write the collection data on the outside of the triangle until you are ready to mount and label the specimen. **Papered** specimens must be relaxed before mounting.

Before you begin to work with your butterfly, cut several thin strips of paper about 1/4 inch wide and 8-10 inches long. Once these are ready, pick up the insect and carefully push a pin through the middle of its thorax (Fig. 28, step B). Adjust the position of the butterfly on the pinning block, being careful not to damage the fragile wings. Remove the pinned insect from the pinning block and push the pin into the middle slot of your spreading board until the bases of the wings are just level with the top of the two side pieces (Figure 28, step D).

Slip a paper strip between the wings (if they are upright) and use it to force the wings on one side down into position (Figure 28, step E). Pin the ends of the paper down. Do the same with the wings on the other side, also pinning the ends of the paper down (Figure 28, step F).

Now take another insect pin and slip the point through the front edge of the right forewing (there is a strong vein just at the front edge of each wing) near its attachment to the thorax (Figure 28, step F). Be careful not to tear the wing. Loosen the forward end of the paper strip and gradually bring the forewing up into final position (Figure 29). Pin the wing down with a paper strip. Repeat this procedure with the forewing on the other side (Figure 29, Steps G-H). Using the same technique bring both hindwings into proper position and fasten all four wings firmly with the paper strips (Figure 29, step I).

The rear edge of the two forewings should make a perfectly straight line across the back (Figures 29, Step I). The hindwings should be pinned so that the rear edge is held just slightly away from the abdomen. Position antennae with pins and if the abdomen has drooped, prop it up with pins so that it dries in a natural position.

Allow specimens to dry for several days before you remove the pins. Rushing the drying process by placing specimens in an oven at 125°F. for about an hour will work, but may result in the wingtips curling upward and spoiling the insect's appearance. Using wider paper strips to hold the wings down will help prevent distortion.

Large-bodied moths like cecropias should be cut open on the underside of the abdomen and the contents removed with a cotton swab. The cavity should be filled with cotton so that the specimen looks natural from above. If this is not done, the fatty material in the abdomen will decompose and ruin the specimen.

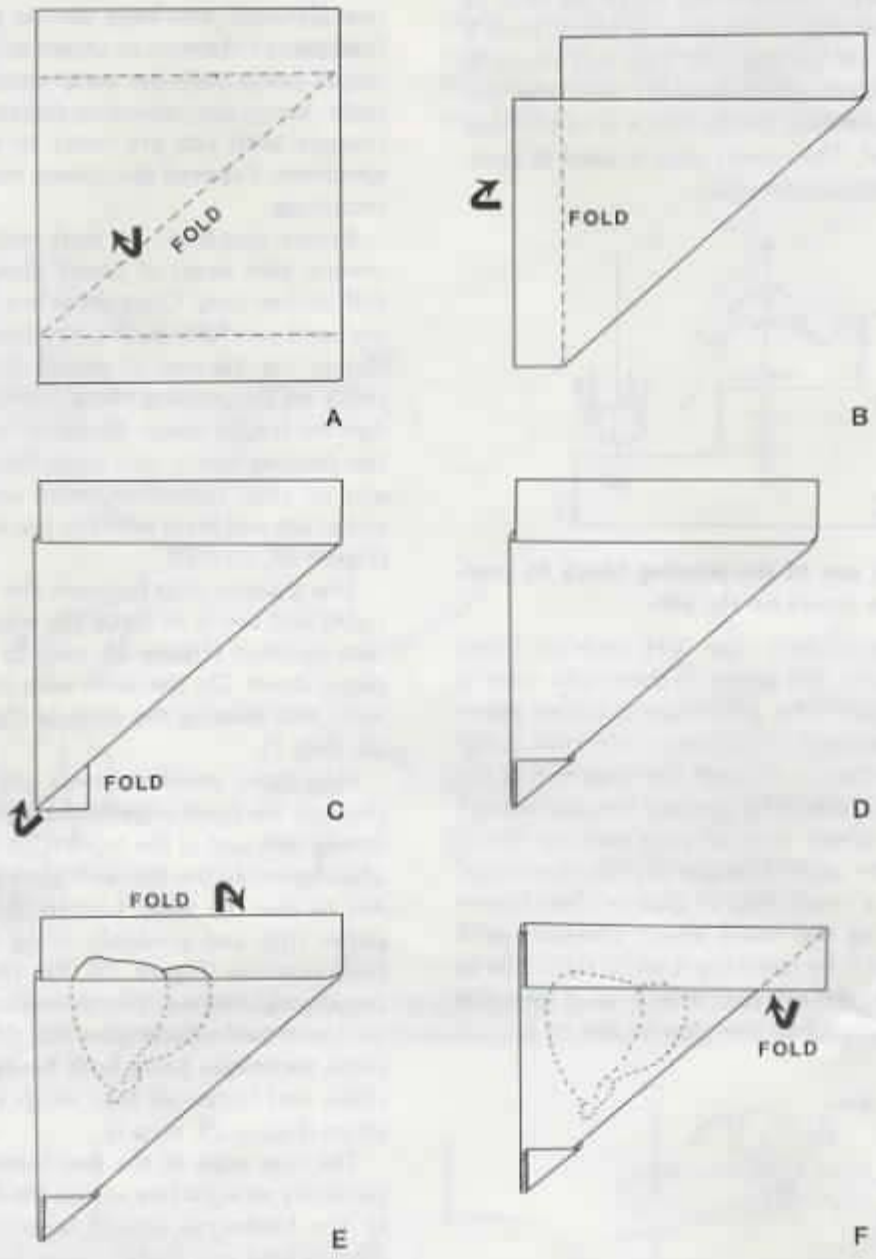


Figure 27 - Steps for folding paper triangles to temporarily store insects.

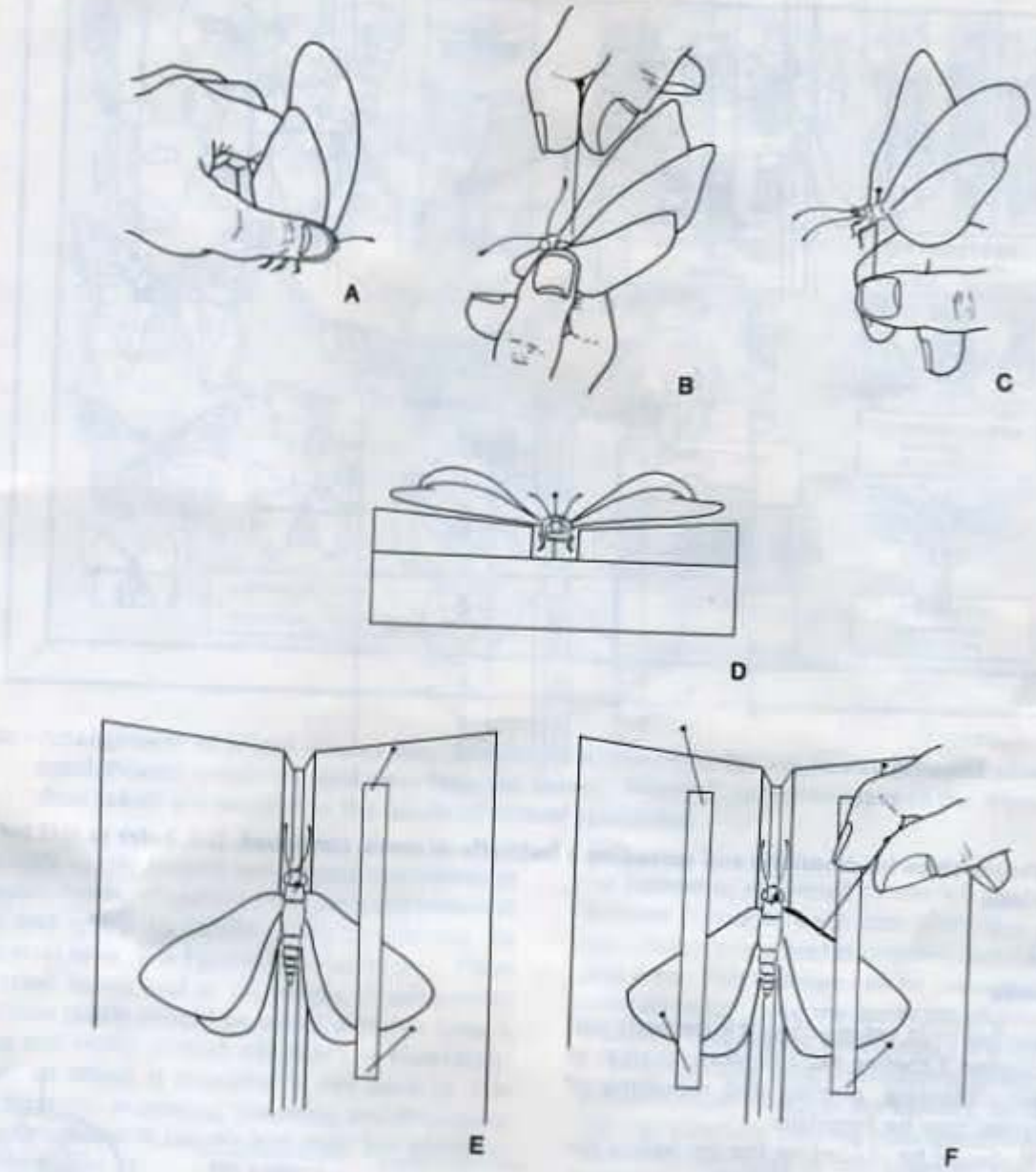


Figure 28 - Proper steps for mounting and spreading a butterfly or moth, A-F. Refer to text for instructions.

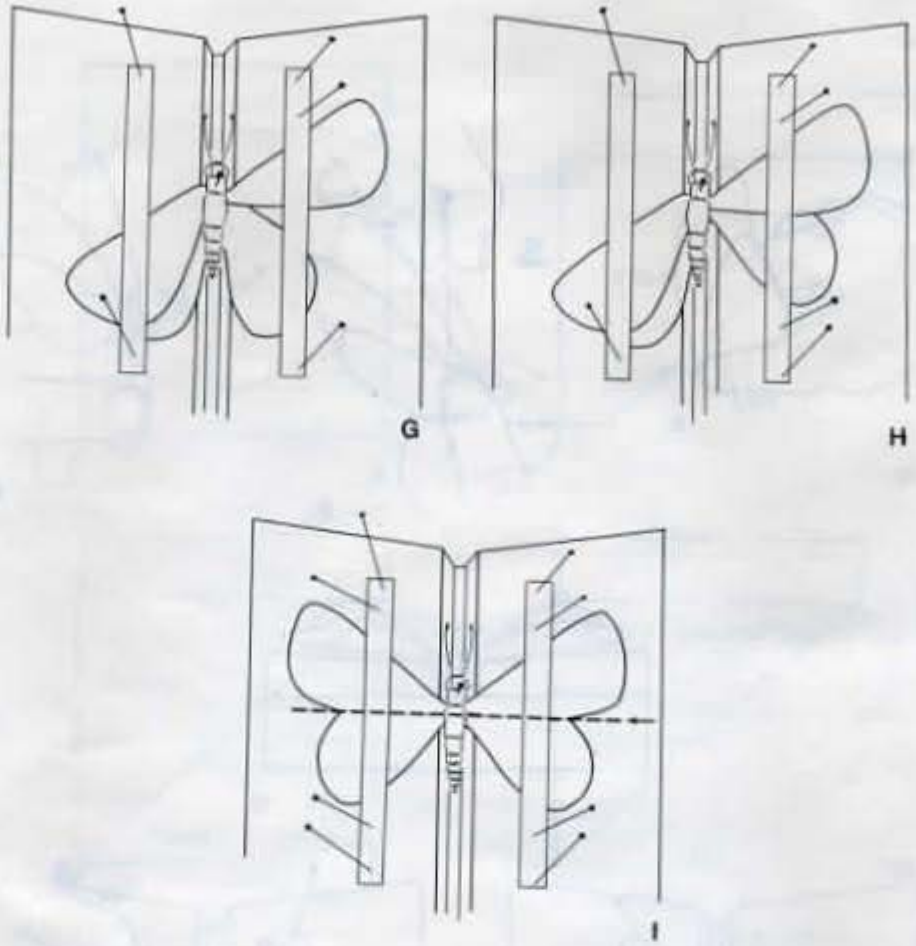


Figure 29 - Proper steps for mounting and spreading a butterfly or moth, continued, G-I. Refer to text for instructions.

Labeling Insects

A collection has little value unless it is properly and accurately labeled. Labeling must be done as soon as possible after collecting, pinning and mounting or vital information may be forgotten.

Two labels should be placed on the pin below the insect specimen. Both labels should be lined up parallel to the length of the body of the insect **(not crosswise)**, as shown in Figure 30. The insect head should be at the left and the label should read from left to right. However, with "pointed" specimens, the labels should be parallel to the length of the point as shown in Figure 26. The top label should have the county and state in which the insect was collected, the collection date and the name of the collector. The lower label should show the correct order name of the insect. Many entomologists place another label beneath the collection label which gives the host plant, habitat or other pertinent information. Print the information on the labels as neatly as you can. **Neatness is important.**

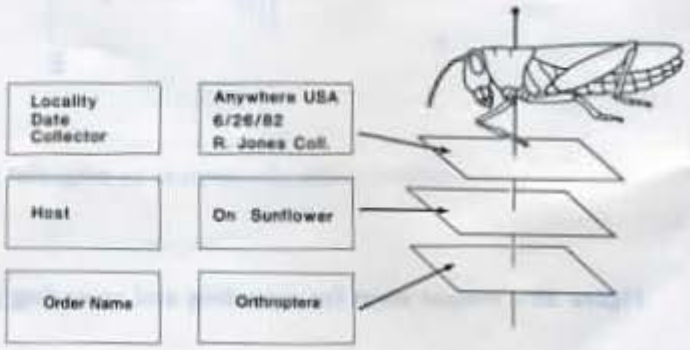


Figure 30 - Correct procedure for labeling an insect specimen. Labels should not be larger than those shown here.

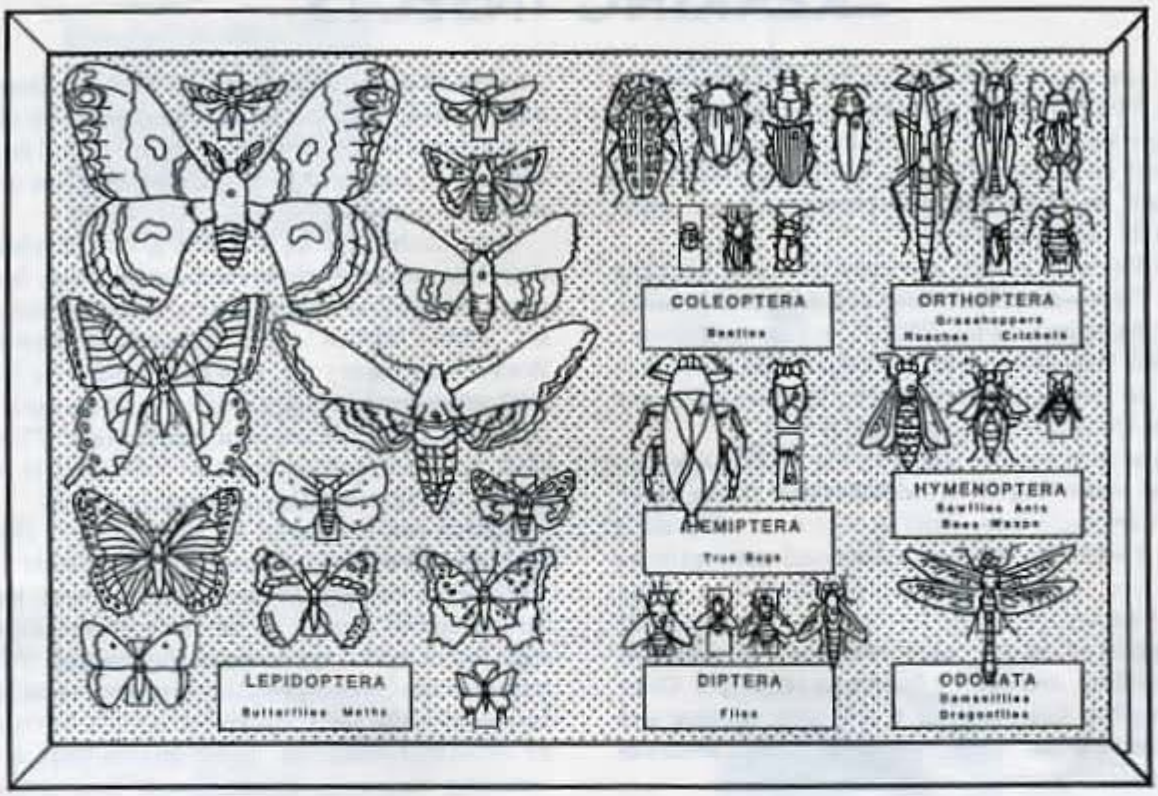


Figure 31 - Arrangement of insect display box. Specimens within an order are neatly grouped above the order label. Pinned specimens face away from the viewer. "Pointed" specimens face to the viewer's right, but their labels are parallel to the labels of pinned specimens.

Place only neatly pinned and labeled specimens in your display boxes. Organize them into sections and position and space all labels neatly on the pin, by order, in neat rows. See Figure 30 for label size. Place a large label below and in the center of each order group. These labels should be about 3 inches long, 1 inch wide and neatly printed with black or blue lettering. A set of labels is provided in the back of this manual. Neatness in pinning, mounting and displaying insects is important in county and state fair competition. Study Figure 31.

Boxes of pinned and mounted insects must be protected from museum pests, small beetles (dermestids) and their larvae which devour specimens. If left unprotected, for as little as a few months, damage can occur. Collections that are ignored will eventually be destroyed. To protect your collection, put a tablespoon or so of moth crystals (naphthalene or PDB) inside the display case every 6-8 months, either loose on the bottom or in a small cardboard container glued in a lower corner of each box. Note that moth crystals can chemically affect styrofoam, and cause it to twist and warp. This damage can be prevented by using the crystals to fumigate the boxes for short periods (about 1 week). Refumigate about every 3-6 months.

When putting your collection together, be sure that all identification labels are correct. By double checking and carefully running your specimens through the identification keys in this manual, you can be sure. Check once again that you have enough insects and insect orders in your collection to meet the minimum requirements for displays at county and state fairs. These can be found in your county and state fair premium lists. Collections that do not meet these minimum requirements may not be allowed in competition, depending on the interpretation of the judge. In any case, they will be discounted for inaccuracies, so check them over carefully before the fair.

CHAPTER VI

REARING INSECTS

You may want to rear an insect for one or two reasons. You may have collected an immature insect that you want to rear to the adult stage to put in your collection or to identify more easily. Secondly, you may want to study the development of an insect through its entire life cycle.

Many kinds of insects are easy to rear if you can provide them with proper food and a favorable environment. Most insects are difficult to rear continuously because they enter dormant stages. This dormancy is hard to break unless lighting, temperature and moisture are artificially regulated.

To raise an immature insect to the adult stage, you will need something for it to eat. If you find a caterpillar on an apple tree, don't expect it to eat grass if you put it into a jar. Instead, take small cuttings from the tree you found it on and place them in a water-filled container inside the jar or cage. See Figure 31 for examples of rearing cages. Water will prevent drying of the food, and keep it fresh and attractive. Once the caterpillar has matured it will stop feeding and change into a **pupa.** It may take several days, weeks or months before it comes out as the adult.

Your specimen may also die, either because of improper conditions or because of parasites or disease. Sometimes we raise a caterpillar as far as the pupa stage and instead of the butterfly or moth we expected, several small wasps come out of the empty shell. This seems confusing, until we realize that they are parasites that have killed the caterpillar. If this happens, you have learned something about natural insect control. Because of this possibility, it is often best to rear several specimens if you can find them.

Simple rearing cages can be made out of screen wire, cheesecloth, and glass jars or flower pots, as shown in the figures. Replace the food often and keep the cages clean to prevent starvation and disease. To further reduce the chance of disease development don't crowd too many insects into a small container. It is sometimes a good idea to put an inch or two of moist (not wet) soil on the bottom of the rearing cage, since many caterpillars pupate in the soil.

Many people want to raise insects continuously, which can be done with some, but not all, insects. Continuous rearing requires regular care to see that food, moisture and other requirements are met or the culture may die out.

Insects that can be easily reared throughout their life cycles include house flies, cockroaches, aphids, white flies, flour beetles and boxelder bugs.

House flies can be reared in glass jars with a small dish or jar cap filled with damp bran and a small amount of sugar in the bottom. Keep the bran moist, but not wet. Eggs, larvae and pupae can be observed in the bran. Watch for adults to emerge. House flies are easy to find near feedlots, garbage cans or rotting material of any sort.

Cockroaches can be reared in glass jars where bran, dog food or some other food product has been supplied. Supplement these with occasional bits of celery, apple, lettuce, meat scraps or powdered milk. Water is necessary and can be provided by making a wick arrangement with a small vial and a piece of cotton. Rear cockroaches in a warm place (75-80°F). A start for your culture may be obtained in infested homes, garages or other infested buildings.

Aphids can be reared on many plants. The greenbug, an aphid pest of grain sorghum would be especially easy to rear on sorghum or wheat seedlings. Young aphids appear to be born alive (actually the eggs hatch within the body of the mother). Whiteflies (not true flies, but more closely related to aphids) can be raised in the same manner as aphids, but on squash or velvetleaf seedlings. These insects have a very interesting life cycle. If you have a local greenhouse, give them a call and see if you can obtain some specimens to begin your culture. They'll be glad to be rid of a few.

Flour beetles are common pests of stored products, including many items found in the kitchen (cereal, spices, dry dog food, flour, etc.). These insects can be raised in a jar of whole wheat flour or corn meal. Place several beetles in the flour and leave the jar at 75-80°F. All stages of reproduction, including eggs, larvae, pupae and adults, should be present. You will need a hand magnifier to study them. Examine old grain bins for a start for your culture. Ask a parent to check kitchen supplies, too.

Boxelder bugs are relatively easy to rear. They can be collected on boxelder, ash or soft maple trees when you are gathering seeds to feed your culture. Collect seeds and establish your cultures in May and June when the seeds mature and fall. Look for young bugs on seeds clustered near buildings or in nearby flower beds. Place seeds and bugs inside the rearing container. Rub the inside rim of the culture jar lightly with petroleum jelly or make a muslin or cheesecloth cover to keep the bugs inside. Use a vial and wick to provide the bugs with water. Boxelder bugs can be maintained indefinitely if the seeds are replaced periodically. Put a small rolled up ball of cheesecloth in the bottom of the container for the bugs to lay eggs on.

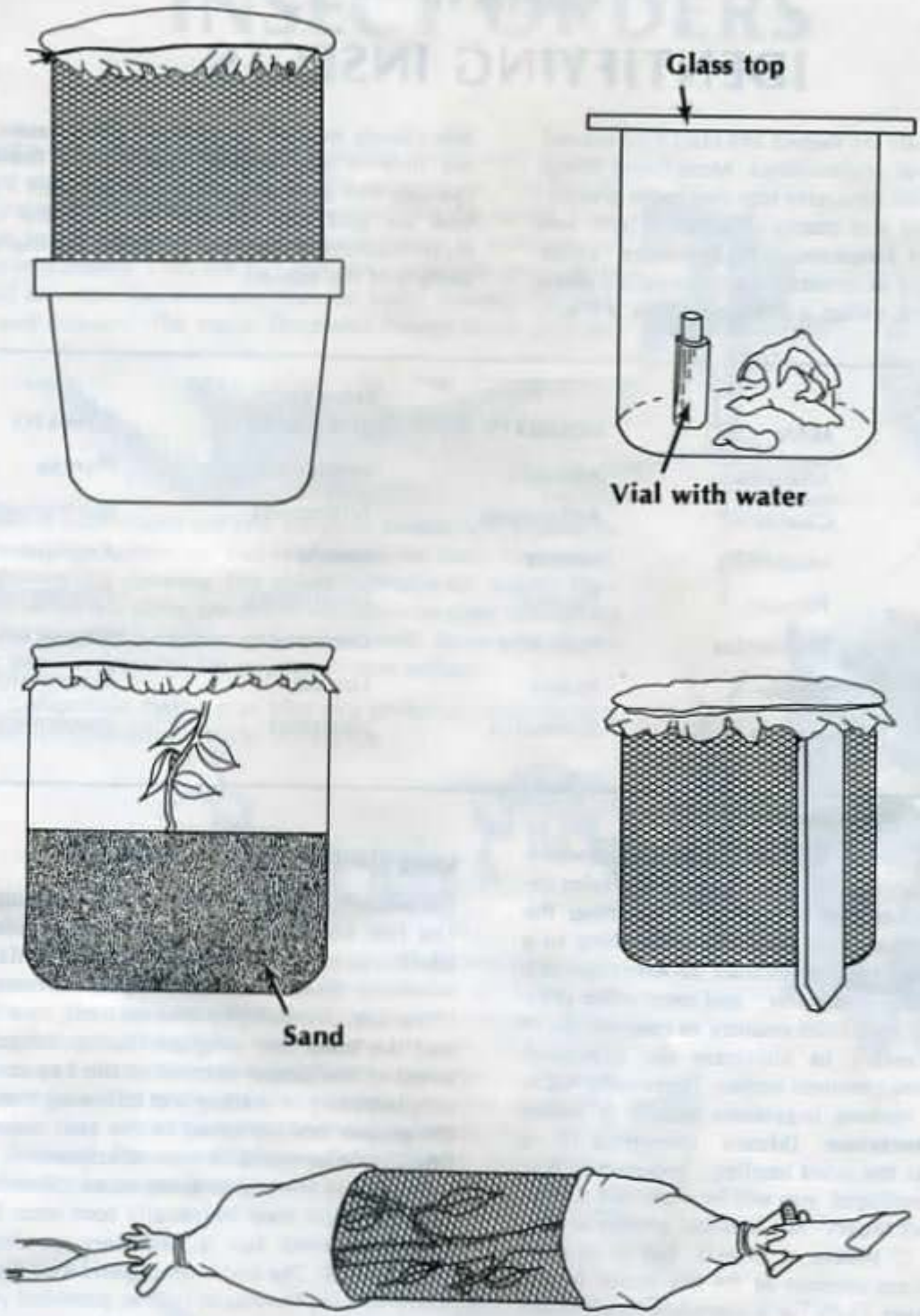


Figure 31 - Some examples of cages for rearing insects.

CHAPTER VII

IDENTIFYING INSECTS

All known animals are named and classified according to their natural relationships. Most living things can be placed quite naturally into two main groups - animals (Animalia) and plants (Plantae). These two groups are called **kingdoms.** Kingdoms are further divided into groups of similar organisms called **phyla** (one single group is called a **phylum**). Phyla are split into closely related sub-groups called **classes.** Classes are broken into **orders,** orders into **families** and families into **genera.** Genera (one is called a **genus**) in turn are split into **species.** Here are the complete classifications of man, the housefly, the monarch butterfly and the tomato.

GROUP	MAN	HOUSEFLY	MONARCH BUTTERFLY	TOMATO
KINGDOM	Animalia	Animalia	Animalia	Plantae
PHYLUM	Chordata	Arthropoda	Arthropoda	Spermatophyta
CLASS	Mammalia	Insecta	Insecta	Angiospermae
ORDER	Primate	Diptera	Lepidoptera	Polemoniales
FAMILY	Hominidae	Muscidae	Danaidae	Solanaceae
GENUS	Homo	Musca	Danaus	Lycopersicon
SPECIES	sapiens	domestica	plexippus	esculentum

The names of all animals and plants are standardized world-wide according to procedures and rules developed by international agreement. Therefore, the name, *Musca domestica*, means the same thing to a Russian that it does to an Australian, an American or a European. The term "housefly," and most other common names, may vary from country to country. Strict rules were necessary to eliminate the confusion caused by so many common names. These rules led to our system of naming organisms, which is called **binomial nomenclature.** (*Musca domestica* is a "binomial" or, as the word implies, "two names.")

As a 4-H entomologist, you will be expected to recognize only insect orders - not families, genera or species. There are 27 orders of insects, but several of these are either uncommon or do not occur in the midwest. See pages 31-39 for a complete description of the major insect orders. Identification of insects to the order level is quite easy, after some practice, if you use the insect **keys** provided in this manual (see pages 40-48). Keys are simple identification aids. If you want to identify insects to the family level, you will need a dissecting microscope or something else to provide some magnification, such as a 10X hand lens. You will also need to purchase or check out a library book that has good identification keys to the family level. Many helpful references are listed for you in this manual (see pages 51-53).

Using The Keys To Insect Orders

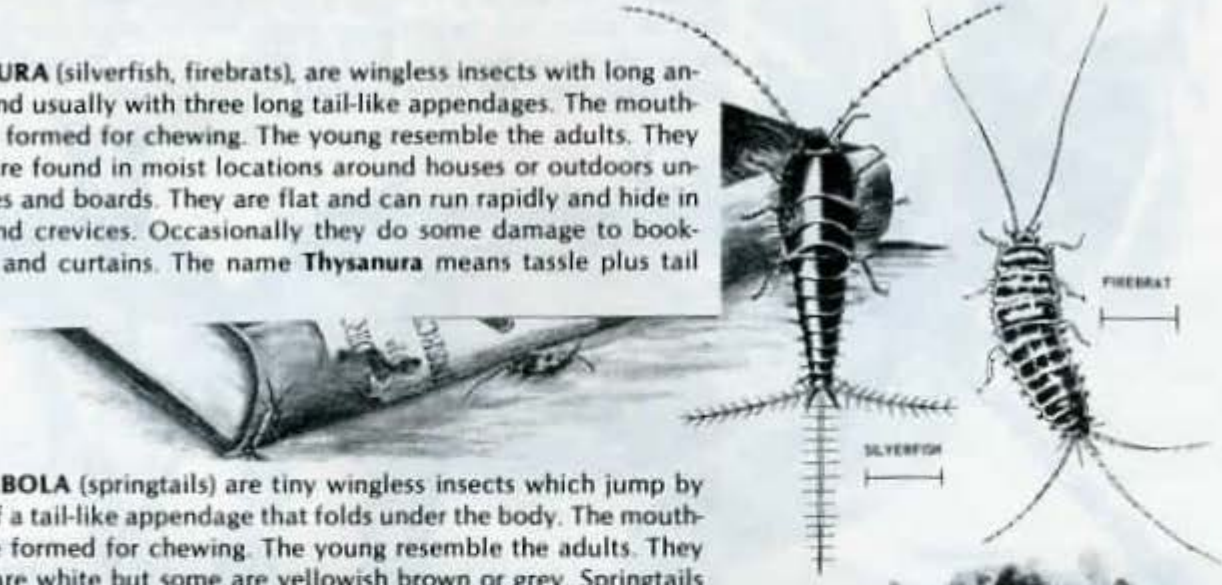
Two insect identification keys are provided for you. The first key (pages 40-43) is made to identify only **adult** insects; it will not work for caterpillars or other immature insects. The key to adult insects is a branching key, divided into two sections, one for winged and the other for wingless insects. After you have selected the proper section of the key to use, it is a simple matter of reading and following the choices, to the proper box indicated in the key, where you will find the order name of your specimen.

Immature insects, in many cases, do not look at all like the adult they eventually turn into. Because of this, a separate key is necessary to identify them (pages 44-48). The key is simple and well-illustrated, so it will be easy for you to follow, provided you do have some sort of magnification. While most of the major orders of insects are included in the key, several smaller orders are missing.

To use the key, start at choice number one and follow the choices, carefully checking the descriptions given against those of your specimen. Eventually you will reach the correct answer.

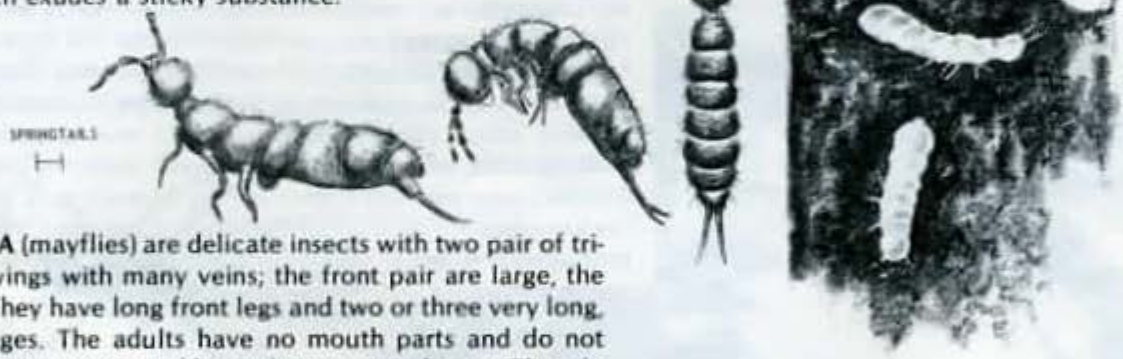
INSECT ORDERS

THYSANURA (silverfish, firebrats), are wingless insects with long antennae and usually with three long tail-like appendages. The mouthparts are formed for chewing. 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 bookbindings and curtains. The name **Thysanura** means tassle plus tail **(ura)**.

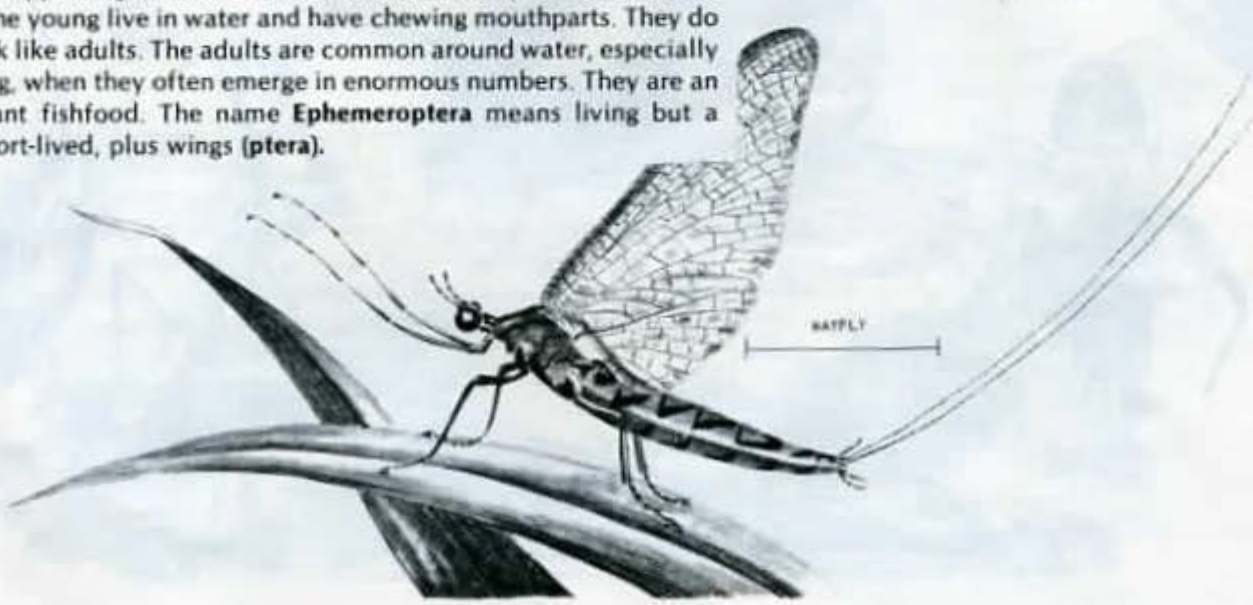


COLLEMBOLA (springtails) are tiny wingless insects which jump by means of a tail-like appendage that folds under the body. The mouthparts are formed for chewing. The young resemble the adults. They usually are white but some are yellowish brown or grey. Springtails are common in moist locations and in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

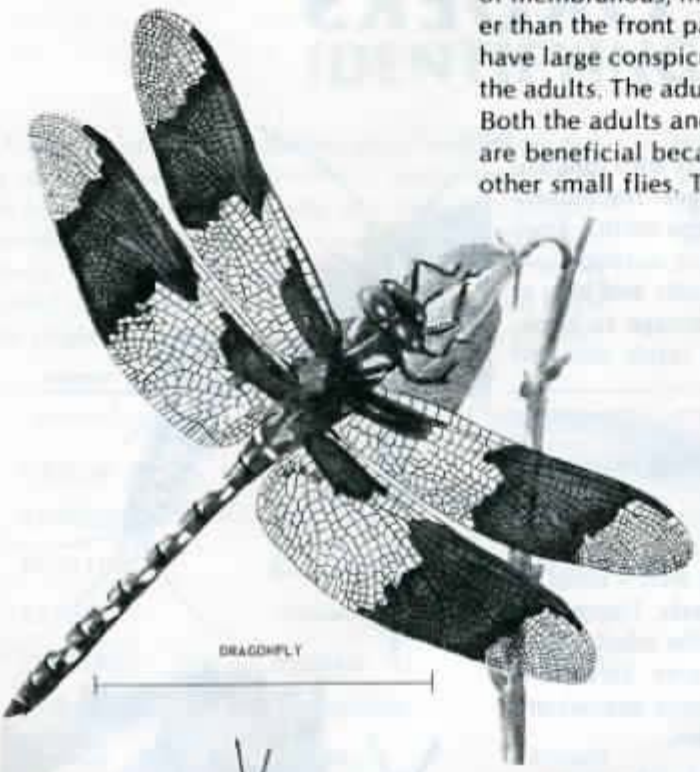
The name **Collembola** means glue plus peg **(embola)**, referring to a ventral tube which exudes a sticky substance.

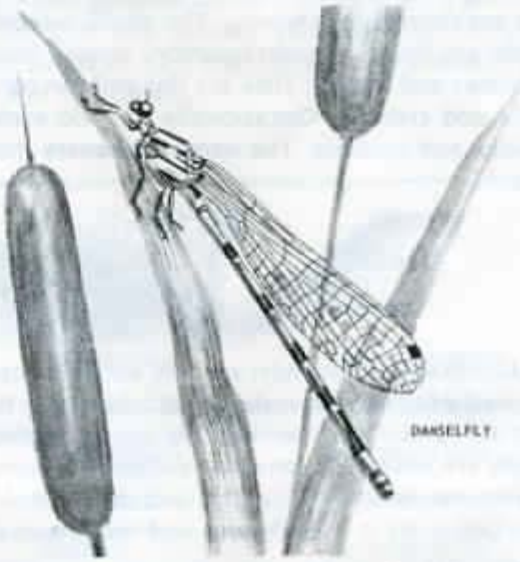


EPHEMEROPTERA (mayflies) are delicate insects with two pair of triangular-shaped wings with many veins; the front pair are large, the hind pair small. They have long front legs and two or three very long, tail-like appendages. The adults have no mouth parts and do not feed. The young live in water and have chewing mouthparts. 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 fishfood. The name **Ephemeroptera** means living but a day, short-lived, plus wings **(ptera)**.

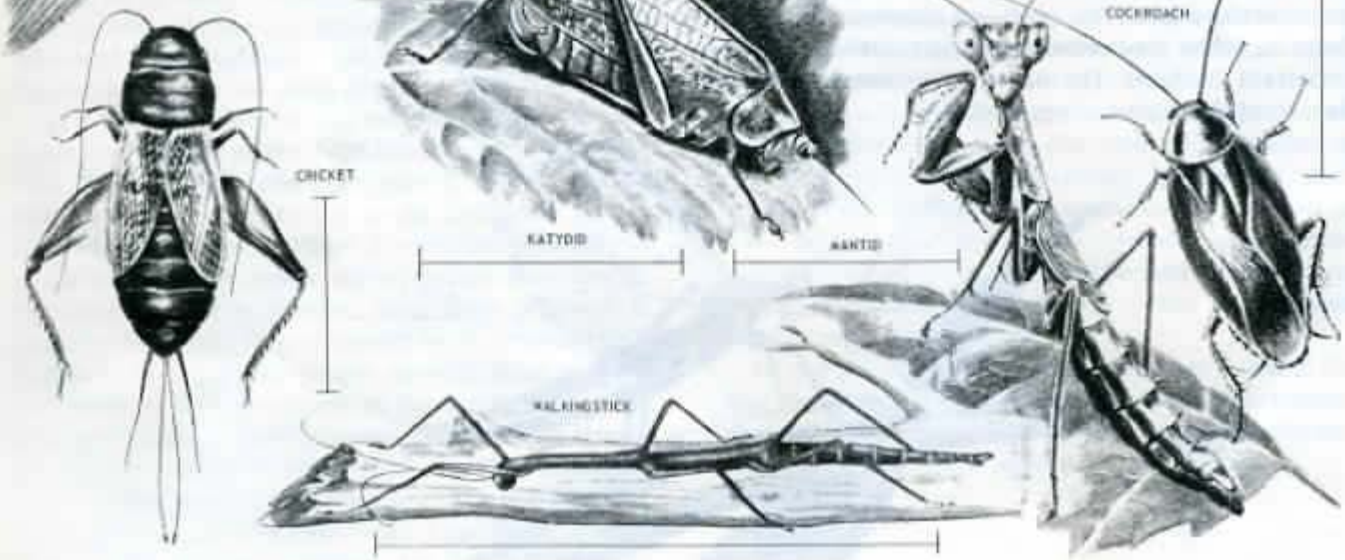


ODONATA (dragonflies, damselflies) are large insects with two pair of membranous, many-veined wings, the hind pair as large as or larger than the front pair. The mouthparts are formed for chewing. They have large conspicuous eyes. The young live in water and are not like the adults. The adults are common around ponds, lakes, and streams. Both the 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.

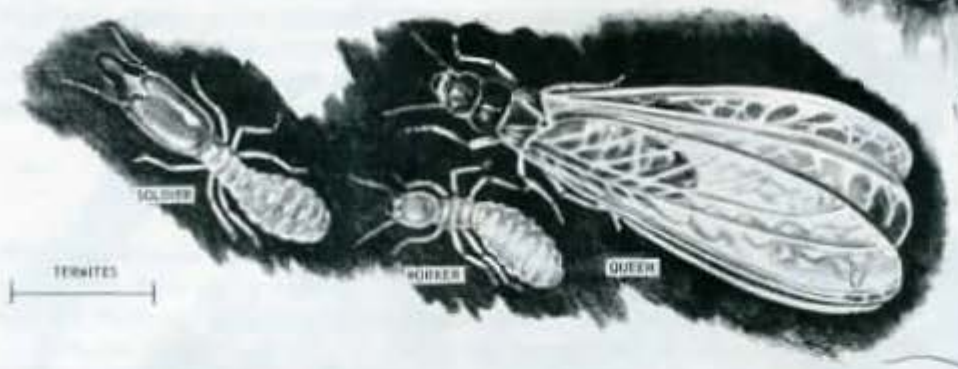




ORTHOPTERA (grasshoppers, crickets, katydids, roaches, mantids, walkingsticks) generally have two pair of wings which have many veins. The front pair usually is slender and the hind pair broad and fanlike. The mouthparts are formed for chewing. The nymphs resemble the adults. Several groups in this order have adults which never develop wings. These include such odd insects as 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 commonest household pests. The name **Orthoptera** means straight plus wings (**ptera**).



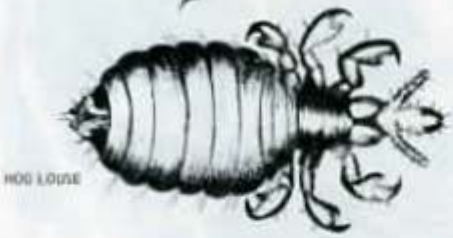
ISOPTERA (termites) are small, soft-bodied yellowish or whitish insects that live in colonies in wood. Colonies consist of three classes—workers, soldiers, and swarmers. The workers and soldiers are wingless and never leave the colony. The swarmers are reproductive forms having dark bodies and four long,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



PLECOPTERA (stoneflies) are large soft-bodied insects, 1/2 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 mouthparts, 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. The name **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 hindwings are folded under these. A pair of nonpoisonous pinchers are found at the end of the abdomen. They have chewing mouthparts, and they go through a gradual metamorphosis. Usually they are found outdoors, hiding under leaves, boards, or in cracks during the day. The name **Dermaptera** means skin plus wings (**ptera**), referring to the texture of the front wings.

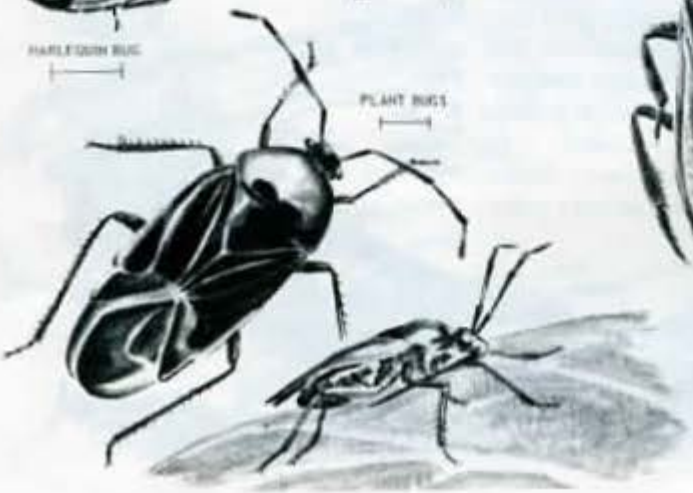
MALLOPHAGA (biting lice or bird lice) are small, flat, wingless parasitic insects with mouthparts formed for chewing. The legs and antennae are short. The immature stages resemble the adults. They feed upon feathers, hair, wool, and skin scales. They are frequently important pests of domestic fowls and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

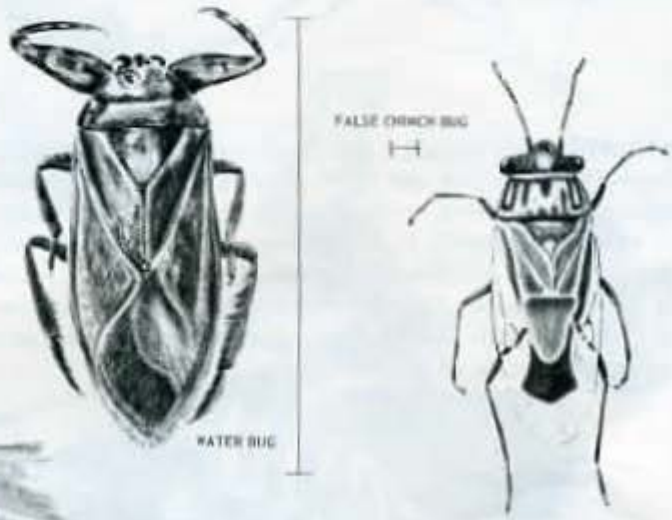


ANOPLURA (true lice or sucking lice) are small, flat, wingless, parasitic insects with mouthparts formed for piercing and sucking. The legs and antennae are short. The immature stages resemble the adults. These insects are found on man and domestic animals, but not on fowls. They feed by sucking blood. The common cootie, or body louse of man, transmits the dread typhus. The name **Anoplura** means unarmed, without a tail **(ura)**.

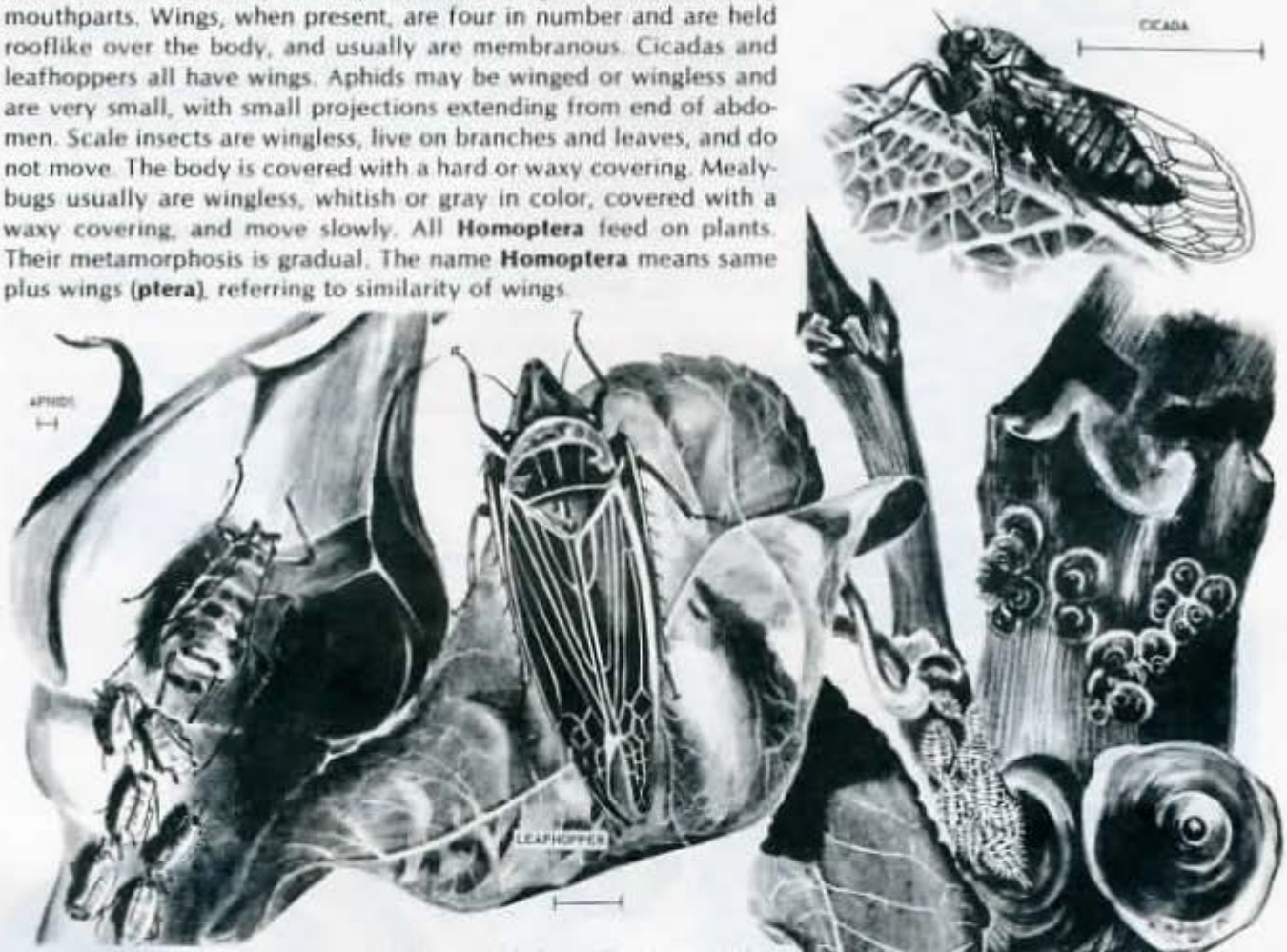
THYSANOPTERA (thrips) are mostly very small insects about 1/8 inch long, usually with two pair of slender wings with few veins but fringed with long hairs. The legs and antennae are short. The mouthparts are formed for piercing and sucking, and the immature stages resemble the adults. Some of these insects 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 mouthparts are for sucking and are prolonged into a beak. The insects are found in water, on plants and 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.

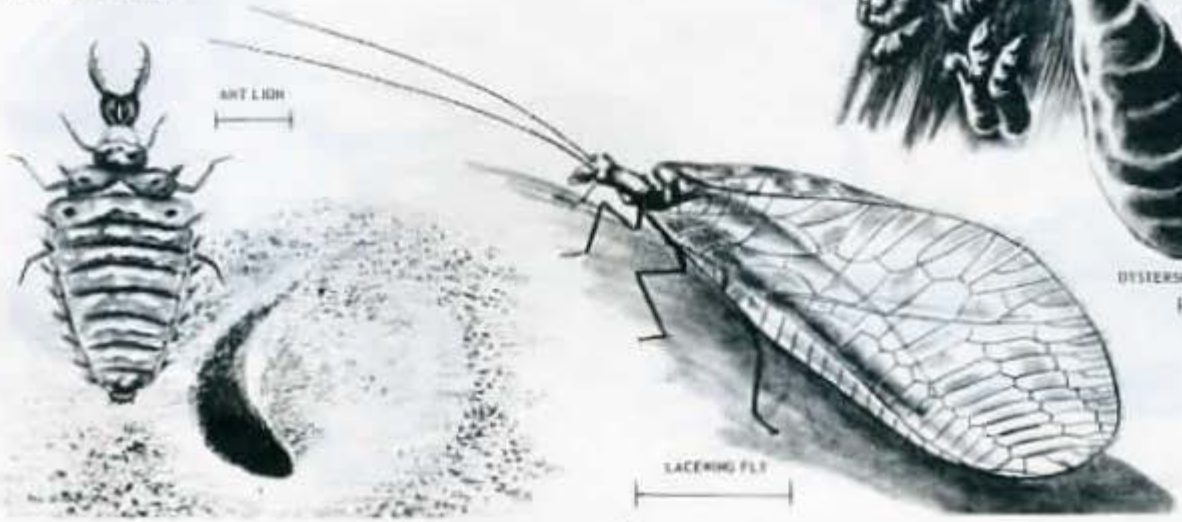




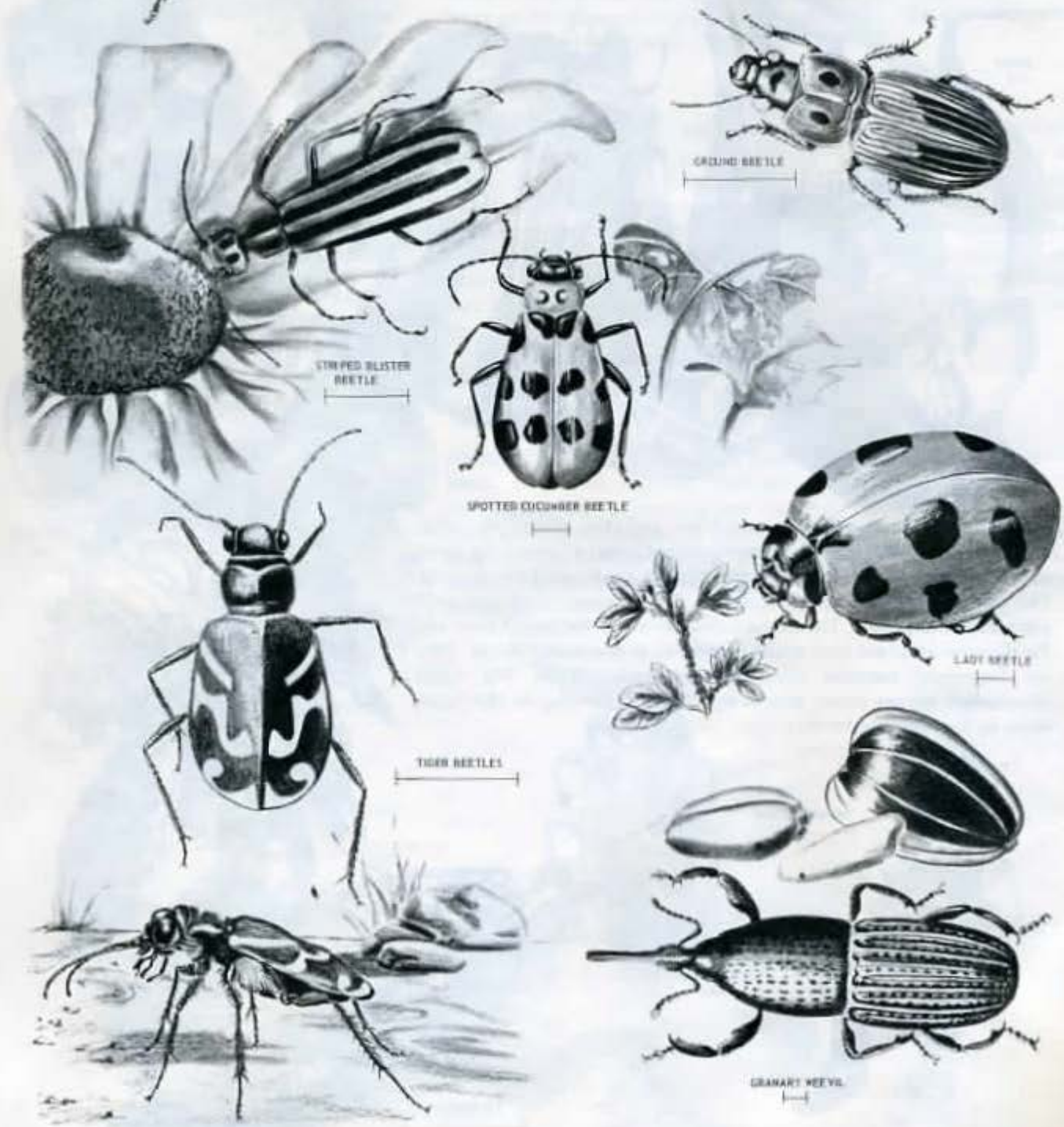
HOMOPTERA (aphids, leafhoppers, cicadas, whiteflies, mealybugs, and scale insects) may or may not have wings. All have sucking mouthparts. Wings, when present, are four in number and are held rooflike over the body, and usually are membranous. Cicadas and leafhoppers all have wings. Aphids may be winged or wingless and are very small, with small projections extending from end of 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 (lacewing flies, ant lions, and their allies) are rather fragile insects with two pair of many-veined wings of about the same size. The antennae are long. The mouthparts are formed for chewing. The immature stages are predaceous. These insects undergo complete metamorphosis. The commonest 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.

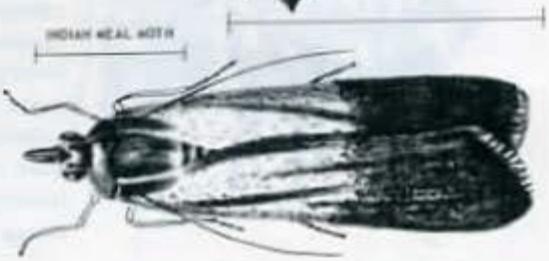


COLEOPTERA (beetles and weevils) usually are winged, with two pair of wings. The front pair are thick, forming a hard shell and meeting in a straight line down the middle of the back. The hindwings are membranous and are folded under the front wings when at rest. The mouthparts are formed for chewing. The immature stages are grublike or wormlike, 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 of our insect enemies. 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.



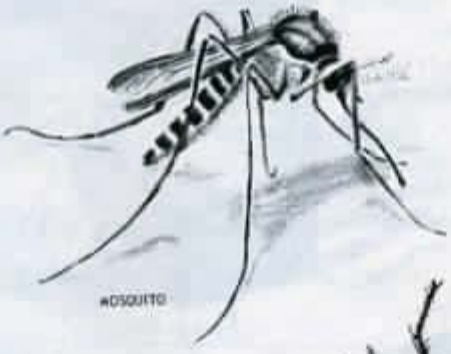
TRICHOPTERA (caddisflies) are soft-bodied insects with two pair of wings clothed with silky hairs and having a medium number of veins. The antennae are long. The mouthparts of the adults are vestigial. The immature stages are wormlike and live in water. Most of them build cases about their bodies. The adults are common among 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. The mouthparts of the adults are formed for sucking. The immature stages are wormlike. Some are known as caterpillars, cutworms, or hornworms. Their mouthparts are formed for chewing. 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, cabbageworm, and many other common forms. In the immature stages, most of the species feed on leaves of plants; others bore in plant stems, and some are leaf miners. The name **Lepidoptera** means scale plus wings (**ptera**).

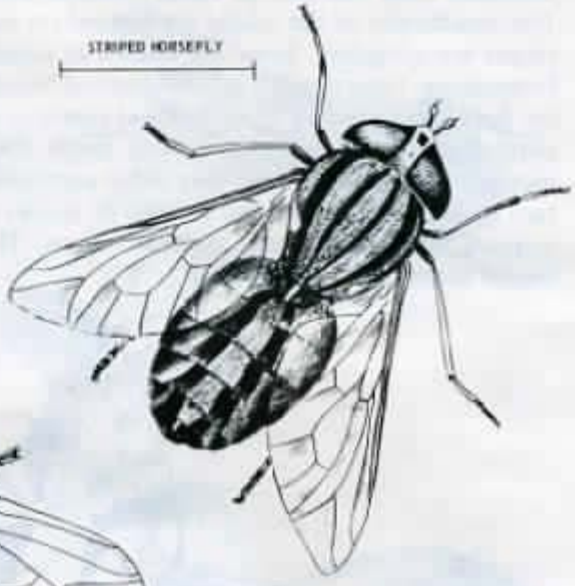


HOUSEFLY

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 mouthparts are formed for sucking or piercing and sucking. The immature stages are wormlike and usually are known as maggots; they are entirely unlike the adults. The order includes forms that are parasitic, others that are predaceous, and some that live on either living or dead plant material. Because many of the species carry diseases, this is one of the most important orders from the standpoint of human welfare. Other members of the order cause a great amount of damage to crops. The name **Diptera** means two plus wings **(ptera)**, referring to the single pair of wings.



MOSQUITO



STRIPED HORSEFLY

FLESHFLY

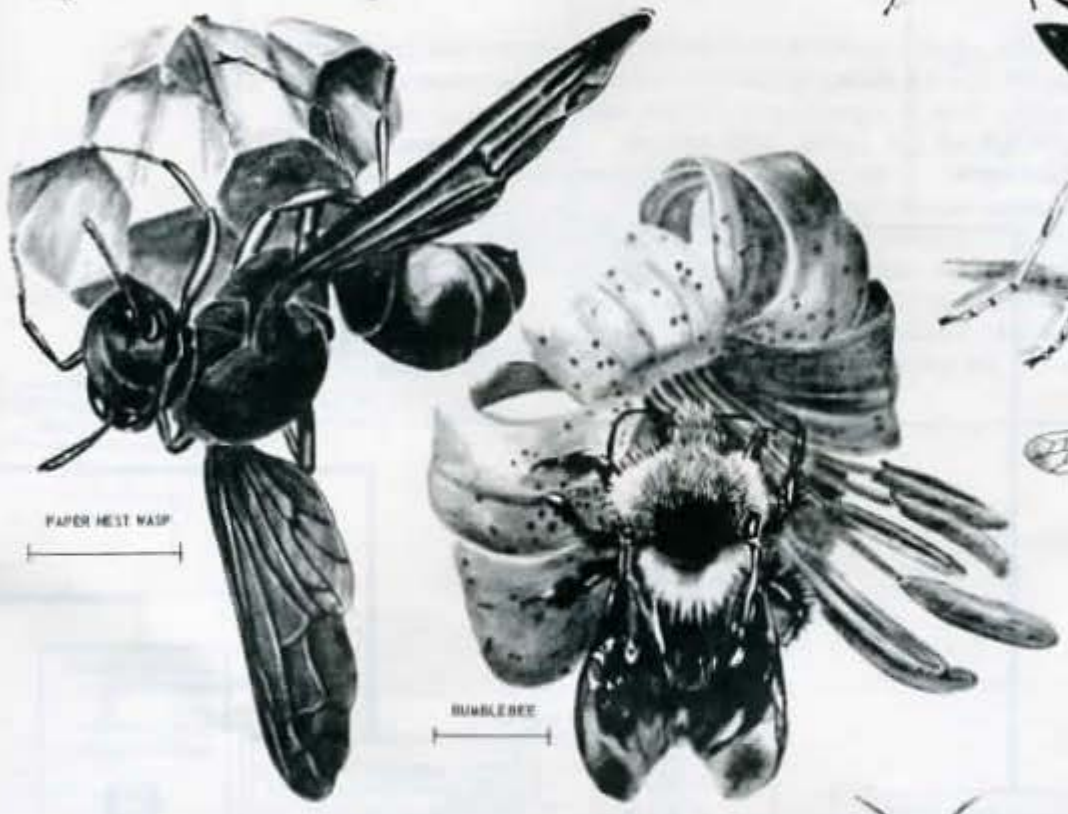
WESTERN HORSEFLY

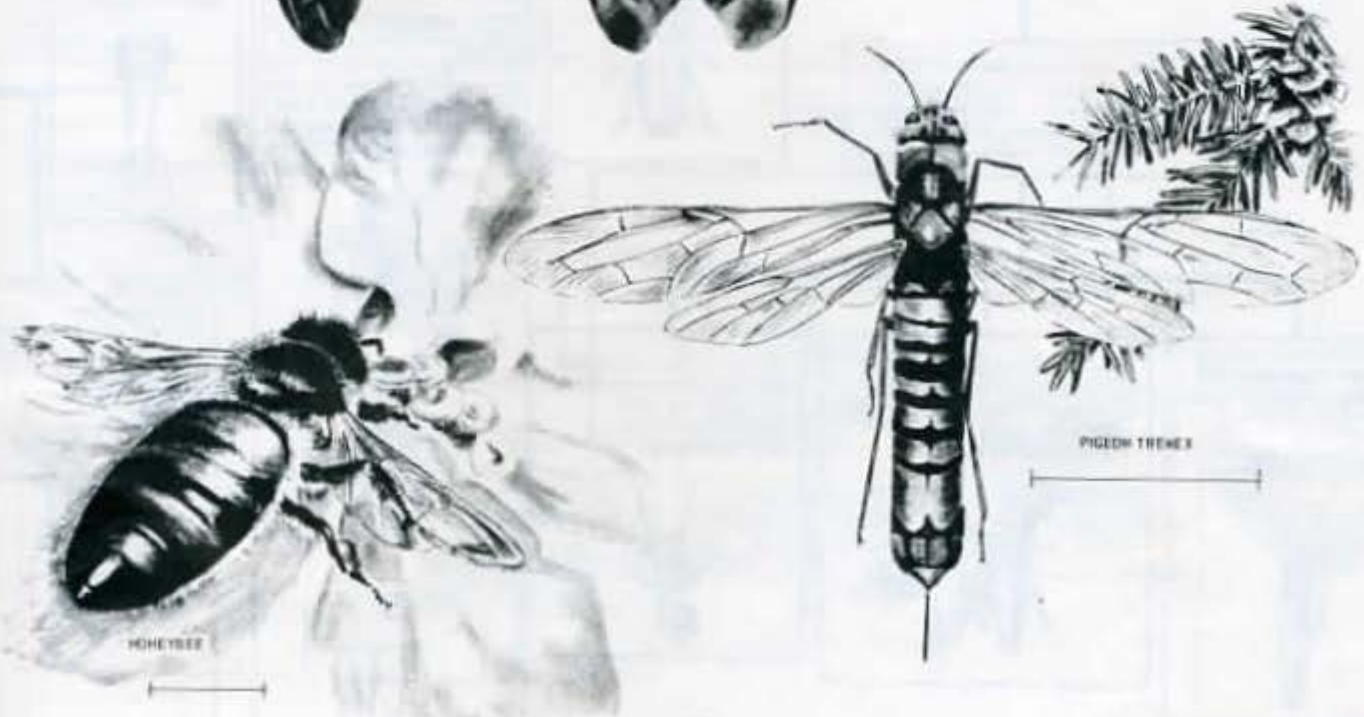
STABLEFLY

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 mouthparts are formed for piercing and sucking. The immature stages are wormlike, 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 man. One species transmits bubonic plague, an important disease in tropical countries. The name **Siphonaptera** means tube plus without wings **(aptera)**.

HYMENOPTERA (bees, wasps, ants, and their allies) are winged or wingless insects. The winged members have two pair of membranous wings with few veins. The mouthparts are formed for chewing or for chewing and lapping. The body usually is greatly constricted between abdomen and thorax. The immature stages are maggotlike or caterpillarlike 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.

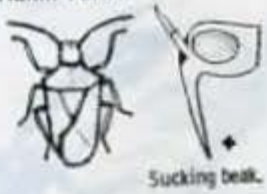




Wings present -- may be short, long, delicate or shell-like.

Four wings -- two wings may form hard shell or cover over body.

First pair wings overlap at tip--sucking beak. True Bugs. **HEMIPTERA**



Sucking beak.

Wings not overlapping at tip.

Only two wings. Flies. **DIPTERA**

Wings not covered with scales or hairs.

Wings not forming hard shells over body.

Wings form hard shell over body and meet in straight line on middle of back. Beetles. **COLEOPTERA**

Wings held over body like a roof. Sucking mouthparts. Beak appears to come from the rear of the head or close to front legs. Aphids, Leaf-hoppers, Cicadas, Scales, Mealy bugs. **HOMOPTERA**

Chewing mouthparts on end of beak. Scorpionflies. **MECOPTERA**

Wings with small scales or hairs. Hairs may be very small and seen only with aid of magnifying glass. Scales may appear as dust when touched with fingers.

No mouth parts--wings usually folded along the back--long antennae. Caddisflies. **TRICHOPTERA**

Very small insects--about 1/8" long--hairs confined to edges of wings--can be seen only under magnifying glass. Thrips. **THYSANOPTERA**

Mouth in form of coiled tube which may be pulled up under the head. Butterflies, Moths. **LEPIDOPTERA**

Forewings short, not reaching tip of abdomen--pincer-like forceps at tip of abdomen. Earwigs. **DERMAPTERA**

ADULT INSECT SPECIMENS
WINGED

HOW TO USE THIS KEY

This key is designed to help identify only adult insects so make certain you have an adult insect. A special key is required to identify immature insects (pages 44-48).

If the insect has wings---use this section of the key (pages 40-41). If the insect is without wings use the section on pages 42-43. Insect wings vary in their appearance from delicate membranes to hard-leathery shell-like structures. Starting at the top (left), follow the broken line to the crossroad (+). At each crossroad you must go either one of two or three ways. Always try to heavy line first. If the description fits your specimen. If the description fits your specimen and an order name is in the box, you have identified your specimen. If the description does not fit your specimen, then go back to the crossroad (+) and take the other road. This description should fit your specimen. Continue following the line to the next crossroad and repeat the procedure by again taking the heavy line to the order.

Wings not held over body like a roof.

+

Mouthparts not on end of beak.

+

Front wings thick and leathery; hindwings membraneous.

Forewings usually reach tip, or extend well past tip of abdomen. Legs for running and jumping. Grasshoppers, Roaches, Mantids, Katydids, crickets, Walking-sticks. **ORTHOPTERA**

Both pairs of wings thin--often transparent.

+

Wings with few veins and crossveins. Ants, Bees, Wasps. **HYMENOPTERA**

Wings with many veins and crossveins.

+

Four wings about equal in size with notch in front margin. Dragonflies, Damselflies. **ODONATA**

Wings not equal in size and without notch in front margin.

Hind pair of wings fold lengthwise--two short projections on tip of abdomen. Stoneflies. **PLECOPTERA**

No long thin projections on tip of abdomen. Lacewings. Antlions. **NEUROPTERA**

Long projections on tip of abdomen--hind pair of wings smaller than the front pair. Mayflies. **EPHEMEROPTERA**

Chewing mouthparts.

Body not covered with powder-like scales.

Body covered with powder-like scales. Usually have a pair of long hair-like projections on tip of body. Silverfish, Firebrats.
THYSANURA

Not flat but round insect. Size varies from small to large.

Small flattened insect with round front margin of head. Found as a parasite on birds and mammals. Chewing lice.
MALLOPHAGA

Abdomen wide at base.

Abdomen very narrow at base of waist. Ants, Bees, Wasps.
HYMENOPTERA

Small insect about 1/8" long, with a springing mechanism at tip of abdomen. Springtails.
COLLEMBOLA

Larger than 1/8", no springing mechanism.

Abdomen with 2 short projections at tip. Legs well suited for walking, running, or jumping. Grasshoppers, Roaches, Mantids, Katydids, Crickets, Walkingsticks.
ORTHOPTERA

Abdomen does not have projections at tip, usually whitish insects with brown heads. Termites. **ISOPTERA**

ADULT INSECT SPECIMENS
WINGLESS

No wings present in adult state

Mouthparts not chewing — may be piercing, sucking or siphoning.

Body flattened sideways (compressed). Legs are fitted for jumping. Small dark-colored insects. Fleas.
SIPHONAPTERA

Body not flattened sideways. Legs not fitted for running or jumping.

Mouthparts have a long beak.

Mouthparts not jointed May be fleshy or beak may appear absent

Antennae not hidden in pits but visible from above. Legs have one claw. Sucking lice. **ANOPLURA**

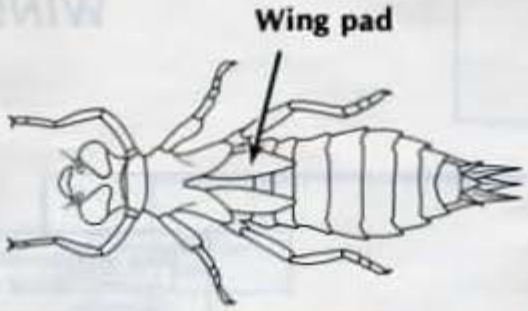
Antennae hidden in pits of head— not seen from above. Body looks like a tick. Flies. **DIPTERA**

Beak projects from the front part of head. True bugs. **HEMIPTERA**

Beak appears to come from the rear of head or close to front of legs. Aphids, Leafhoppers, Cicadas, Scales, Mealy bugs.
HOMOPTERA

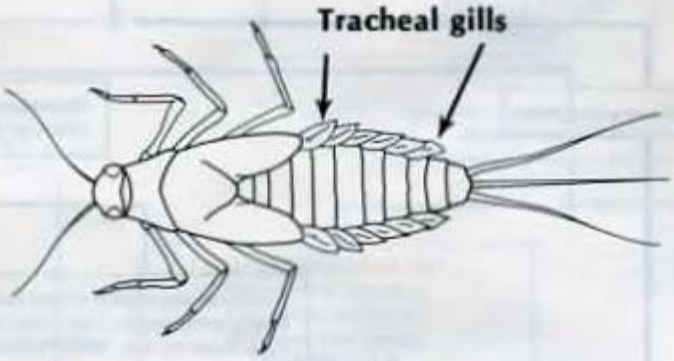
KEY TO IMMATURE INSECTS

1. A. Wing pads usually visible; compound eyes present 2



B. External wing pads absent; compound eyes absent 11

2. A. Tracheal gills present 3

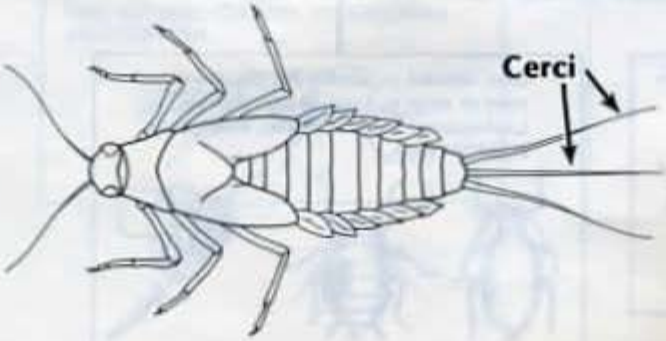


B. Tracheal gills absent 5

3. A. Gills on abdomen only 4

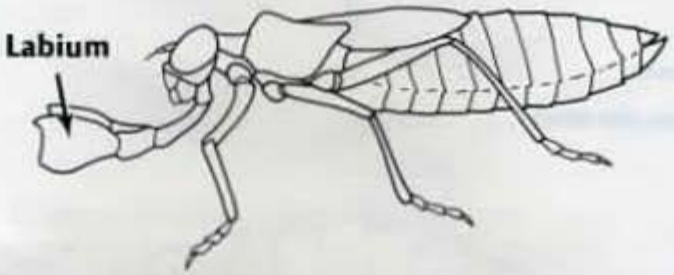
B. Gills found on thorax (sometimes on abdomen); 2 abdominal cerci ..... **PLECOPTERA** (Stoneflies)

4. A. Abdomen with 2 or 3 long cerci at caudal end of abdomen ..... **EPHEMEROPTERA** (Mayflies)



B. Abdomen without long cerci; living in cases constructed from stones or plant debris ..... **TRICHOPTERA**
(Caddisflies)

5. A. Labium when extended much longer than broad ..... **ODONATA**
(Dragonflies, Damselflies)

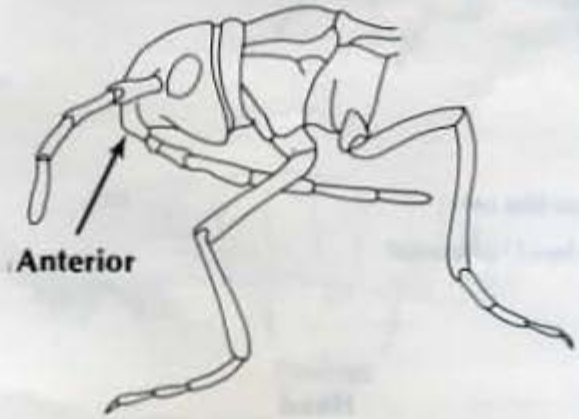


B. Labium of normal type (piercing-sucking or chewing type) 6

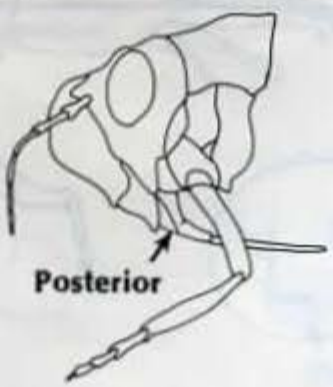
6. A. Mouthparts piercing-sucking 7

B. Mouthparts chewing 8

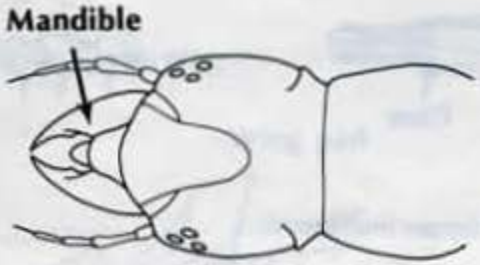
7. A. Mouthparts usually arising from the anterior portion of the head ..... **HEMIPTERA**
(True Bugs)



B. Mouthparts arising from the posterior portion of the head ..... **HOMOPTERA**
(Cicadas, Leafhoppers, Planthoppers, Treehoppers, Aphids, Scales)

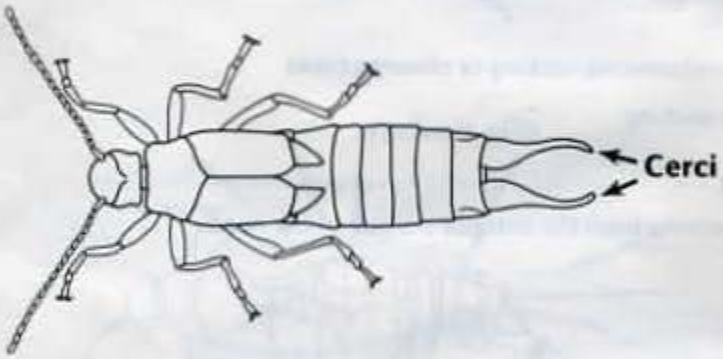


8. A. Mandibles and maxillae long and sickle-shaped; modified for sucking ..... **NEUROPTERA**
(Lacewings, Ant Lions, Dobsonflies)



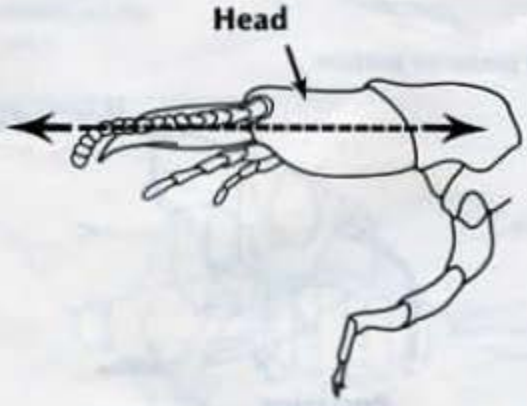
B. Mandibles not as above 9

9. A. Abdomen with forceps-like cerci ..... **DERMAPTERA**
(Earwigs)

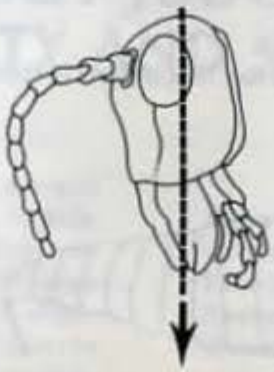


B. Abdomen without forceps-like cerci 10

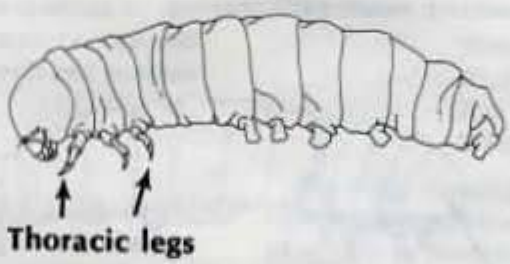
10. A. Body white; long axis of head horizontal ..... **ISOPTERA**
(Termites)



B. Body variously colored; long axis of head vertical ..... **ORTHOPTERA**
(Cockroaches, Crickets, Katydids, Grasshoppers, Mantids)

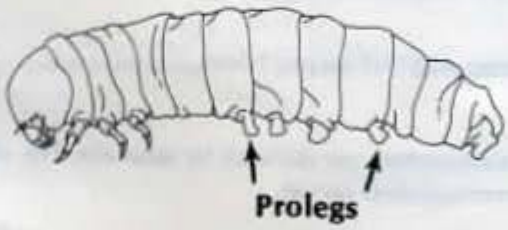


11. A. Thoracic legs present 12



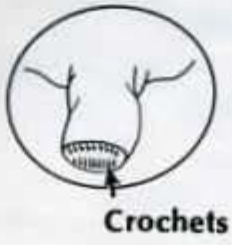
B. Thoracic legs absent 14

12. A. Abdominal prolegs present 13



B. Abdominal prolegs absent 15

13. A. Crochets (hooks) present on abdominal prolegs ..... **LEPIDOPTERA**
(Butterflies and Moths)



B. Crochets absent on prolegs ..... **HYMENOPTERA**
(Ants, Bees, Wasps)

14. A. Head capsule not sclerotized, difficult to see; mouthparts in form of hooks ..... **DIPTERA**
(Flies)

Hook

B. Head capsule distinctly sclerotized; mouth-parts chewing 15

Head capsule

15. A. Spiracles present on prothorax and mesothorax ..... **HYMENOPTERA**
(Sawflies)

B. Spiracles present on mesothorax, ABSENT on prothorax ..... **COLEOPTERA**
(Beetles)

Note: Larvae of Coleoptera and Hymenoptera are difficult to separate. The above couplet will distinguish only a few coleopterous and hymenopterous larvae.

CHAPTER VIII

ENTOMOLOGY JUDGING GUIDE FOR COUNTY AND STATE FAIRS

Usually, the entomology collections are grouped together according to project unit at the fair. In judging these displays, judges should be generous with younger age groups and apply somewhat higher standards to older, more experienced exhibitors. The objectives are to encourage beginning 4-H entomologists to remain in the project and to encourage older youth to strive harder for excellence in their insect studies.

Step One: Review Requirements

The first thing the judge should do is check to see that basic exhibit requirements were met, i.e. size and number of boxes, total number of insects and number of insect orders represented.

Step Two: First Impression

The judge may then go through each group of exhibits and give each a tentative rating based on overall neatness and attractiveness. Each display should then be examined in detail. Check for the fine points such as proper pinning, labeling and spelling, correct identification of specimens and proper spreading of butterflies and moths.

Step Three: Assign Points

With a total of 100 possible points, collections may be scored as follows:

	Possible Points
Basic Requirements	20
Correct Identification	30
Labeling	15
Pinning	15
Overall Neatness	20
	100

Step Four: Determine Final Placing and Assign Ribbon

Collections can then be graded on the following basis:

Purple - 94 - 100 points
Blue - 85 - 93 points
Red - 75 - 84 points
White - 74 - points

The judge should be available for a prescribed time interval for individual critiques or to answer questions of 4-H'ers or parents. If this cannot be done, written comments should be attached to each display. The following Help Sheet is provided to serve as a convenient way for judges to provide comments for 4-H entomology exhibitors. Such communication is very important because youth need to know where they made mistakes if they are to improve.

4-H Entomology Collection Help Sheet

This sheet of helpful hints is provided by the entomology judges to assist you with improving your collection. These comments reflect the guidelines set in the 4-H Entomology Manual as well as accepted collection management procedures followed in museum research collections. You will probably do much better at the next fair if you follow the suggestions listed below. Good luck!

1.	Minimum number of orders (Class Insecta only)	O.K.	Not enough
2.	Minimum number of specimens (Class Insecta only)	O.K.	Not enough
3.	Mounting:		
	a. location of pin	O.K.	Needs improvement
	b. height of specimen on pin	O.K.	Needs improvement
	c. wings of Lepidoptera		
	I. front wings	O.K.	Move forward
	II. hindwings	O.K.	Move forward
	III. wings should be flat, not angled	O.K.	Do
	d. paper mounting points		
	I. size	O.K.	Make smaller
	II. specimen glued on right side	O.K.	Reverse
4.	Labels:		
	a. labels facing proper direction	O.K.	Reverse
	b. location, date, collector's name on top label; order name on bottom label	O.K.	Change accordingly
	c. labels properly spaced on pin	O.K.	Adjust
	d. order labels present & correctly spelled	O.K.	Needs improvement
5.	Specimens correctly identified	O.K.	Incorrect
6.	Neatness of collection:		
	a. proper alignment of rows & columns	O.K.	Needs improvement
	b. consistent orientation of specimens and labels	O.K.	Needs improvement
	c. neatness of lettering	O.K.	Needs improvement
	d. condition of specimens	O.K.	Needs improvement
	e. size of display box	O.K.	Incorrect; see manual
7.	Additional comments and/or clarification		

CHAPTER IX

USEFUL REFERENCES

Following is a list of references by topic. For example, if you want to locate a book on beekeeping, refer to the numbered reference under the topic, then refer to the listing of books which follow. Show the listing to your local librarian or bookseller if you want to obtain the book. Some can be obtained from other libraries through inter-library loan programs.

Topic	Reference Numbers
General Entomology	1, 2, 3, 6, 7, 13, 16, 18, 23, 29, 31, 37, 46, 47, 48, 49, 53, 67, 68, 69, 71, 74
Identification and Classification	2, 3, 5, 7, 15, 16, 28, 30, 34, 35, 39, 41, 42, 44, 48, 49, 50, 63, 64, 68, 69, 74
Insect Biology	4, 7, 9, 10, 11, 12, 16, 17, 20, 21, 23, 24, 25, 26, 27, 32, 37, 52, 54, 55, 58, 59, 61, 62, 63, 65, 66, 70, 72, 73
Pests	1, 19, 38, 49, 57, 69
Beekeeping	8, 14, 20, 21, 22, 36, 45, 51, 56, 60
Insect Relatives	2, 39, 42, 44, 63
Insects and Diseases	33, 43, 75
Aquatic Insects	52

1. Anonymous. Insects - Yearbook of Agriculture. USDA, U.S. Government Publishing Office, 1952, 700 pp.
2. Borrer, D. J., D. M. DeLong and C.A. Triplehorn. An Introduction to the Study of Insects. 4th ed., New York: Holt, Rinehart and Winston, 1976, 852 pp.
3. Borrer, D.J. and R.E. White. A Field Guide to the Insects of America North of Mexico. Boston: Houghton Mifflin Co., 1970, 404 pp.
4. Buddenbrock, W. von. The Senses. University of Michigan Press, 1958, 177 pp.
5. Chu, H.F. How to Know the Immature Insects. W.C. Brown Co., Dubuque, Iowa 52003, 1949, 234 pp.
6. Clausen, Luch W. Insect Fact and Folklore, 1961.
7. Comstock, J.H. "An Introduction to Entomology." Comstock Publication, Ithaca, New York, 1940, 1064 pp.
8. Dadant and Sons. The Hive and the Honey Bee. 4th ed., Hamilton, Illinois: Dadant and Sons, Inc., 1975, 740 pp.
9. Davey, K.G. Reproduction in Insects. 1965, 96 pp.
10. Dethier, V. G. To Know A Fly. 1962.
11. Dethier, V. G. The Ant Heap, Darwin Press, Princeton, NJ 1979. 151 pp.
12. Dethier, V. G. The World of the Tent-Makers, Univ. Mass. Press, 1980, 148 pp.
13. Eddy, P.F. Insects in English Poetry. Scientific Monthly, 33:53-77, 1931, pp. 148-163.
14. Editors, Gleanings in Bee Culture. Starting Right With Bees. Medina, Ohio: A.I. Root Co., 1973, 96 pp.
15. Ehrlich, P.R. and A.H. Ehrlich. How to Know the Butterflies. W.C. Brown Co., Dubuque, Iowa 52003, 1961, 262 pp.
16. Elzinga, R. J. Fundamentals of Entomology. 2nd ed. Prentice-Hall, 1978, 422 pp.

17. Evans, H.E. Wasp Farm. Garden City, New York: Anchor Press/Doubleday and Co., Inc., 1973, 188 pp.

18. Farb, P. The Insects. New York: Time Incorporated, 1962, 191 pp.

19. Fichter, G.S. and H.S. Zim. Insect Pests. New York: Golden Press, 1966, 160 pp.

20. Frisch, Karl von. Bees: Their Vision, Chemical Senses and Language. 2nd ed., Cornell University Press, Ithaca, New York: 1971, 157 pp.

21. Frisch, Karl von. The Dancing Bees: An Account of the Life and Senses of the Honeybee, 1966, 183 pp.

22. Frisch, Karl von. Ten Little Housemates, 1960.

23. Frost, S.W. Insect Life and Insect Natural History. Dover Publications, Inc., New York: 1959, 526 pp.

24. Goetsch, Wilhelm. Ants. 1957.

25. Haskell, P.T. Insect Behavior. 1966, 113 pp.

26. Haskell, P. Insect Sounds. 1961, 189 pp.

27. Haskins, Caryl P. Ants and Men. 1945.

28. Helfer, J.R. How to Know the Grasshoppers, Cockroaches and Their Allies. W.C. Brown Co., Dubuque, Iowa 52003, 1953, 535 pp.

29. Hocking, Brian. Six-Legged Science. Cambridge, Mass: Schenkman Publishing Co., Inc., 1971, 199 pp.

30. Holland, W.J. The Moth Book. Dover Publications, Inc. New York: 1968, 479 pp.

31. Holt, V.M. Why Not Eat Insects? (Reprint of 1885 book) 1967, 99 pp.

32. Horn, D.J. Biology of Insects. W.B. Saunders Co., Philadelphia-London-Toronto: 1976, 439 pp.

33. James, M.T. and R.F. Harwood. Medical Entomology. 6th ed., The MacMillan Co., Collier-MacMillan Ltd., London, Eng., 1969, 484 pp.

34. Jacques, H.E. How to Know the Beetles. W.C. Brown Co., Dubuque, Iowa 52003 1951, 372 pp.

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36. Jaycox, E.R. Beekeeping in the Midwest. Circular 1125, University of Illinois at Urbana-Champaign, College of Agriculture, Cooperative Extension Service, 1976.

37. Johnsgard, P.A. Animal Behavior. W.C. Brown Co., Dubuque, Iowa 52003, 1967, 156 pp.

38. Johnson, W.T. And H.D. Lyon. Insects That Feed on Trees and Shrubs. Comstock Publishing Association, Ithaca, N.Y., 1976, 464 pp.

39. Kaston, B.J. How to Know the Spiders. W.C. Brown Co., Dubuque, Iowa 52003, 1953, 220 pp.

40. Klots, A.B. and E.B. Klots. 1001 Answers to Questions About Insects. Grosset and Dunlap, New York, N.Y.: 1961, 260 pp.

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42. Krantz, G.W. A Manual of Acarology. Oregon State University Book Stores, Inc., Corvallis, Oregon, 1970, 335 pp.

43. Leach, J.G. Insect Transmission of Plant Diseases. McGraw-Hill Co., New York, N.Y. and London, England: 1940, 615 pp.

44. Levi, H.W., L.L. Levi and H.S. Zim. A Guide to Spiders and Their Kin. Golden Press, New York: 1968, 160 pp.

45. Lindauer, M. Communication Among Social Bees. 1971, 173 pp.

46. Linsenmaier, W. Insects of the World. New York: McGraw-Hill, 1972, 392 pp.

47. Marquis, Don. The Lives and Times of Archie and Mehitabel. Doubleday, 1935.

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49. Metcalf, C.L., W.P. Flint and R.L. Metcalf. "Destructive and Useful Insects." New York: McGraw-Hill, 1962, 1087 pp.

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51. Morse, R.A. The Complete Guide to Beekeeping. 2nd ed., New York: E.P. Dutton and Co., 1974, 219 pp.

52. Needham, J.G. and P.R. Needham. A Guide to the Study of Fresh-Water Biology. Holdren-Day, Inc., San Francisco: 1962, 108 pp.

53. Oman, P.W. and A.D. Cushman. Collection and Preservation of Insects. USDA Miscellaneous publication #601, U.S. Government Printing Office, 1946, 42 pp.

54. Ordish, G. The Year of the Butterfly, 1975.

55. Ordish, G. The Year of the Ant, 1978. Brown Publishing, 139 pp.

56. Pellet, F.C. American Honey Plants. Hamilton, Illinois: Dadant and Sons, Inc., 1976 (reprint of 1947 edition), 467 pp.

57. Pfadt, R.E. Fundamentals of Applied Entomology. New York, N.Y.: MacMillan Publishing Co., Inc., 1971, 693 pp.

58. Portmann, A. Animal Camouflage. 1959. 111 pp.

59. Pringle, J.W.S. Insect Flight. 1957, 133 pp.

60. Root, A.I., E.R. Root, H.H. Root and J.A. Root. The ABC and XYZ of Bee Culture. Medina, Ohio: A.I. Root Co., 36th ed., 1975, 726 pp.

61. Sammis, K. The Beginning Knowledge Book of Butterflies. New York, N.Y.: MacMillan Co., 1965, 28 pp.

62. Sargent, T. D. Legions of Night: The Underwing Moths, Univ. Mass. Press, 1976. 224 pp.

63. Savory, T.H. Introduction to Arachnology. 1974.

64. Savory, T.H. Naming the Living World: Introduction to Principles of Nomenclature. 1969.

65. Savory, T.H. Spiders, Men and Scorpions. 1961.

66. Savory, T.H. The Spiders Web. 1952.

67. Skaife, S.H. Dwellers in Darkness. 1956, 134 pp.

68. Smith, R.C., E.G. Kelly, G.A. Dean, H.R. Bryson and R.L. Parker. Insects in Kansas. Distribution Center, Umberger Hall, Kansas State University, Manhattan, Kansas 66502, 1943 ed. revised by Gates, D.E. and L.L. Peters, 1962.

69. Stein, J.D. and P.C. Kennedy. Key to Shelterbelt Insects in the Northern Great Plains. USDA Forest Service Research Paper RM-85. Superintendent of Documents, U.S. Gov't. Printing Office, Washington, D.C. 20402, 1972, 153 pp.

70. Stephenson, E.M. and C. Stewart. Animal Camouflage, 1946, 195 pp.

71. Taylor, Ronald L. Butterflies in My Stomach.

72. Wickler, W. Mimicry in Plants and Animals. London, WI: Weidenfeld and Nicolson, 5 Winsley Street, 1968, 255 pp.

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74. Zim, H.S. and C. Cottam. Insects. New York, N.Y.: Golden Press, 1951, 384 pp.

75. Zinsser, H. Rats, Lice and History. New York, N.Y.: Bantam Books, 1935, 228 pp.

CHAPTER X

SOURCES OF ENTOMOLOGICAL EQUIPMENT AND SUPPLIES

Survival Security Corp.
Entomological Research Inst.
4000 - 6th Avenue
Lake City, MN 55041

Fisher Scientific Co.
Educational Materials Division
4901 N. LeMoyne Ave.
Chicago, IL 60651
- must be over 18 years old
- minimum order of $15.00

Ward's Natural Science Establishment, Inc.
P.O. Box 1712
Rochester, NY 14603
- minimum order of $15.00

Aztec Biological
311 Bernadette Dr.
Columbia, MO 65201
(314) 445-7610
- minimum order of $15.00

BioQuip Products
17803 LaSalle Avenue
Gardena, CA 90248
(213) 324-0620
- minimum order of $15.00

Lane Science Equipment Co.
105 Chambers St.
New York, NY 10007

Carolina Biological Supply Co.
Main Office & Laboratories
Burlington, NC 27215
- minimum order of $15.00

Ward's Natural Science
Establishment, Inc.
P.O. Box 1749
Monterey, CA 93940
- minimum order of $15.00

Nebraska State 4-H Office
114 Ag Hall
University of Nebraska
Lincoln, NE 68583-0700
(402) 472-2805
- No. 3 insect pins
- Labels: sheet, 4-H F 8
card, F 16-06, 78

If you have questions about collecting, identifying or studying insects or want information on careers in entomology, write or call:

Department of Entomology
Extension Entomologist
202 Plant Industry Building
University of Nebraska
Lincoln, NE 68583-0816
(402) 472-2125 or 472-2123

CHAPTER XI

CAREERS IN ENTOMOLOGY

Entomologists will always be needed to study insects. New insect problems seem to arise each year and the old ones appear to be changing constantly. The image of the entomologist who wears a pith helmet and chases butterflies across the landscape has changed. Today's entomologist is often seen in the laboratory working with complex mechanical and chemical apparatus and using the latest computerized techniques to analyze results. However, there is much field work to be done as well.

The research entomologist may choose a basic area of interest in entomology from the following: insect control (biological or chemical), insect biology (study of life cycles), insect physiology (how insects function), toxicology (how insecticides work), insect ecology (how insects relate and respond to their environment), taxonomy (the identification and classification of insects) and morphology (study of insect structure).

Some entomologists teach courses in entomology to students entering other career areas. Students majoring in agronomy, agricultural engineering, agricultural economics, agricultural education, animal science, plant pathology and zoology would all benefit from a course in entomology, as would many others. Many teaching entomologists are employed by small colleges as well as large universities. Almost everyone, but especially someone who intends to farm should know something about insects, because such knowledge is very practical. A farmer, for instance can save thousands of dollars by knowing about insects.

Extension entomologists do what their title implies - they extend information about insects from universities to the general public. The information is developed by research entomologists and is modified or adapted by the extension entomologist, who then releases it to extension agents, farmers, ranchers or anyone who requests it. The extension entomologist educates others by preparing bulletins and circulars, through public meetings, writing articles for magazines and newspapers, and by appearing on radio and television. The extension entomologist and the extension agent work as a team to keep farmers, ranchers and homeowners informed of insect problems and what to do about them.

An increasing number of entomologists are self-employed as private consultants for farmers and ranchers. These people organize and conduct field scouting programs to detect field crop pests and give control advice to farmers when pests are threatening.

Other entomologists work for commercial companies as fieldmen, in research, or in chemical sales. Many entomologists have accepted foreign assignments on cooperative projects. Other entomologists become beekeepers (apiculturists) and some enter the field of pest control.

If you would like more information about entomology as a career, write to the Entomological Society of America, 9301 Annapolis Rd., College Park, MD 20706.

CHAPTER XII

IDEAS FOR 4-H ENTOMOLOGY PROJECTS

As a 4-H entomologist, you have a broad choice of topics from which to choose. The first three suggestions (Units 1-3) are basic projects for beginners; each involves collecting, pinning and mounting insects and developing a display collection for exhibit at county or state fairs. These three projects provide the general background, basic principles and experience for youth who wish to continue their entomological studies in more advanced study units. Advanced entomology projects may also result in county and state fair displays.

All insects need not have been collected by you. Mom, Dad, brothers and sisters can help. However, most of the specimens should have been collected and mounted by the exhibitor. In any case, the label should have the name of the **person who actually collected the specimen and the location where it was found.** Purchased or traded insects cannot count toward meeting the basic requirements given in county or state fair premium books.

Advanced 4-H entomology projects

These projects are intended for young people who are especially enthusiastic about insect study. They offer a wide range of activities and individual choices for study topics. Any 4-H'er who takes one or more of these advanced projects should be or have previously been enrolled in Units 1, 2, or 3. However, if one or more of Units 1-3 have been completed, the 4-H entomologist can take any one or more of the advanced projects. These units should be taken only once, if a fair exhibit has been shown.

Advanced projects should result in a fair display, but you have the freedom to follow individual tastes in developing it. Use your imagination. Display ideas

might include the following:

1. A display of a particular group of insects in which you are especially interested.
2. An exhibit of insect homes.
3. A collection of immature insects.
4. A poster about insects - you may want to include some insect photography or other artwork.
5. A display box of insects found in corn fields.
6. A display of useful products made by insects (e.g. honey and wax, etc.)

Don't limit yourself to these suggestions - use your imagination! Use some artwork, woodwork or photography. Remember, these advanced projects are to allow you to spread your entomological wings.

In choosing which unit(s) you will take, be certain not to over-extend yourself. Try not to take more than two projects at once, or you may not have time to get much out of any one. Allow time for reading, thinking, and recording your observations. Consult your 4-H leader before you decide to take on too much responsibility. Remember, your objective is to have fun while learning. Before you begin, write out what you expect to learn from the project — a list of personal objectives. Consult the list of references in Chapter IX and then go to work!

Notice that we have included a guide for county and state fair judges in this manual. Be sure to review these as you prepare your displays for exhibit. It will help you to know how the judges are likely to think.

Following is a list of suggested projects. Others may be available too. Consult your local extension office for the latest listing of entomology projects.

Basic Projects

Here are some basic projects. These may be entered in the State Fair.

- **1st year collection: 25 or more different kinds (species) of insects representing at least six orders. Limit to one box.**
- **2nd year collection: at least 50 kinds (species) of insects representing at least eight orders. Limit to two boxes.**
- **3rd year collection: at least 75 kinds (species) of insects representing at least 10 orders. Limit to three boxes.**

Special Interest Projects

Here are some ideas for special projects. If these were entered at the State Fair, they would be Class IV entries. These projects are for those members who yearn to "plunge in" and explore a particular area of entomology. These projects are especially good for members who have become weary of the usual collections or who lack the technical skills to compete in other classes. The emphasis here is on accuracy, educational value, originality and creativity. These ideas are just starters. Give imagination and creativity free reign and have fun!

1. Collect and identify a special group of insects or arthropods such as aquatic insects, spiders, beneficial insects, etc.

2. Keep a journal of the *succession* of insects that occur on a given host. For example, collect the insects found on roses or cabbage. This type of insect collection can be done easily while doing a gardening project for Horticulture.

3. Make a display of *damage* done by insects. Collect leaves, stems, fruits, etc. damaged by insects. Collect damaged plant parts while making a leaf or twig display for Forestry — twice the fun, half the work.

4. Make a *poster* display explaining some aspect of insect biology. Why not, for example, make a poster explaining the role of an arthropod, such as a tick or bark beetle, in the transmission of an animal or plant disease.

5. Combine artistic talent with interest in entomology. Submit paintings, drawings or sculptures of insects.

Demonstrations - Some Examples

Entomology projects provide many interesting and valuable topics for demonstrations that you can give at county and state fairs, your school, extension club meetings or to other 4-H clubs. Share your knowledge with others! A few suggested topics for demonstrations are:

- What is an insect?
- The importance of honeybees.
- Controlling cattle grubs.
- Controlling cattle lice.
- How to make collecting equipment.
- How to mount, pin and display insect collections.
- How insects grow.
- Rearing insects in a jar.
- Scouting fields for pests.
- Our friends, the insects.

You can prepare these and many other demonstrations from materials in this manual, references in public libraries and bookstores, and information available from your extension agent.

Youth 4-H Record Book

To complete your 4-H project, it is important to exhibit at the county fair and also to complete your project record sheets. As a part of your report, you will be asked to complete a project story and to list your activities.

Your project story might include: 1) how you became interested in insects; 2) a list of things you learned in your project; 3) accomplishments; 4) results, such as exhibits, ribbons, demonstrations, scrapbooks, etc.; 5) what you like most about the project; 6) your service activities for the year, including helping your extension agent, parents or community; 7) pictures; and 8) ideas for careers related to entomology.

COLLEMBOLA Springtails	**PSOCOPTERA** Bark Lice Book Lice	**STREPSIPTERA** Twisted-wing Parasites
THYSANURA Silverfish	**PLECOPTERA** Stoneflies	**TRICHOPTERA** Caddisflies
EPHEMEROPTERA Mayflies	**MALLOPHAGA** Biting Lice	**SIPHONAPTERA** Fleas
ODONATA Damselflies Dragonflies	**ANOPLURA** Sucking Lice	**MECOPTERA** Scorpionflies

ORTHOPTERA
Grasshoppers
Roaches Crickets

HEMIPTERA
True Bugs

NEUROPTERA
Lacewings

DERMAPTERA
Earwigs

HOMOPTERA
Aphids
Leafhoppers

DIPTERA
Flies

ISOPTERA
Termites

THYSANOPTERA
Thrips

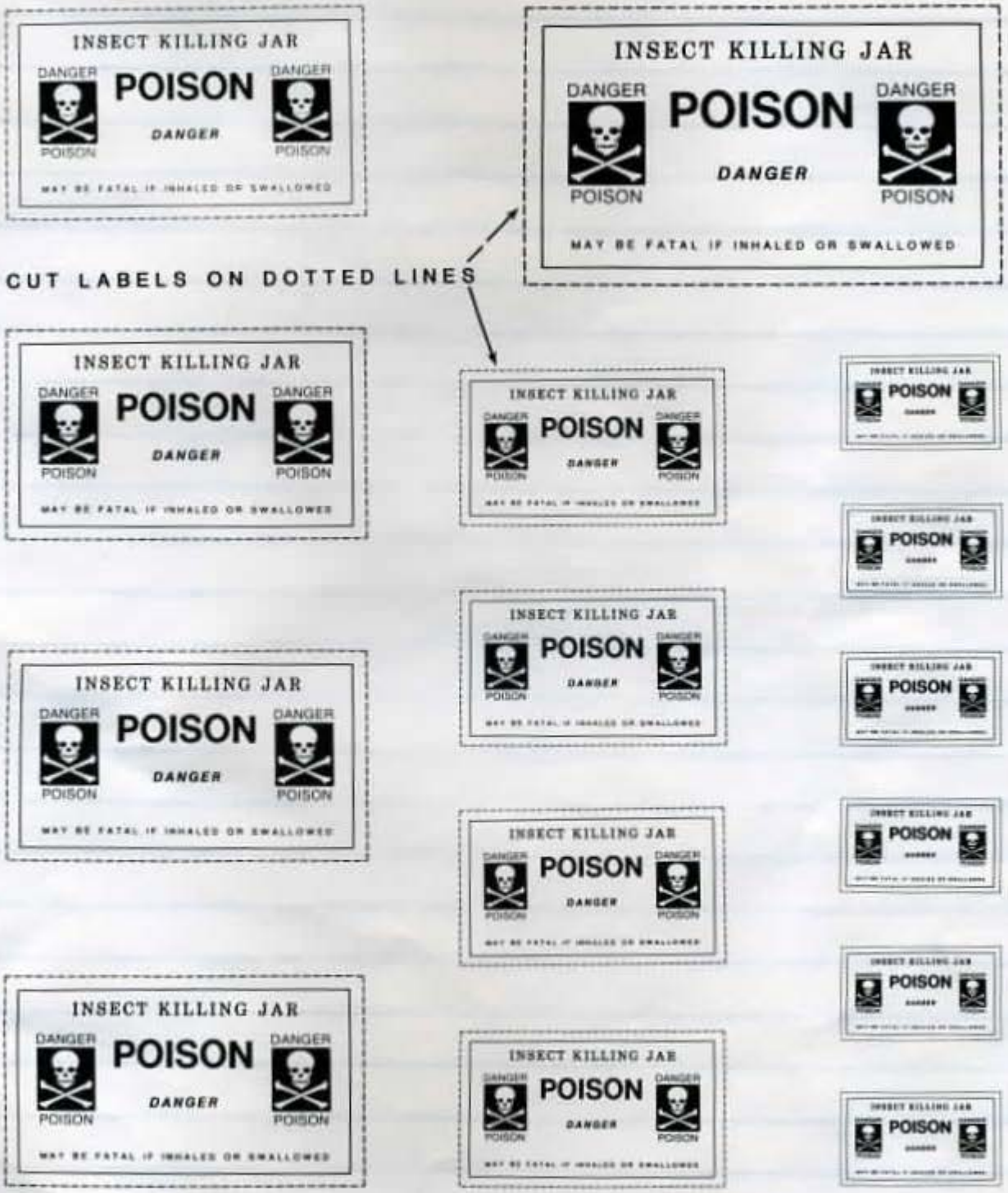
LEPIDOPTERA
Butterflies Moths

COLEOPTERA
Beetles

HYMENOPTERA
Sawflies Ants
Bees Wasps

ARACHNIDA	CHILOPODA	CRUSTACEA
DIPLOPODA	INSECTA	

POISON LABELS FOR KILLING JARS



CUT LABELS ON DOTTED LINES

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