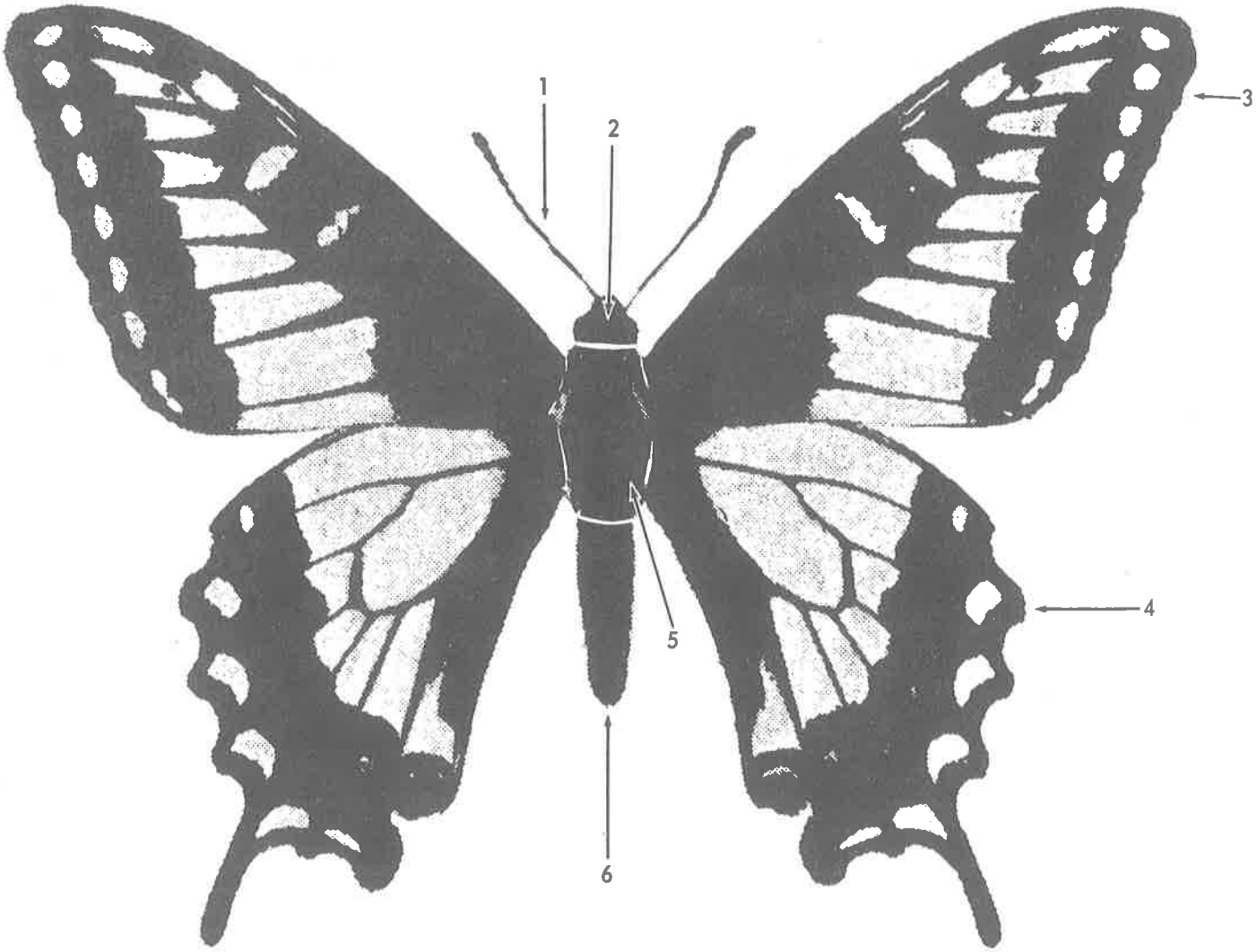
Order *Lepidoptera*

Meaning of order name Scale wings

Type of mouthparts Siphoning



6 abdomen	2 head
1 antennae	4 hindwing
3 forewing	5 thorax

4-H ENTOMOLOGY WORKSHEET - 1

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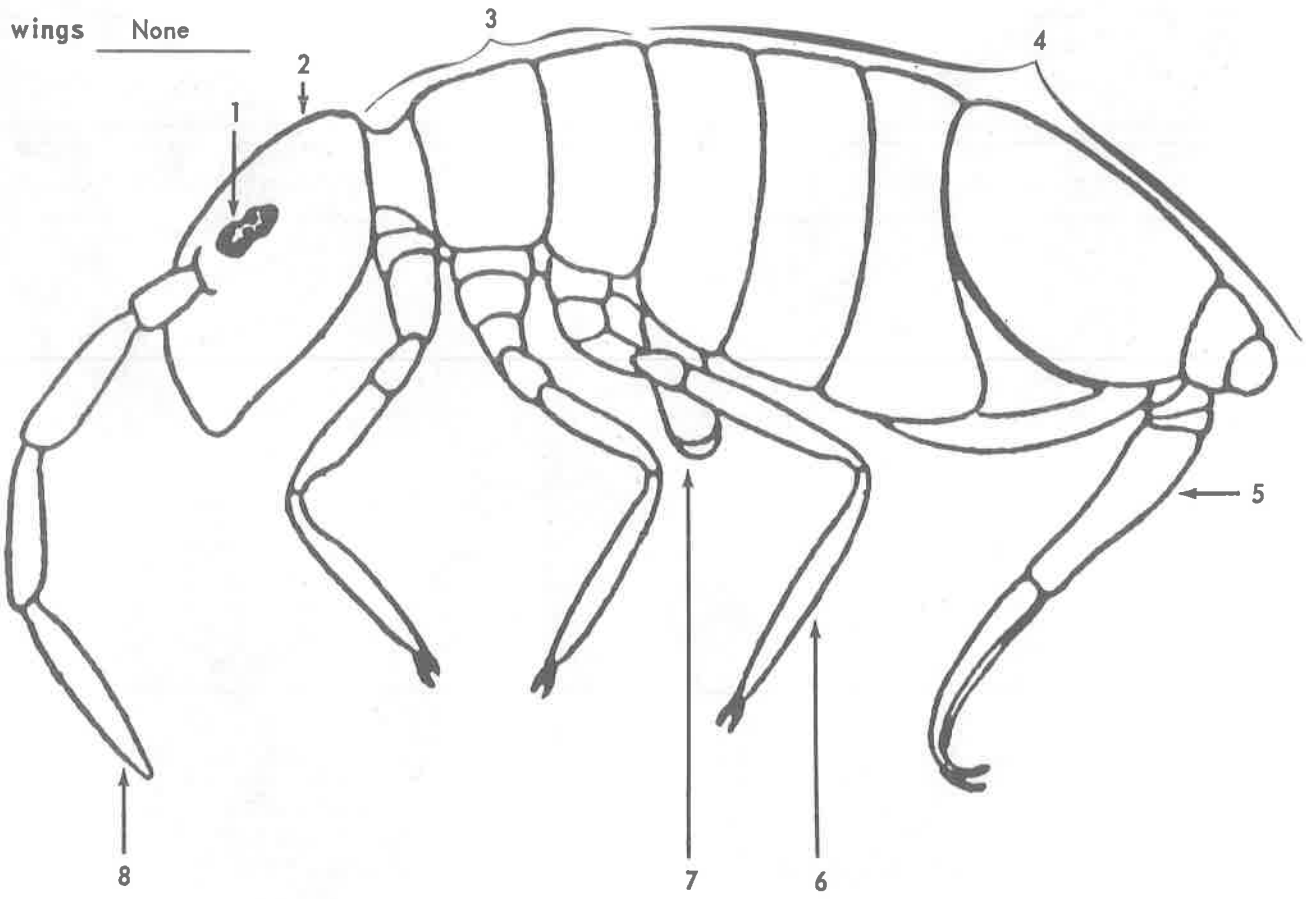
Order *Collembola*

Meaning of order name Glue peg

Type of mouthparts Chewing

Number of wings None



4 abdomen
8 antenna
1 eye
5 furcula
2 head
6 leg
3 thorax
7 ventral tube

4-H ENTOMOLOGY WORKSHEET - 2

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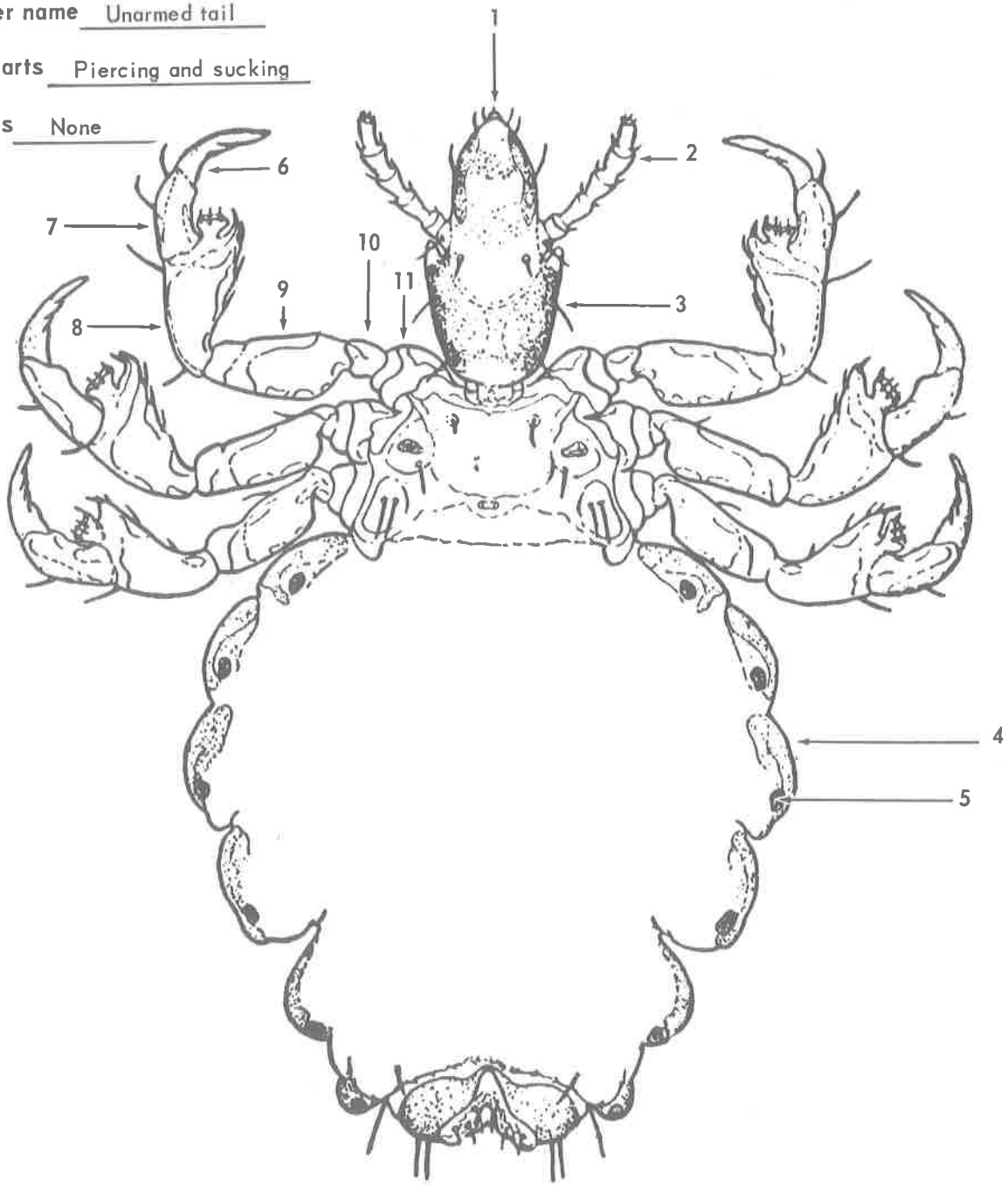
Order *Anoplura*

Meaning of order name Unarmed tail

Type of mouthparts Piercing and sucking

Number of wings None



4 abdomen	11 coxa	1 mouth	8 tibia
2 antenna	9 femur	5 spiracle	10 trochanter
6 claw	3 head	7 tarsus	

4-H ENTOMOLOGY WORKSHEET - 3

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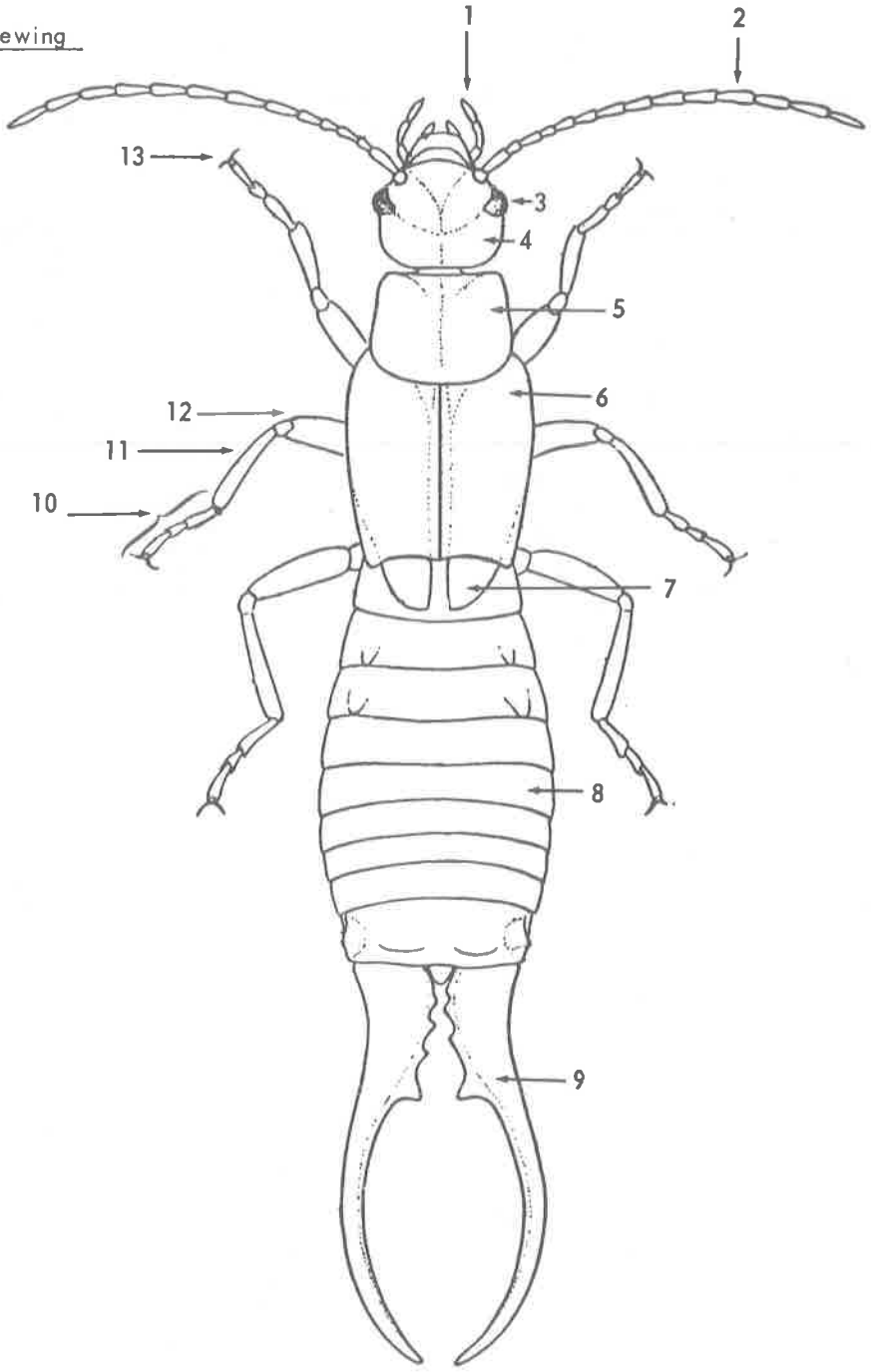
Order *Dermaptera*

Meaning of order name Skin wings

Type of mouthparts Chewing



8 abdomen	3 eye	4 head	10 tarsus
2 antenna	12 femur	7 hindwing	6 tegmina
9 cerci	9 forceps	1 palps	11 tibia
13 claw	6 forewing	5 pronotum	

4-H ENTOMOLOGY WORKSHEET - 4

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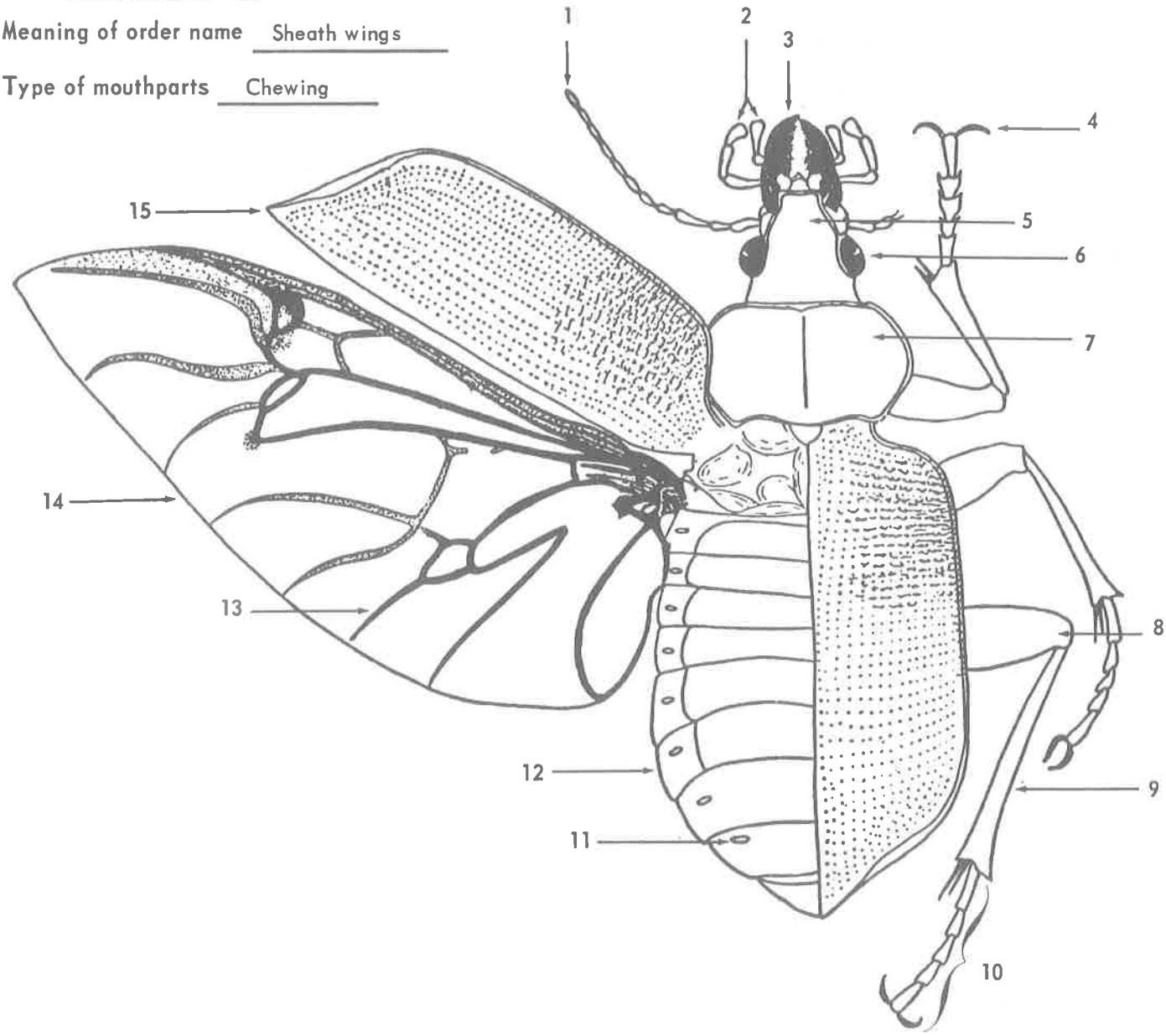
Order *Coleoptera*

Meaning of order name Sheath wings

Type of mouthparts Chewing



12 abdomen	15 elytra	14 hindwing	11 spiracle
1 antenna	8 femur	3 mandible	10 tarsus
4 claws	15 forewing	2 palps	9 tibia
6 compound eye	5 head	7 pronotum	13 vein

4-H ENTOMOLOGY WORKSHEET - 5

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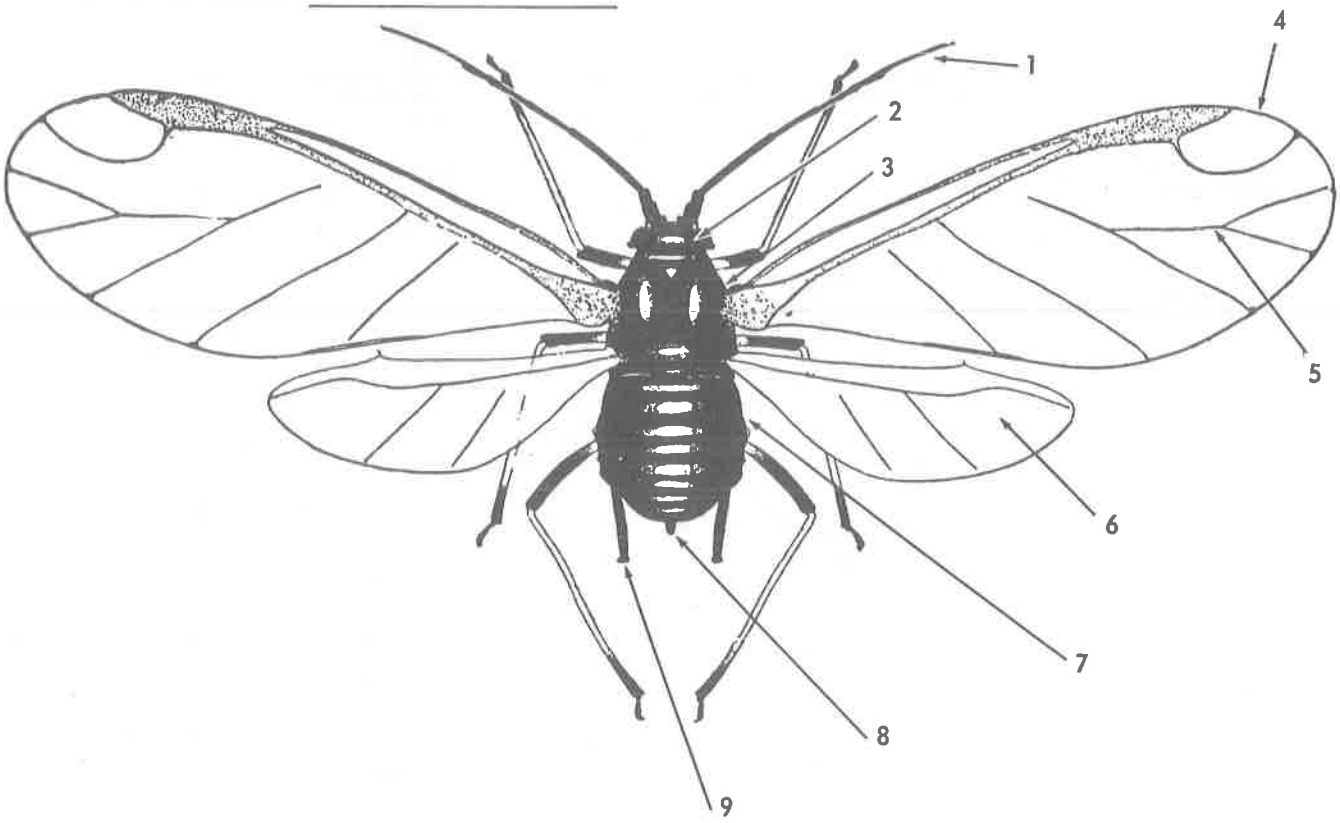
Order *Homoptera*

Meaning of order name Same wings

Type of mouthparts Piercing and sucking



7 abdomen	9 cornicle	6 hindwing
1 antenna	4 forewing	3 thorax
8 cauda	2 head	5 wing veins

4-H ENTOMOLOGY WORKSHEET - 6

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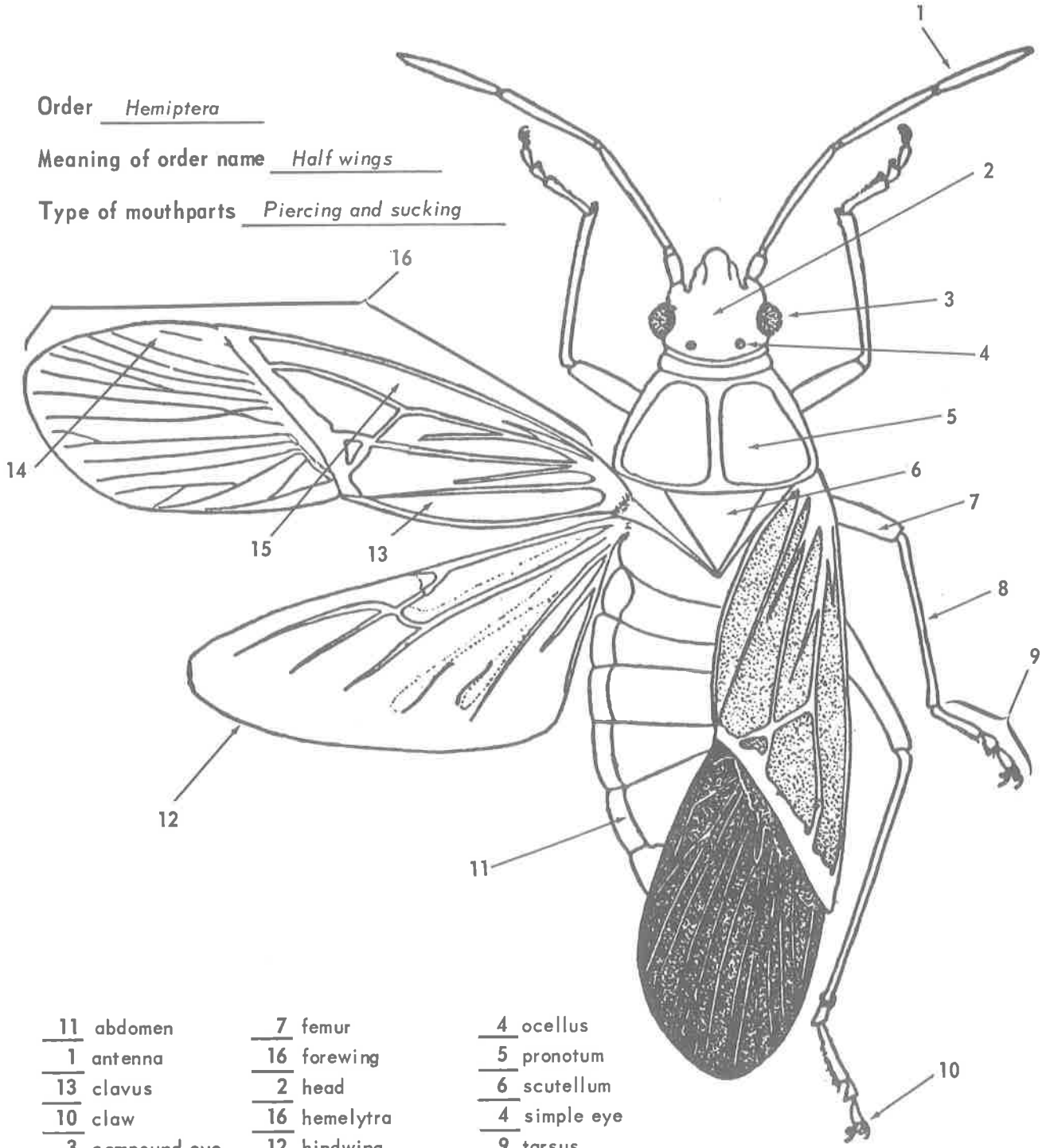
Order *Hemiptera*

Meaning of order name *Half wings*

Type of mouthparts *Piercing and sucking*



11	abdomen	7	femur	4	ocellus
1	antenna	16	forewing	5	pronotum
13	clavus	2	head	6	scutellum
10	claw	16	hemelytra	4	simple eye
3	compound eye	12	hindwing	9	tarsus
15	corium	14	membrane	8	tibia

4-H ENTOMOLOGY WORKSHEET - 7

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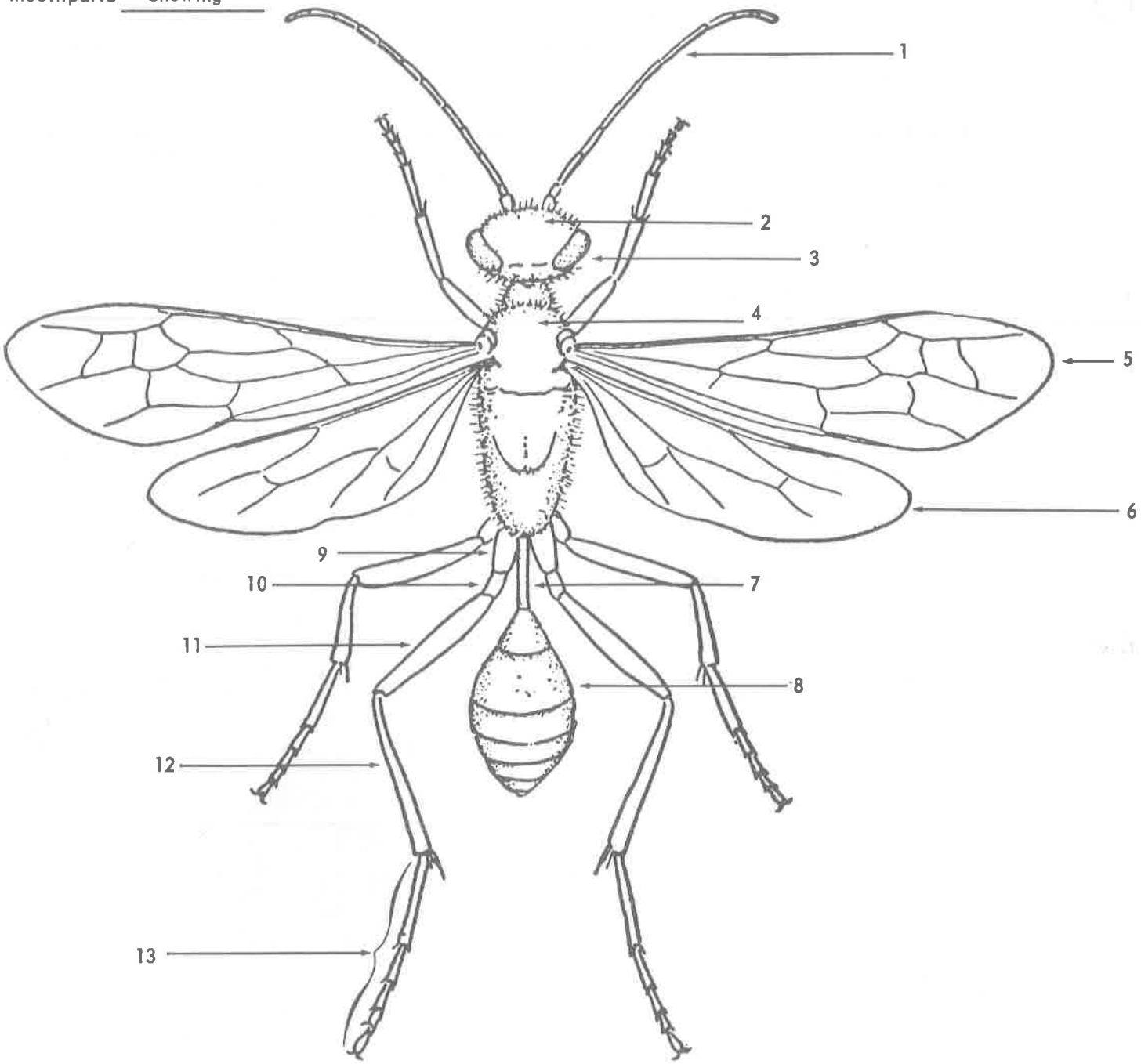
Order *Hymenoptera*

Meaning of order name Membranous wings

Type of mouthparts Chewing



8 abdomen	11 femur	6 hindwing	4 thorax
1 antenna	5 forewing	7 pedicle	12 tibia
9 coxa	2 head	13 tarsus	10 trochanter
3 eye			

4-H ENTOMOLOGY WORKSHEET - 8

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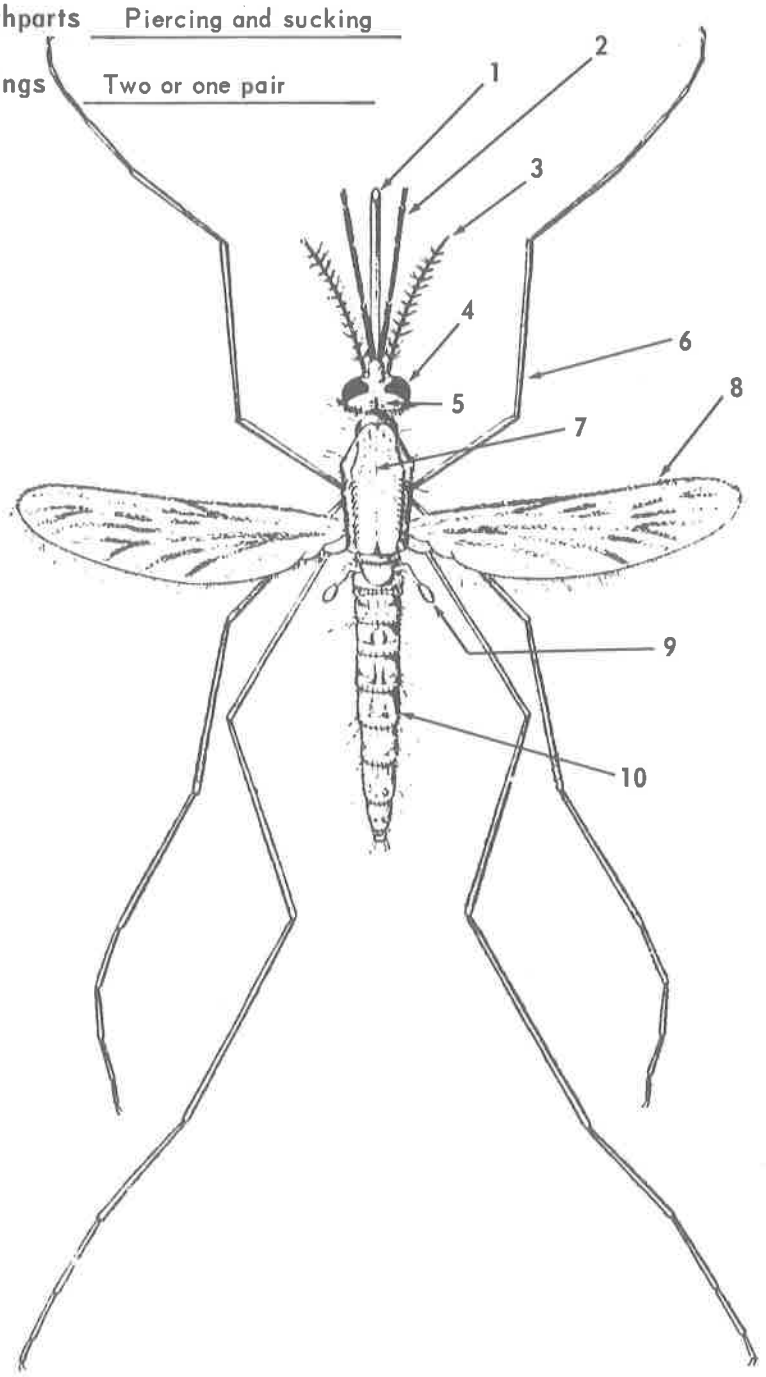
Order *Diptera*

Meaning of order name Two wings

Type of mouthparts Piercing and sucking

Number of wings Two or one pair



10 abdomen	5 head	1 proboscis
3 antenna	6 leg	7 thorax
4 eye	2 palps	8 wing
9 halter		

4-H ENTOMOLOGY WORKSHEET - 9

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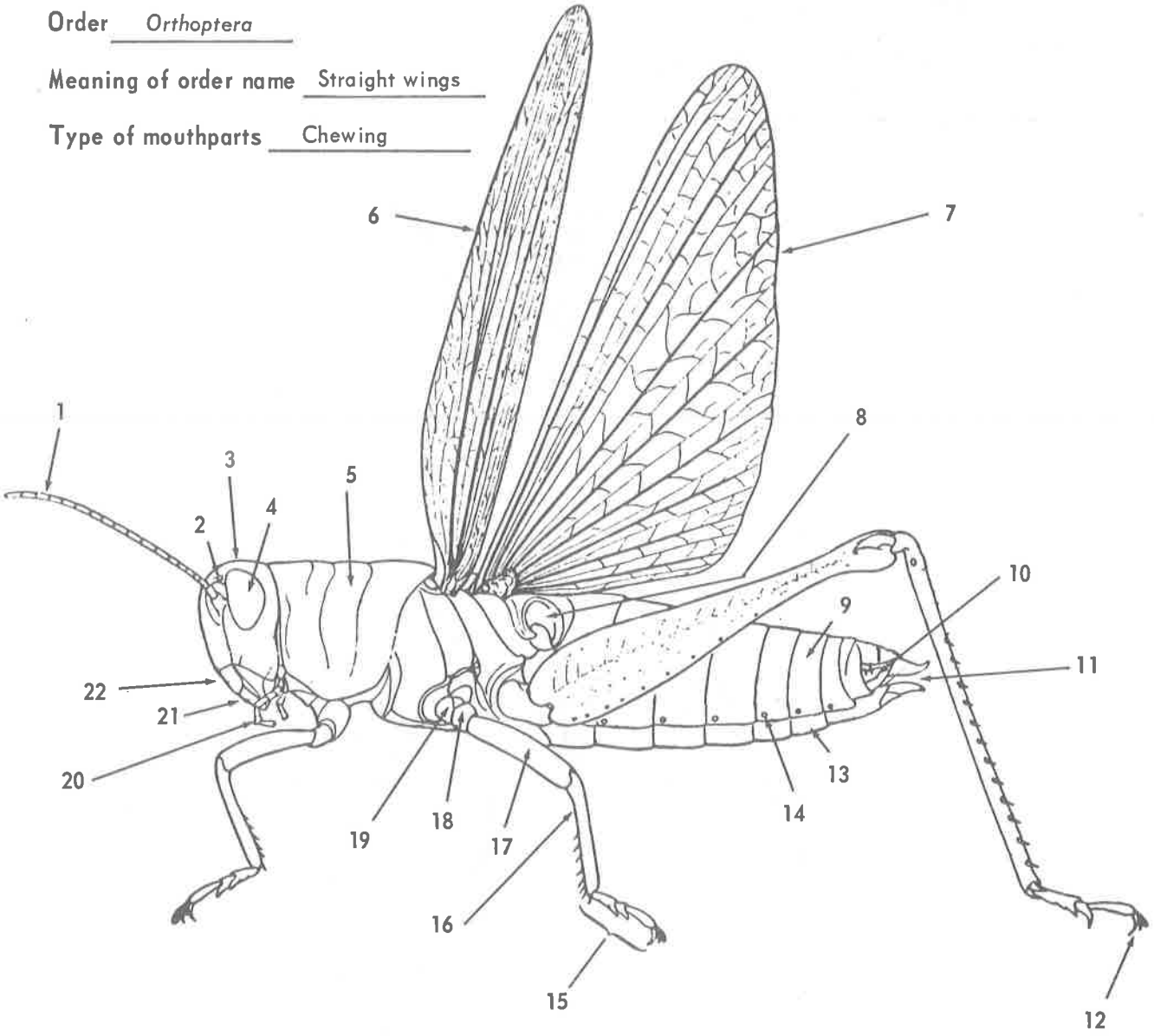
Order *Orthoptera*

Meaning of order name Straight wings

Type of mouthparts Chewing



1 antenna	19 coxa	7 hindwing	5 pronotum	6 tegmen
10 cercus	8 ear	21 labrum	2 simple eye	9 tergite
12 claw	17 femur	2 ocellus	14 spiracle	16 tibia
22 clypeus	6 forewing	11 ovipositor	13 sternite	18 trochanter
4 compound eye	3 head	20 palps	15 tarsus	8 tympanum

4-H ENTOMOLOGY WORKSHEET-10

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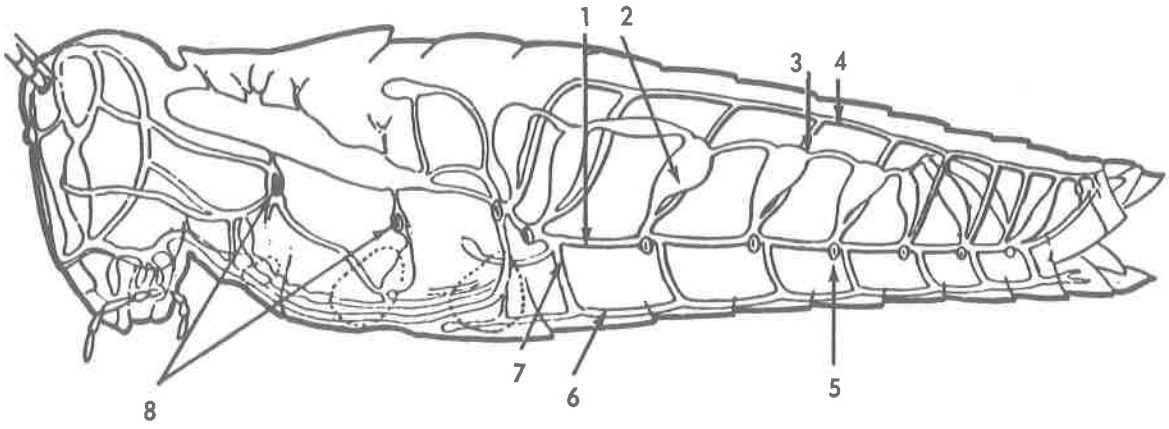
Respiratory system



2 abdominal air sac	1 lateral tracheal trunk
5 abdominal spiracle	8 thoracic spiracles
3 dorsal branch	7 ventral branch
4 dorsal tracheal trunk	6 ventral tracheal trunk

4-H ENTOMOLOGY WORKSHEET - 11

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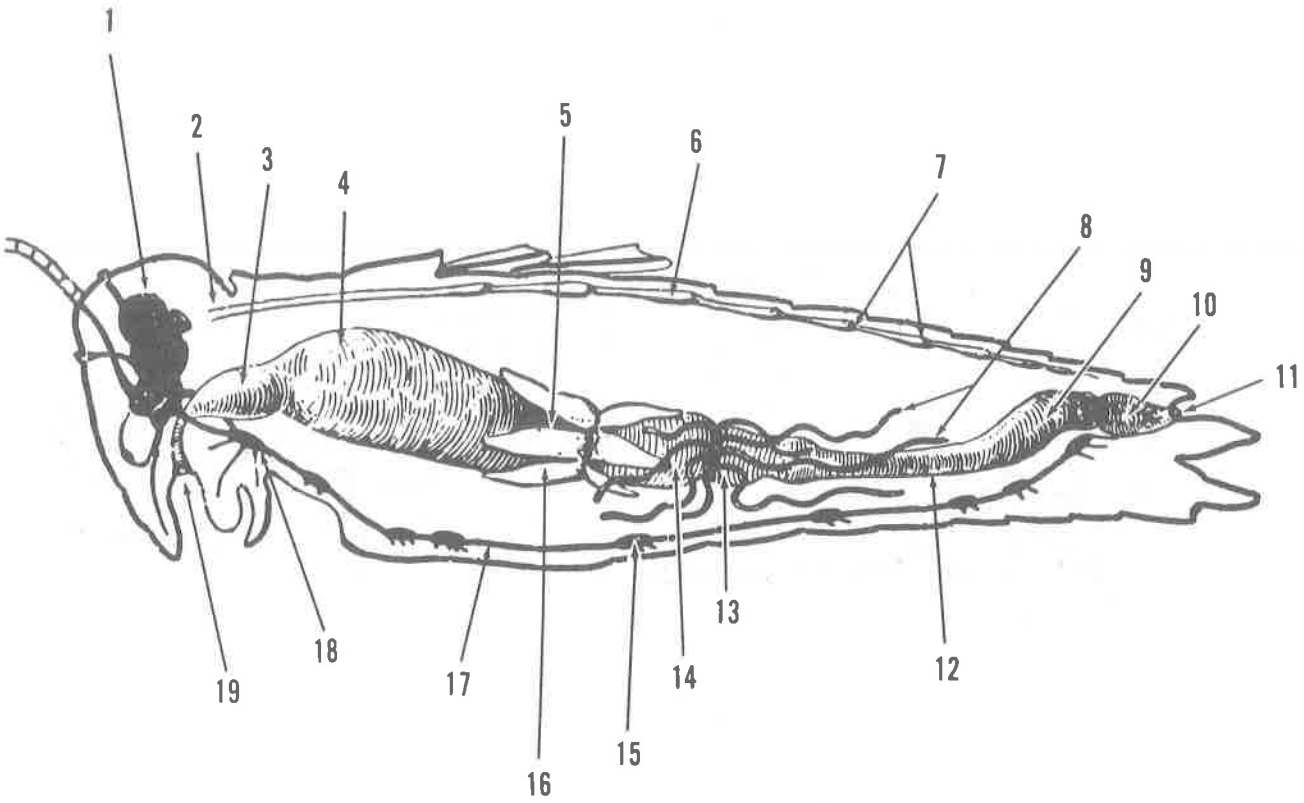
Circulatory, digestive, and nervous systems



15 abdominal ganglion
11 anus
2 aorta
1 brain
9 colon
4 crop
16 gastric caeca
6 heart
12 ileum
8 malpighian tubules
19 mouth
17 nerve cord
3 oesophagus
7 ostia
5 proventriculus
13 pylorus
10 rectal sac
18 thoracic ganglion
14 ventriculus

4-H ENTOMOLOGY WORKSHEET - 12

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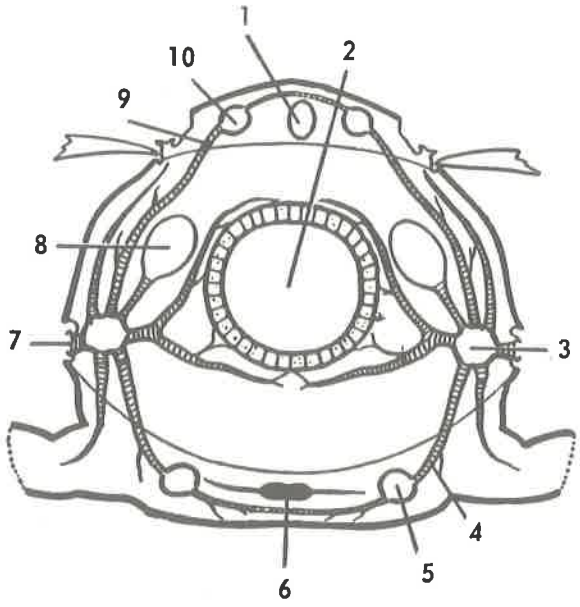
Cross sectional view of circulatory, digestive, nervous and respiratory systems.



8	air sac	1	heart
2	alimentary canal	4	lateral branch
9	dorsal branch	3	lateral tracheal trunk
10	dorsal tracheal trunk	7	spiracle
6	ganglion	5	ventral tracheal trunk

4-H ENTOMOLOGY WORKSHEET-13

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ENTOMOLOGY – SUPPLEMENTARY REPORT

Record of Insects Collected

	ORDER	COMMON NAME (Tiger Beetle, Stink Bug, etc.)	COLLECTED FROM (plant or animal host or other place)	LOCALITY (nearest town and county)	COLLECTION DATE	IMPORTANCE TO MAN			NUMBER OF WINGS			KIND OF MOUTH PARTS		
						Beneficial	Harmful	Doubtful	0	2	4	Chewing	Sucking	Lapping
1														
2														
3														
4														
5														
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Record of Life Histories of Insects You Reared

NAME OF INSECT		Stages Observed			
		Egg	Larva or Nymph	Pupa	Adult
	Length of this stage				
	Kind of food consumed				
	Length of this stage				
	Kind of food consumed				
	Length of this stage				
	Kind of food consumed				
	Length of this stage				
	Kind of food consumed				
	Length of this stage				
	Kind of food consumed				
	Length of this stage				
	Kind of food consumed				
	Length of this stage				
	Kind of food consumed				
	Length of this stage				
	Kind of food consumed				

Insect Control Record

Insects controlled	Host (animal, plant, etc.)	Insecticides used— (Rotenone, DDT, Cryolite, etc.)	Spray or dust (per cent or dilution used)	Results: How effective was control?

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FEBRUARY 1969--4000 Rev.

4-H ENTOMOLOGY

PROJECT OUTLINE

In this project you will have an opportunity to:

- understand the effect that insects have on our lives.
- learn how insects help us.
- learn how to control destructive insects.

Beginning Unit

In this unit you will collect and identify insects. Follow the instructions in your 4-H Entomology Manual and attend project meetings. You will:

MAKE OR GET

Essential equipment

- Killing jar
- Package of No. 2 or No. 3 insect pins
- Collection box (cigar box is adequate)

Other useful equipment

- Aerial collection net
- Relaxing jar
- Spreading board
- Pinning block

Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

4-H–2020

REPRINTED AUGUST 1981

LEARN

- to distinguish insects from other small animals.
- to recognize and identify at least 10 of the orders of insects listed in the 4-H Club Entomology Project Manual.

DO

- Make a collection suitable for display. Include at least 25 different insects representing 10 orders.
- Exhibit your collection and equipment if possible.
- Give at least one talk or demonstration.
- Keep a complete and accurate project record of work done and insects collected.

Intermediate Unit

In this unit, you will add to your insect collection, learn to rear insects, distinguish between beneficial and harmful insects, and practice insect control. You will:

MAKE OR GET

Essential equipment

Aerial net, pinning block, relaxing jar, and spreading board (if you do not already have them)

Rubbing alcohol and 10 or more small vials

Additional pins, display box, and killing jar, as needed

Sweeping net

Rearing cage

Other useful equipment Beating sheet

LEARN

- three or more additional orders of insects
- the four types of insect development (metamorphosis)
- the important parts of an insecticide label
- how to handle insecticides safely (optional)
- the different methods of insect pest control (optional)
- which of the insects collected are harmful and which are beneficial (optional)

DO

- Rear at least two insects from the nymphal or larval stage.
- Collect and identify to order and label with common name, if known, at least 25 new insects. Include one insect or more from each of the 13 orders studied.
- Give at least one talk or demonstration on insects.
- Enter an exhibit at county events or fairs.
- Control one insect or more with an insecticide; report how the insecticide was used, and the results (optional).
- Keep a complete and accurate project record of all the work done and insects collected.

Advanced Unit

In this unit, you will complete your collection of insect orders, study life histories of insects, and have a choice of several practical methods of insect control. You will:

MAKE OR GET

Additional pins, display boxes, killing jars, etc., as needed

LEARN

- three or more additional orders of insects each year until all 20 orders shown in the manual are covered. As an option, include two other orders – *Corrodentia*, book lice, and *Mecoptera*, scorpion flies. These are not illustrated in your 4-H Entomology Manual.
- the life histories of five insects, one of which must be reared from egg through adult stage. Keep a complete record on those insects reared, showing the time required for each stage of development, i.e. – number of days as an egg, larva, pupa and adult. The life histories of the other four insects may be obtained from books, pamphlets, or from other persons rearing these insects.

DO

- Each year, collect and identify to order and label with common name, if known, at least 25 additional insects. Include at least one species from each of 16 orders.
- Each year identify at least 10 specimens to family.
- Each year:

  Keep a complete and accurate project record of all work done and insects collected.

  Give at least two talks or demonstrations.

  Enter an exhibit at county events or fairs.

- Each year, do at least four of the following:

  Develop a display of at least 10 beneficial insects and the ways in which they benefit man.

  Develop a display of at least 10 destructive insects and illustrate or describe the damage they cause.

  Rear an insect species from egg through the adult stage. Keep a complete record. Include time required for each stage of development, i.e. – number of days as an egg, larva, pupa, and adult.

  Study the life histories of four other insect species. Information may be obtained from books, pamphlets, or other persons rearing these insects.

  Observe and record in detail the action of at least one sucking insect species and one chewing insect species causing damage to plants or animals. Control at least one of the insect species observed with an insecticide and report how the insecticide was used and the final results.

  Try at least three insecticides for the control of an insect species causing damage to plants or animals. Be sure to use insecticides approved for use on the crop or animal. Follow all safety precautions. Report insecticides used, how they were applied, and the results.

  Try three strengths of the same insecticide. Follow requirements listed above.

  Try different formulations of the same insecticide, such as wettable powders, emulsifiable solutions, concentrates, or dusts. Follow requirements listed above.

  Demonstrate biological control by putting a predator or parasite on an insect-infested plant.

  Observe and record examples of insect species that have been killed by disease caused by fungi, virus, or bacteria.

  Conduct a result demonstration. See your farm advisor for ideas that will be of value in your area.

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4-H ENTOMOLOGY

Project Manual

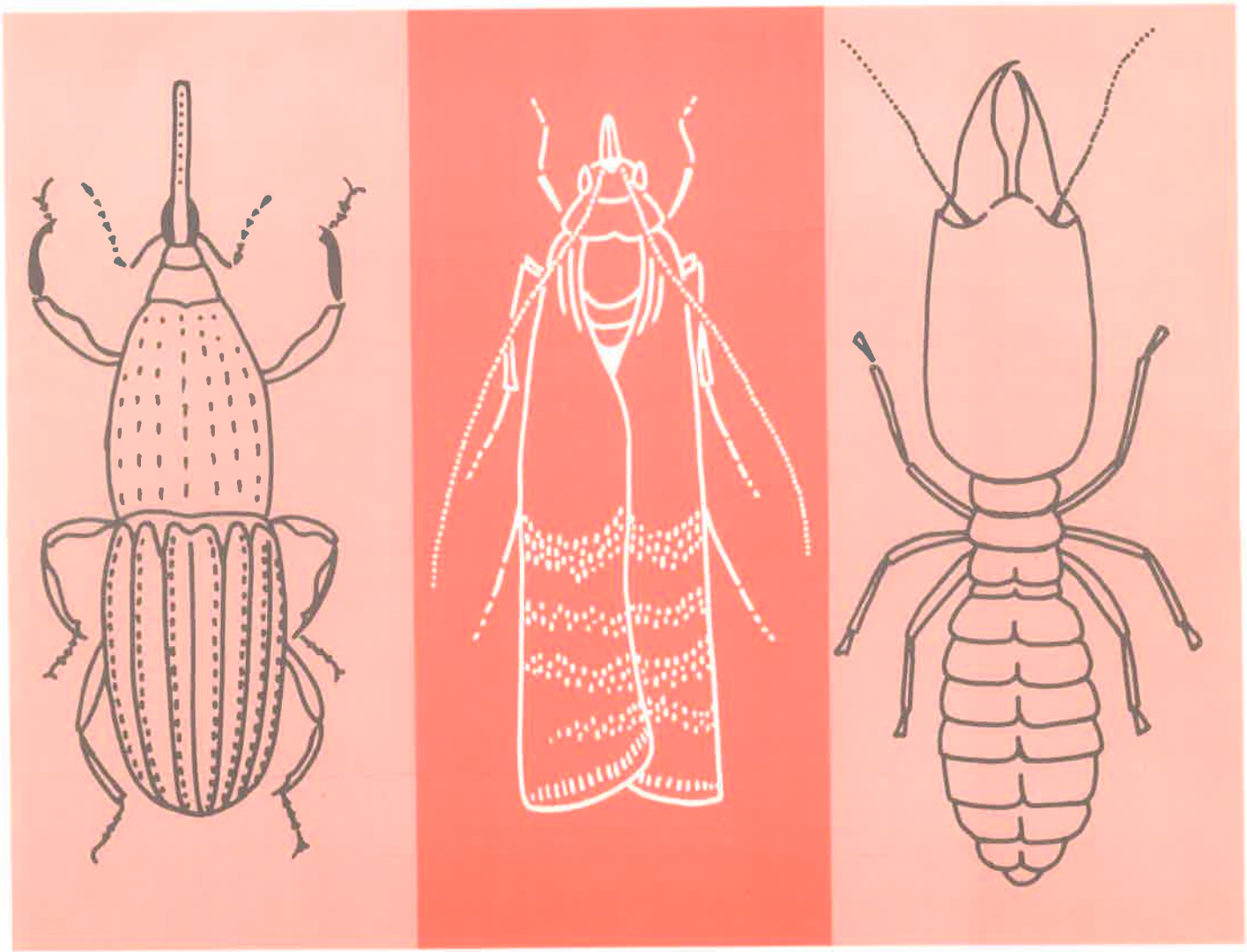

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TABLE OF CONTENTS

The authors are Paul C. Barker, former 4-H Club Specialist; Lonnie D. McGrew, former Farm Advisor, Imperial County; Wallace R. Schreader, Farm Advisor, San Joaquin County; and J. E. Swift, Extension Entomologist, Berkeley.

Revised by W. R. Bowen, Laboratory Technician; Vernon E. Burton, Extension Entomologist, Davis; Clarence S. Davis, Extension Entomologist, Berkeley; Andrew S. Deal, Extension Entomologist, Riverside; and William G. Schneeflock, 4-H Club Specialist, Berkeley.

Acknowledgement is given to Z. P. Metcalf and C. L. Metcalf for the use of sketches used from "A Key to the Principal Orders and Families of Insects," and to University of Michigan Extension Service for the information on imbedding insects in plastic.

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REV. AUGUST 1965

WHAT IS ENTOMOLOGY?

Entomology is the study of insects. The scientist who specializes in this field is called an entomologist.

In the Entomology Project, you will learn how insects differ from other small animals; how to identify and name them; how to make and use special equipment; how to collect, preserve, label, exhibit, and rear insects; and how to control them. From all this, you will learn the economic importance of insects.

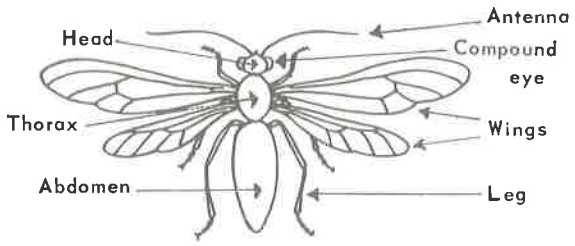
Insects

Insects are small animals. They belong to the largest group in the animal kingdom, the Arthropoda—which means joint-footed.

Arthropods have no backbones. Their bodies are jointed, and so are their legs and feet. The surfaces of their bodies are covered with an organic material called an exoskeleton.

When fully grown or in the adult stage, insects have:

- three definite body regions – head, thorax, abdomen
- three pair of jointed legs
- one pair of feelers, or antennae
- compound eyes, usually
- one or two pair of wings



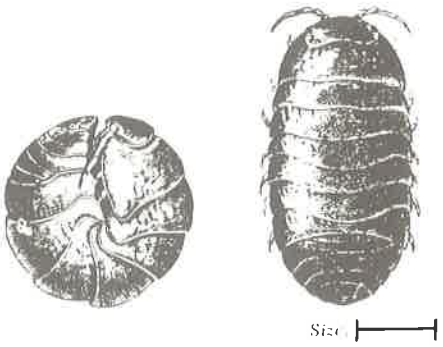
Sketch of an insect showing body parts.

Other Arthropods

In addition to insects, the arthropods include such common creatures as:

crustaceans – sow bugs, pill bugs, shrimps, crabs, lobsters

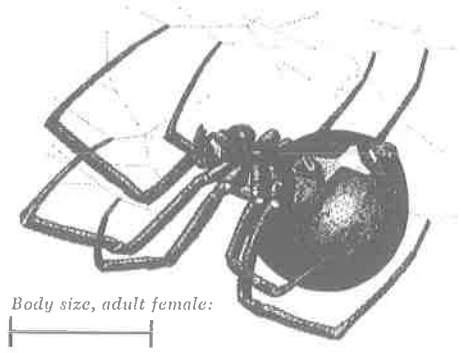
- two main body regions – head merged with thorax, abdomen
- five or more pair of jointed legs
- two pair of antennae



Pill bug, *Armadillidium vulgare* (Lat.)
Pill bug in retracted and extended positions.

arachnids – spiders, scorpions, ticks, mites

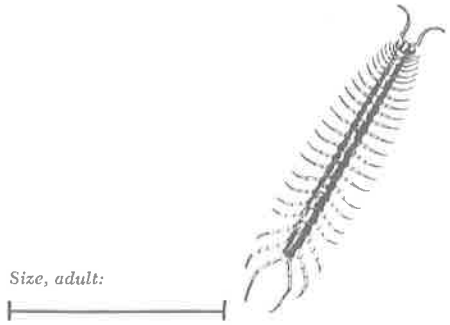
- two main body regions – head merged with thorax, abdomen
- four pair of jointed legs
- antennae and wings lacking



Black Widow Spider, *Latrodectus mactans* (Fabr.)

chilopods – centipedes

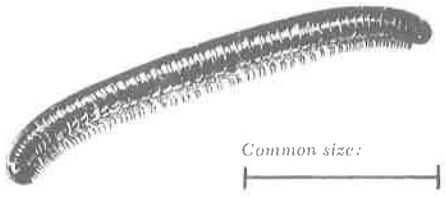
- body wormlike
- head not merged with thorax
- one pair antennae, or none
- wings lacking
- many legs, each body segment with one pair



Centipede, *Cermatia forceps* (Raf.)

diplopods – millipedes

- body wormlike
- head not merged with thorax
- one pair antennae, or none
- wings lacking
- many legs, each body segment with double pair of legs



Millipede

Economic Entomology

Insects play an important part in our everyday lives. The study of how they affect us and our crop production is called economic entomology.

To understand economic entomology, you must be able to recognize the most important insects and know something about their habits and life histories. You also must learn which insects are beneficial and which are harmful.

Beneficial insects. Most insects are not harmful to man, but actually benefit him. Man would be helpless without their aid.

Many insects are the only means of pollinating certain plants. Many flowers and more than 50 important crops depend on insects for pollination. Without these insects, we would not have alfalfa, figs, plums, cantaloupes, sweet cherries, some apple varieties, and many other fruits.

Insects also help destroy refuse in the soil, clean up fallen forest trees, and aerate the soil. The common honeybee gives us honey and beeswax. Other insects produce silk, lac dye, tanning materials, certain medicines, and tonics.

Harmful insects. More than 1½ million insects are known, but only a few of these are injurious pests. Most injurious insects are kept under control by other insects that feed on them.

Many insects carry diseases which affect our health. Insects spread malaria, yellow fever, bubonic plague, sleeping sickness, typhus, and other diseases. Entomologists and parasitologists have shown us how to control disease-carrying insects.

Americans are the best-fed and best-clothed people in the world because we use scientific methods to produce and protect our crops. If we did not control insect pests, many foods we eat would be hard to get or not fit to eat. But in spite of our control, fewer than 100 different insects cause losses of nearly $4 billion each year to our crops, livestock, and forests. You should know how to control insects that are pests.

Biological control is one method entomologists use to control insects. This means that beneficial insects are used to keep down the numbers of harmful insects. Sometimes this is done by using insects already present in the field. At other times, insects are raised or collected and then released in the area where the pests are present. This is one of the best and cheapest ways to keep down the population of harmful insects. It should be used whenever possible. Some common beneficial insects are ladybird beetles, aphid lions, and many of the tiny wasps found in the fields.

Chemical control of insects is familiar to us. It is done by applying a poisonous chemical to the crop when the insect is present.

Chemicals used for insect control are poisonous to us as well as to the insects, so we must use them properly. Chemical control is used when we see that insects are increasing in numbers harmful to the crop.

If you know about the habits and life history of insects, you will be able to decide which of the many kinds of chemicals to use and when to use them for controlling insects. The type you use will depend upon the habits of the insect. Some insects suck juices from

the plant; others eat leaves. For the first type you will use a chemical that kills the insect by coming into contact with its body. For those that eat plants, you will use either a contact poison or a stomach poison.

Some of the many different kinds of chemicals used are DDT, DDD, toxaphene, lindane, rotenone, pyrethrum, parathion, and malathion. When you plan insect control, learn what kind of insect you are trying to kill; then use the best type of chemical.

SAFETY PRECAUTIONS

Always remember that these chemicals are poisonous and must be handled carefully. Read the label on the package and do as it says. Do not take chances.

HOW TO COLLECT AND PRESERVE INSECTS

With simple equipment, the amateur as well as the trained entomologist can make a worthwhile collection of insects. In late spring, summer, and early fall, insects are abundant in fields and woods. Flowers are favorite visiting places of bees, flies, beetles, and other insects. Large numbers of insects may be caught by sweeping with a strong insect net through the grass and branches in woods along the banks of streams, open glades in deep woods, and brush along the forest edges.

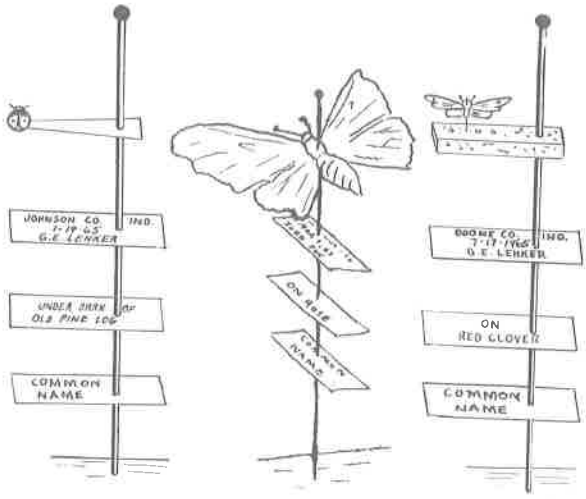
Not all insects are caught in nets. You may find rarer insects in obscure places, such as leaf mold and debris on the surface of the soil, particularly in the woods. Turn over rotten logs and stumps and search carefully under them. Then tear them apart to find other insects that live inside.

Lights attract large numbers of insects, such as June beetles and moths. At night these insects may be collected at street or porch lights or on windows and screens of lighted rooms. You may catch other insects by putting a jar over them as they rest on foliage or flowers.

Insects must be killed quickly without breaking or otherwise damaging them. Place them in the killing jar and mount within a few hours after they are caught. Caterpillars, larval stages of insects, and other soft-bodied specimens should be preserved immediately in preserving fluid. Place butterflies on the spreading board until they are dry.

Records

Each time you catch an insect, make a record of the plant or animal from which it came, the place found, the date, and the common name, if known. You will need this information to label your insects.

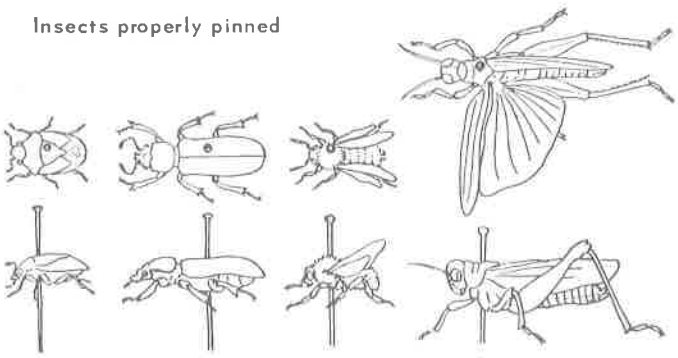


Insects properly mounted and labeled.

Insects should be mounted on pins, labeled, and placed in your collecting box as soon after they die as possible. Place them in neat rows with heads toward the rear of the box, and with all insects of the same kind placed next to each other. Insects too small to mount on pins should be glued to small pieces of paper and then mounted on pins. Push the pin straight through the insect. The illustrations show the correct places on the insect's body to insert the pin.

Be sure that all insects are mounted the same distance from the heads of the pins, and that labels are arranged on the pins the same way. Labels should parallel the longitudinal body axis of the insect on the mount, except those insects that are mounted on card points. Stick pins straight through the insects. Remember that neatness and uniformity make a more attractive insect collection.

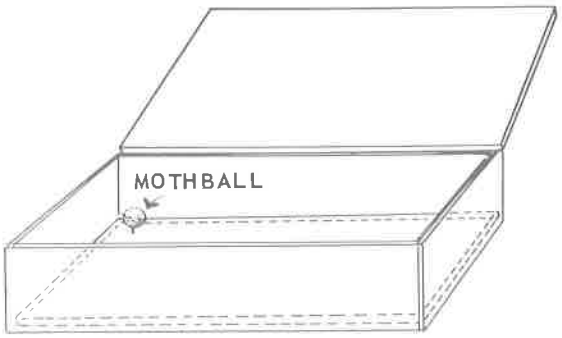
Insects properly pinned



EQUIPMENT YOU WILL NEED

Simple Collection Box

You will need a safe place to keep your collection of insects after you mount them. An inexpensive container can be made from a cigarbox. This will be large enough for the ten orders of insects to be collected in the first unit of work.



Cigarbox for insect collecting

YOU WILL NEED THESE MATERIALS:

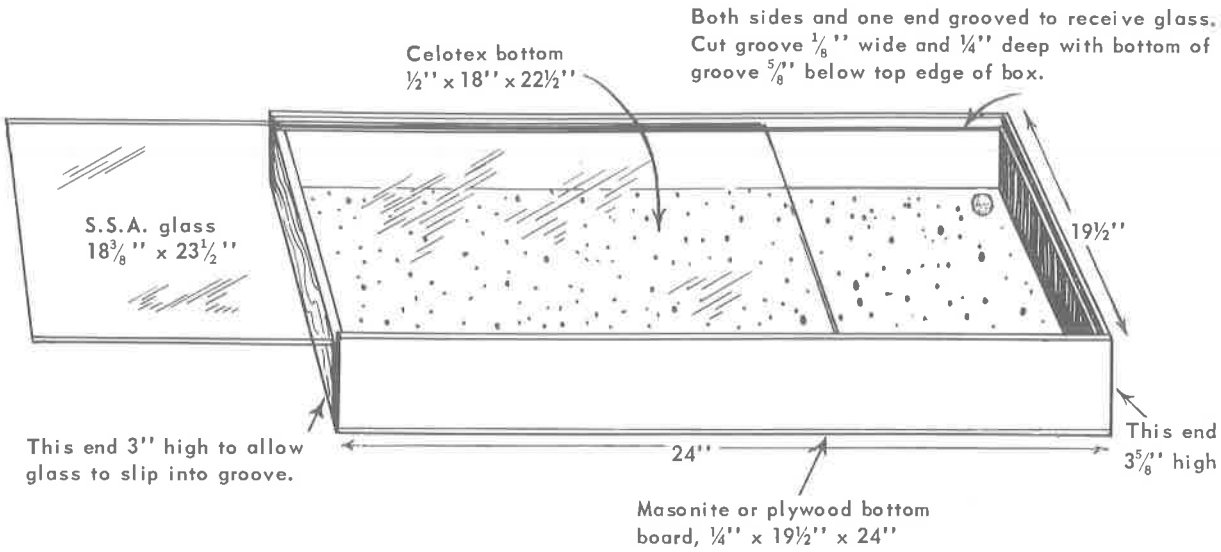
Cigarbox, 2 by 6 by 8 inches preferred
Piece of smooth-faced, corrugated cardboard, or soft fiberboard
Glue, or rubber cement
Mothball
Number 3 insect pins
Matches

MAKE YOUR BOX THIS WAY:

Cut cardboard or fiberboard to fit the box bottom.
Smear glue or rubber cement on bottom of box and insert cardboard or fiberboard.
Heat head of pin with lighted match.
Stick head of pin into mothball, and allow to cool.
Stick mothball on pin into cardboard in one corner of the box.

Display Box

As you continue in the Entomology Project and your collection grows, you will need more than one collection box. You can use several cigarboxes, or you can make a display box. The display box holds more insects and makes a more attractive and safer container when you exhibit your collection. Use clear white pine, ¾ inch thick, for the ends and sides, and double-strength glass for the top.



Collecting Net

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

MAKE YOUR NET THIS WAY:

The handle: Drill two holes (approximately $^{3}/_{16}$ inch in diameter) on opposite sides near one end of a 3-foot piece of broom handle, or 1-inch Douglas-fir doweling. Use straight-grained material. The holes should be offset to correspond with the ends of the wire loop. Make them just deep enough to accommodate the ends of the wire.

Cut a groove on each side of the handle, from each hole to the end of the handle, deep enough for the wire to fit snugly (see diagram).

If a ferrule is to be used to fasten the wire loop to the handle, use brass or aluminum tubing, 1-inch inside diameter. Otherwise, use fine wire or heavy cord.

The loop: Bend a 54-inch piece of No. 8 galvanized iron wire into a 15-inch loop, as in the diagram.

The bag: Make the bag from a single piece of cloth – 30 by 48 inches.

Fold the material so that the doubled cloth is 24 inches across and 30 inches long.

Make a pattern as shown by dotted lines in diagram.

Pin the pattern to the material with the top of the pattern along the selvedge where possible.

Cut the material, ¼ inch beyond the edges of the pattern. This allows for a seam on the lower part of the bag only. Do not cut the folded edge of the material on the upper 6 inches of the bag.

Remove the pattern.

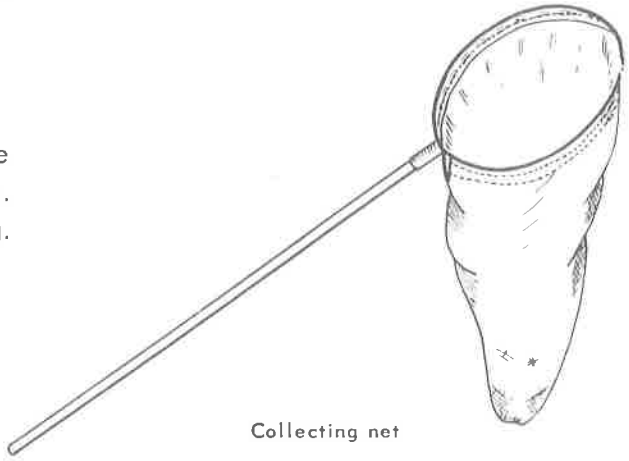
Make a ¼-inch seam along the edges of the bag up to a point 6 inches below the top. Trim material to within ⅛ inch of stitching.

Turn the bag and make a French seam. Then stitch French seam flat to bag, making a fell seam.

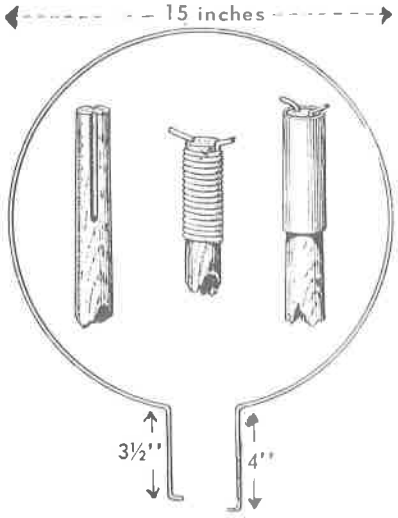
Fold and crease the top of the bag, making a 3-inch hem. Turn under the open ends of the hem and stitch.

Double the hem back over itself, making a finished hem 1½ inches wide. Stitch.

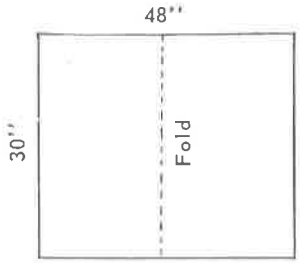
To assemble the bag: Insert the wire loop through the hem at the top of the bag. Attach the loop to the handle by sliding the ferrule over the ends of the loop.

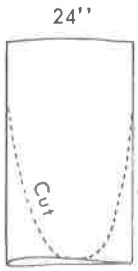


Collecting net



Loop





Killing Jar

After insects have been collected, they must be killed quickly. Any fairly heavy glass jar with a wide mouth and tight screw cap can be used. You will want several – one for moths and butterflies, and one or more for beetles or other small insects. Various chemicals may be used, but ethyl acetate is recommended.

Pour ½ inch of plaster of Paris into the jar and allow it to harden. Dry it thoroughly in the oven. Then pour ethyl acetate into the jar. Allow the plaster of Paris to become thoroughly saturated. Pour off the excess liquid. The jar is now ready for use and will last for months if kept tightly closed. When it no longer kills insects, recharge it with ethyl acetate.

— Plaster of Paris

Relaxing Jar

Insects that have dried after being killed must be relaxed or made limber before they are mounted. This can be done easily in a relaxing jar.

MAKE THE JAR THIS WAY:

Put an inch or two of clean sand into a wide-mouth jar or can with a tight cover. Saturate the sand with water to which you have added a few drops of phenol (carbolic acid) to keep mold from growing. Cover the sand with a piece or two of cardboard cut to fit the jar. It is then ready for use. Specimens must not come in direct contact with the water. Do not leave them in the relaxer too long or they will be spoiled. From 1 to 3 days usually is sufficient. Do not leave relaxer where it will get too warm, or it will sweat on the inside.

Preserving Vials

Soft-bodied insects, such as caterpillars, grubs, and maggots, must be preserved immediately in a fluid such as 70 per cent rubbing alcohol. Place the fluid and the insect in a small vial, size 00, which you can purchase from a drugstore. Fasten the vial in your collecting box with Scotch tape, and pin a label near the cork. Place another label inside the vial, stating – **Where collected, Date, and Collector's name.** This will prevent your data from becoming lost if the outside label is separated from the vial.

Insect preserved in vial

TWEEZERS

Tweezers, 4 or 5 inches long, will help you to handle insects with less chance of damage. There are several kinds.

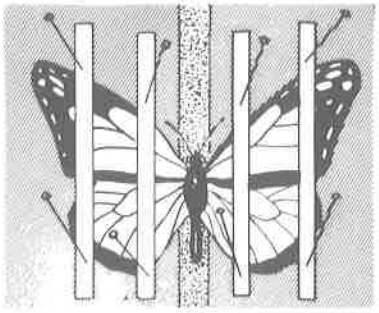
Tweezers for ordinary specimens

Tweezers for unmounted *Lepidoptera*

Spreading Board

YOU WILL NEED THESE MATERIALS:

- 2 end blocks, 1 inch square and 5½ inches long
- 2 top pieces, 2½ inches wide, 12 inches long, and ½ inch thick, planed down to ⅜ inch on the inside edge
- 1 flat strip of corrugated cardboard, 1½ inches wide, 14 inches long, and ¼ to ½ inch thick

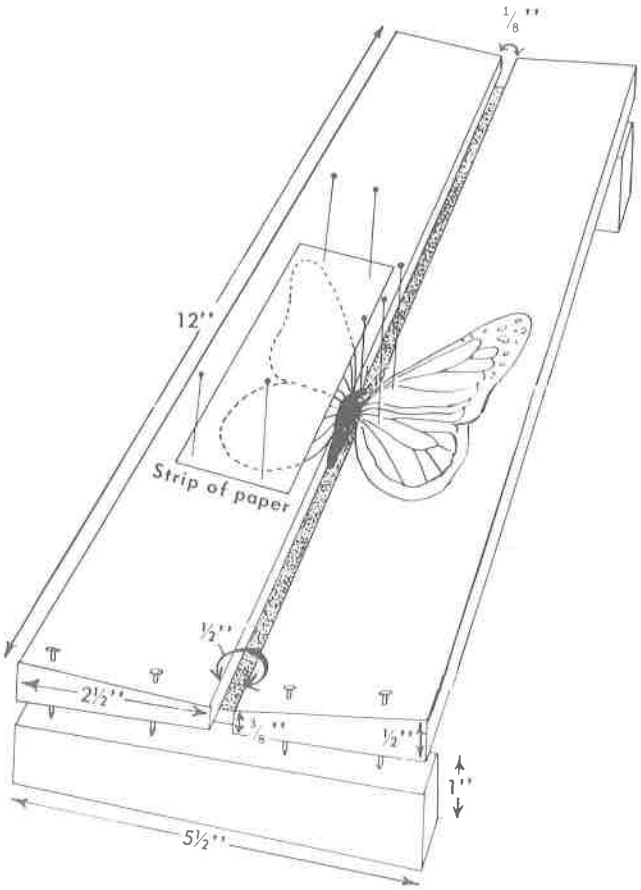


Butterfly properly spread

MAKE YOUR BOARD THIS WAY:

Nail the two top pieces to the end blocks, leaving a space between the two pieces. Tack the strip of cardboard beneath the open space left by the top pieces. This gives you something to pin to while the insects are drying.

After the insect is pinned, insert the pin into the cardboard so that the body of the specimen rests in the groove. Pull the wings forward and hold them temporarily with pins while you permanently secure them with a strip of paper.



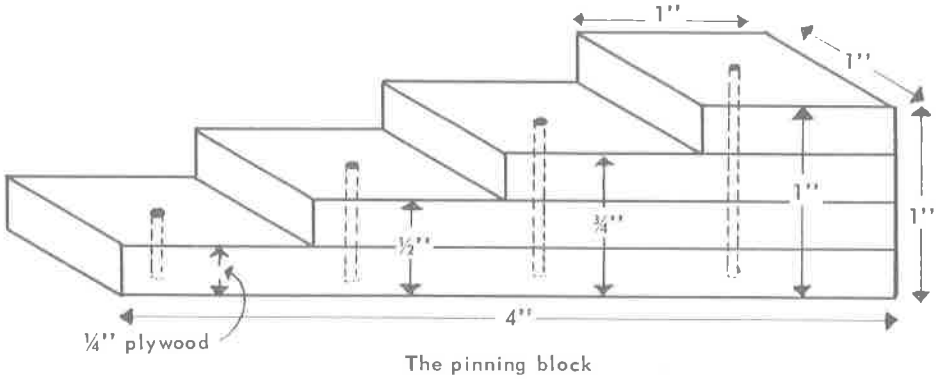
The complete spreading board with dimensions

Pins, Pinning Block, and Labels

Special pins that do not rust or corrode are used for pinning insects. They are long, very sharp, and come in various sizes. The most useful size is No. 3. These pins can be bought from biological supply houses.

The appearance of a collection of insects is improved if all the specimens and labels are placed at a uniform height upon the pins. This is easily done by using a wooden pinning block. The pinning block may be made from a piece of soft wood 1 inch square and 4 inches long, cut into four steps which are ¼, ½, ¾, and 1 inch high. Or it can be made by fastening together four pieces of ¼-inch plywood, 4, 3, 2, and 1 inches in length. Drill a small hole in each step. After the insect is placed upon a pin, place either the head or the point of the pin in the desired hole and adjust the specimen or label to the right height. The pinning block will function better if you nail or glue a piece of Masonite or sheet metal to the bottom of it.

If your collection is to be of value, **every insect must be marked with certain information.** This is done on small paper or cardboard labels. Follow the directions on page 4 and 5 which tell you how to collect and preserve insects.



The pinning block

Rearing Cage

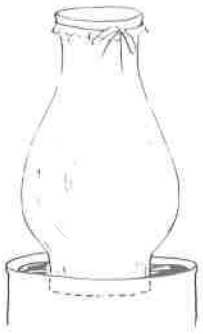
Most insects are easy to rear if you provide them with an environment similar to that in which they were found. Many kinds of rearing cages are used. Most of them are constructed of screen to prevent escape of the adults as they emerge. If you wish to rear a caterpillar you found feeding on oak leaves, place it in your cage with oak leaves to eat. Unless you are familiar with the habits of the insect being reared, it is best to provide a few inches of soil in the bottom of the rearing cage, as many insects must have soil in which to pupate or transform from the larval to the adult stage.

YOU'LL NEED THESE MATERIALS:

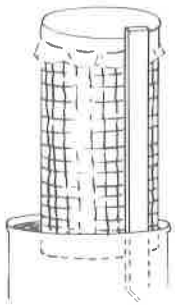
Glass container with open bottom and top, such as a lamp chimney
Piece of cheesecloth
Can to set chimney in
Screen wire
Small sticks of wood to support screen cage
Carpet tacks

MAKE THE GLASS CAGE THIS WAY:

Place globe in the can and firm it in the soil. Then fasten cheesecloth over the top.



Glass
insect-rearing cage



Screened
insect-rearing cage

MAKE THE SCREEN CAGE THIS WAY:

Roll screen to make cylinder desired size. Tack stick to fold in screen. Leave the stick 2 or 3 inches longer than the screen. Fasten cloth or screen over the top. Insert point of stick in soil until screen rests in dirt. Firm soil around base of cage. Drinking water can be supplied by placing cotton in a small bottle of water. The insects will get all the water they need from the cotton. Do not tip the bottle sideways or the water will come out too fast.

LIFE HISTORY OF INSECTS

We study insect biology to learn where an insect lives, what it eats, what its habits are, and how it reproduces. Most of these questions can be answered by a study of the insect's life cycle. The LIFE CYCLE begins with the egg stage and continues through the reproducing adult stage.

An insect needs certain things to complete its life cycle. These include:

Water	Heat
Air	Other insects of its kind
Soil	Food

These biological requirements change as an insect passes from one stage of growth to another in its metamorphosis.

Life Cycle Studies

As part of the study of insects you will want to keep your specimen in a rearing cage so that the different stages of growth you observe will be of the same insect.

An insect must be kept in as natural a condition as possible for it to get all of its biological requirements. Therefore, you will need a cage that holds not only the insect but also all of its biological requirements.

Observations

Everything you can observe about an insect will be of value in understanding and predicting what it will do in the future.

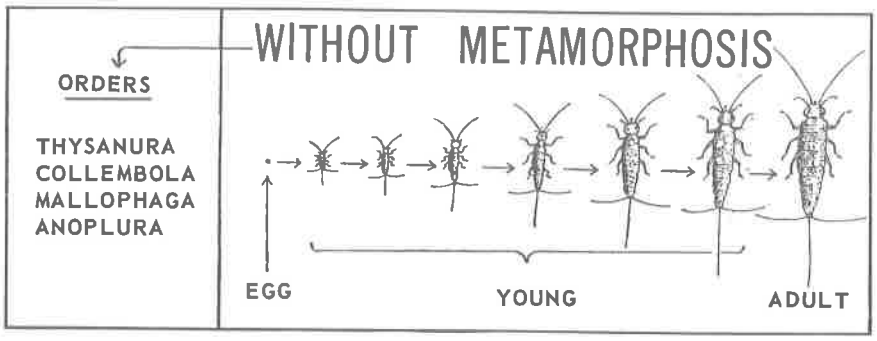
Observations, such as those you will make, help entomologists know when and where to spray and dust for insect control. Observe these vital points:

- How long does an insect stay in one particular stage of growth?
- Where does it spend its time?
- What does it eat?

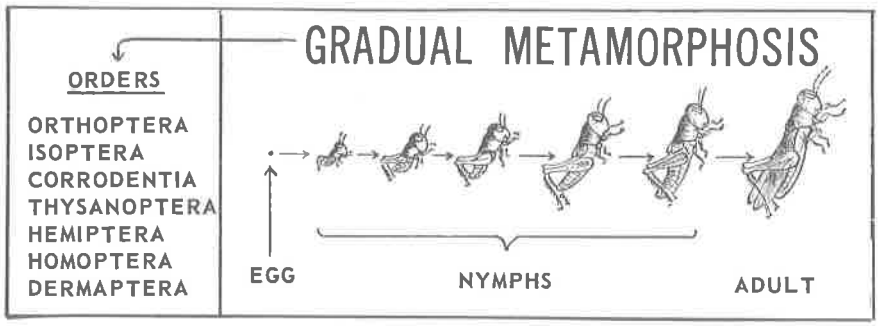
Preservation of the different stages is also very important.

METAMORPHOSIS is the name given to the change in the shape of an insect as it grows. Insects are divided into four groups depending upon their method of metamorphosis.

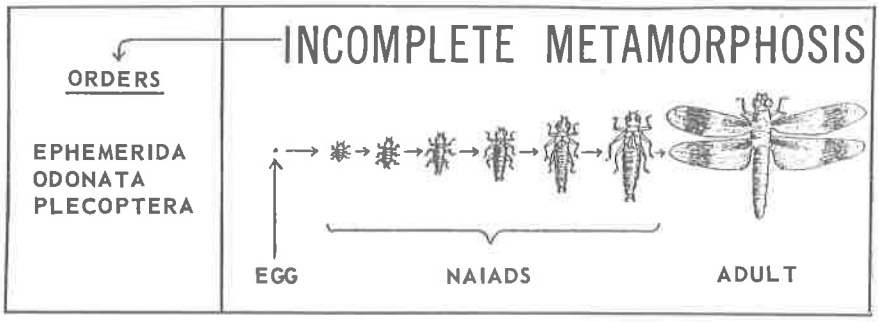
In GROUP 1 the insect that comes from the egg looks exactly like it will when grown, except that it will then be larger.



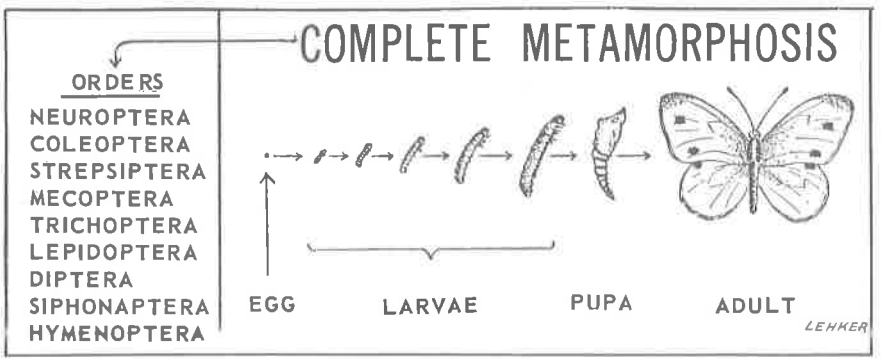
Insects in GROUP 2 change shape gradually. There are three stages of growth, each looking more like an adult.



The young insects in GROUP 3 change shape gradually. They do not look like adults until shedding their last skin. Then there is a quick change.

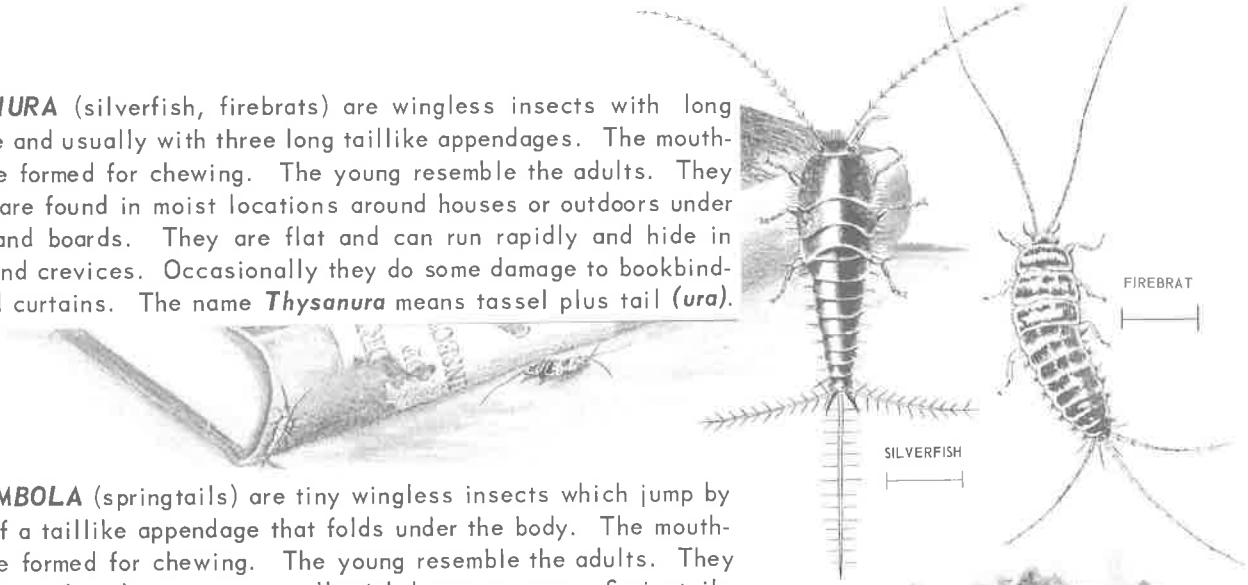


All insects in GROUP 4 go through four stages of growth. None of the young looks like the adult. There is a great change in shape when the adult emerges from the pupal stage.



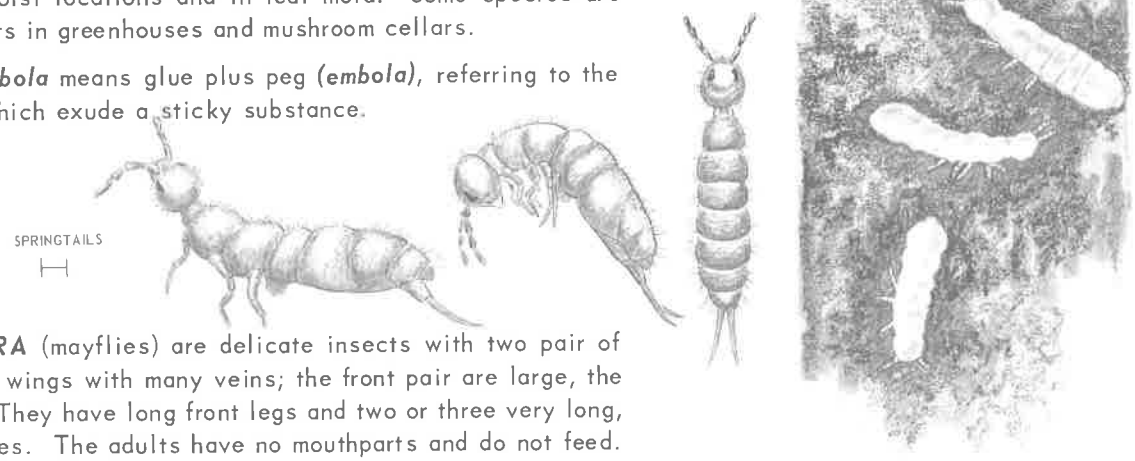
IDENTIFICATION OF INSECTS BY ORDER

THYSANURA (silverfish, firebrats) are wingless insects with long antennae and usually with three long taillike 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 tassel plus tail ***(ura)***.

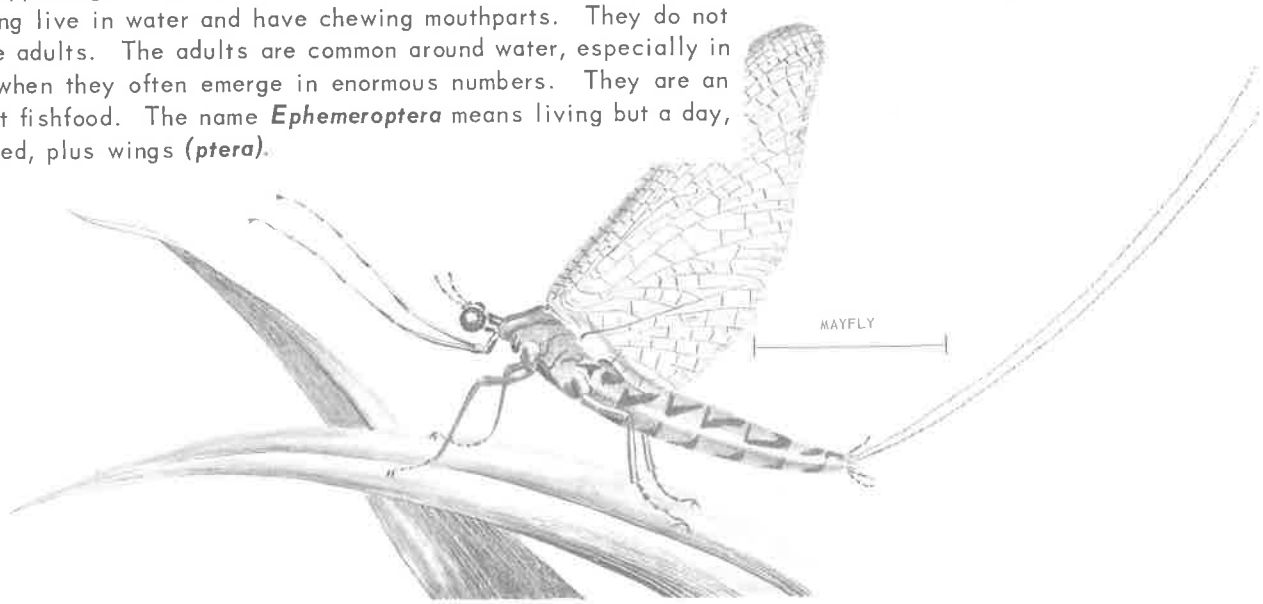


COLLEMBOLA (springtails) are tiny wingless insects which jump by means of a taillike appendage that folds under the body. The mouthparts are formed for chewing. The young resemble the adults. They usually are white but some are yellowish brown or grey. Springtails are common in moist locations and in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

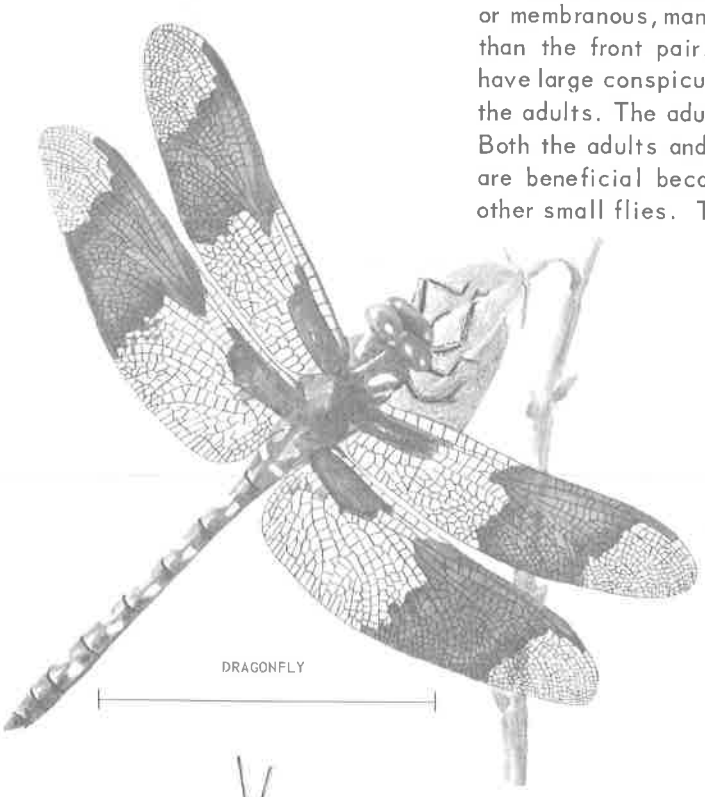
The name ***Collembola*** means glue plus peg ***(embola)***, referring to the ventricle tubes which exude a sticky substance.

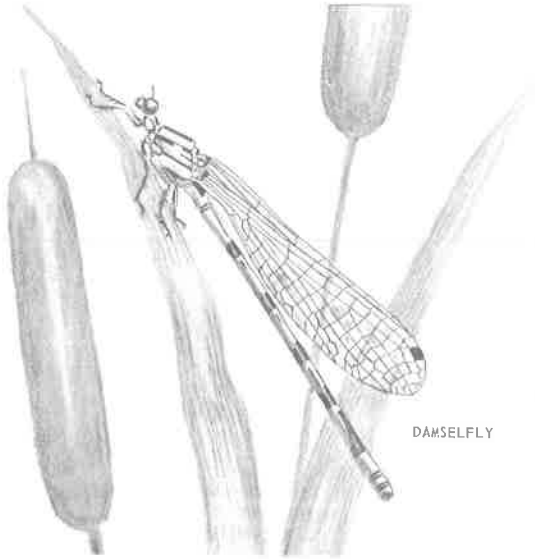


EPHEMEROPTERA (mayflies) are delicate insects with two pair of triangular-shaped wings with many veins; the front pair are large, the hind pair small. They have long front legs and two or three very long, taillike appendages. The adults have no mouthparts and do not feed. The young live in water and 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)***.

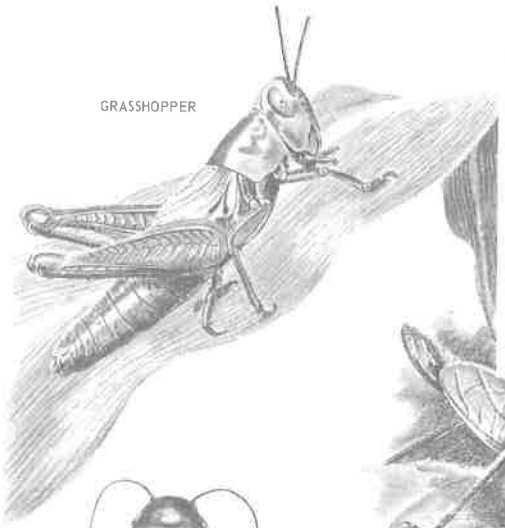


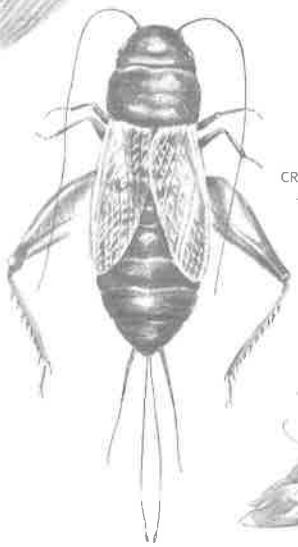
ODONATA (dragonflies, damselflies) are large insects with two pair or membranous, many-veined wings, the hind pair as large as or larger than the front pair. The mouthparts are formed for chewing. They have large conspicuous eyes. The young live in water and are not like the adults. The adults are common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

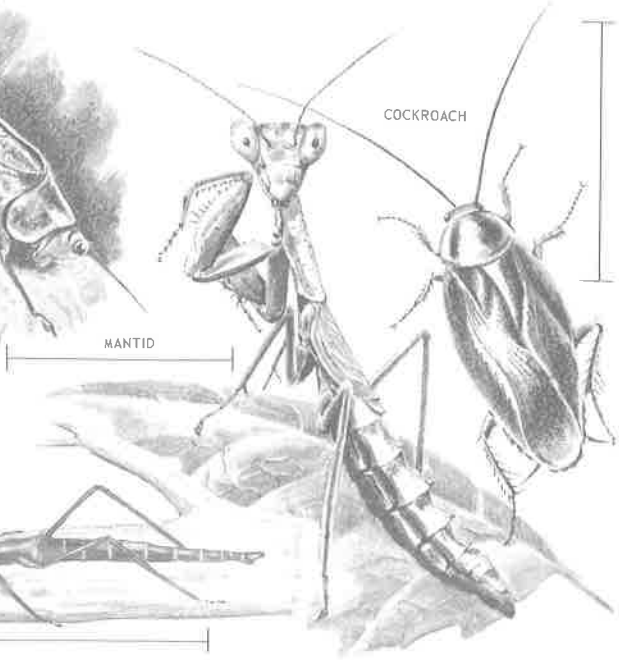


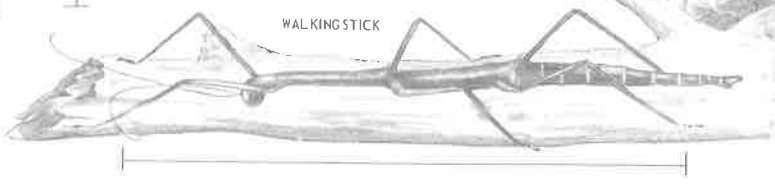


ORTHOPTERA (grasshoppers, crickets, katydids, roaches, mantids, walkingsticks) generally have two pair of wings which have many veins. The front pair usually is slender and the hind pair broad and fanlike. The mouthparts are formed for chewing. The nymphs resemble the adults. Several groups in this order 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)***.

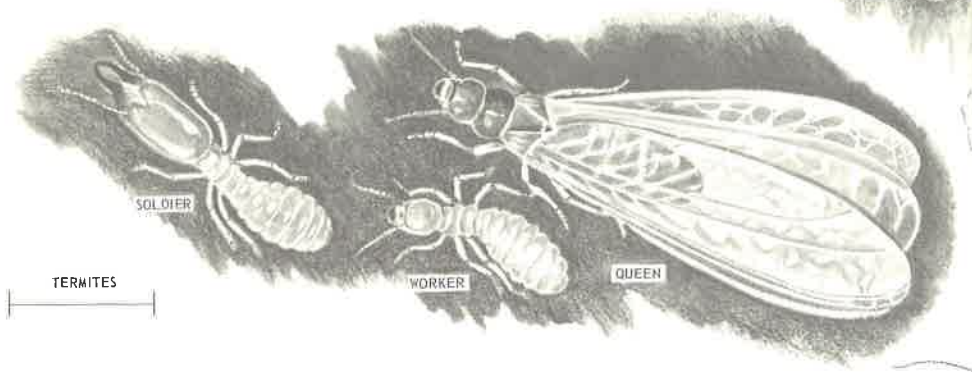




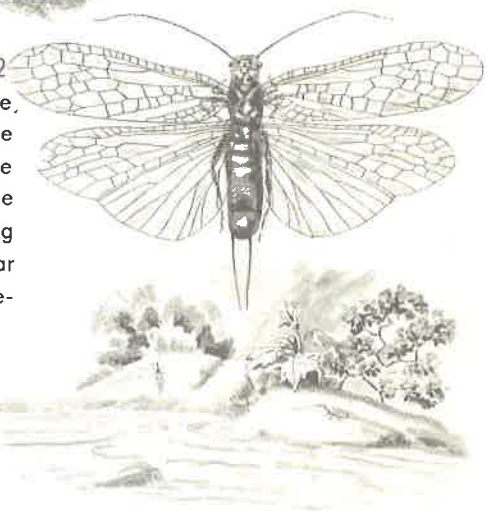


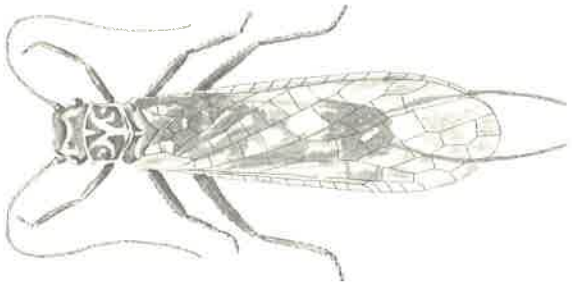


ISOPTERA (termites) are small, soft-bodied yellowish or whitish insects that live in colonies in wood. Colonies consist of three classes —workers, soldiers, and swarmers. The workers and soldiers are wingless and never leave the colony. The swarmers are reproductive forms having dark bodies and four 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.



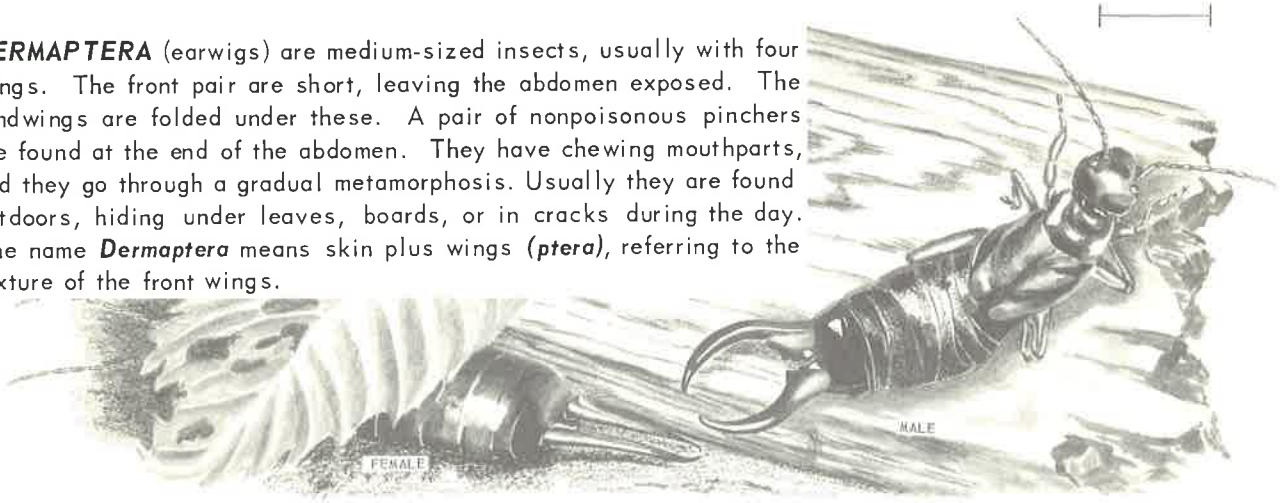
PLECOPTERA (stoneflies) are large soft-bodies insects, ½ to 2 inches long. They have four wings that fold flat over the back; the hind pair fold like a fan and are much larger than the front wings. The antennae are long, and there are two long taillike appendages at the tip of the abdomen. They have 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.

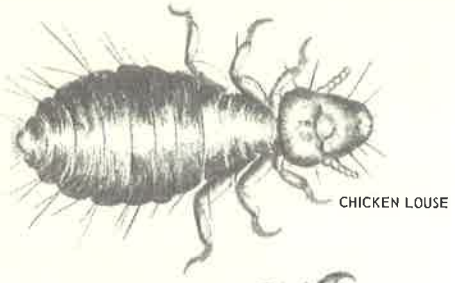




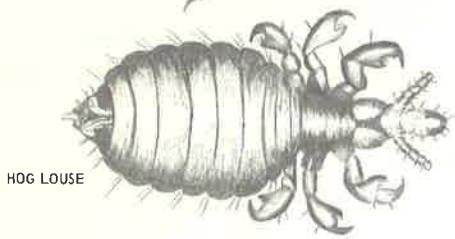
EARWIG

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.

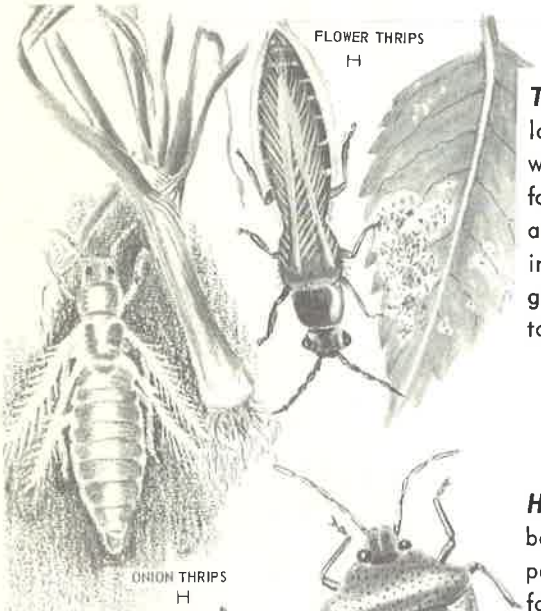




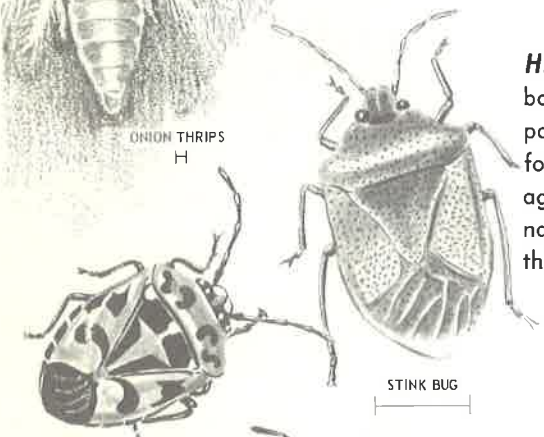
MALLOPHAGA (biting lice or bird lice) are small, flat, wingless, parasitic insects with mouthparts formed for chewing. The legs and antennae are short. The immature stages resemble the adults. They feed upon feathers, hair, wool, and skin scales. They are frequently important pests of domestic fowls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

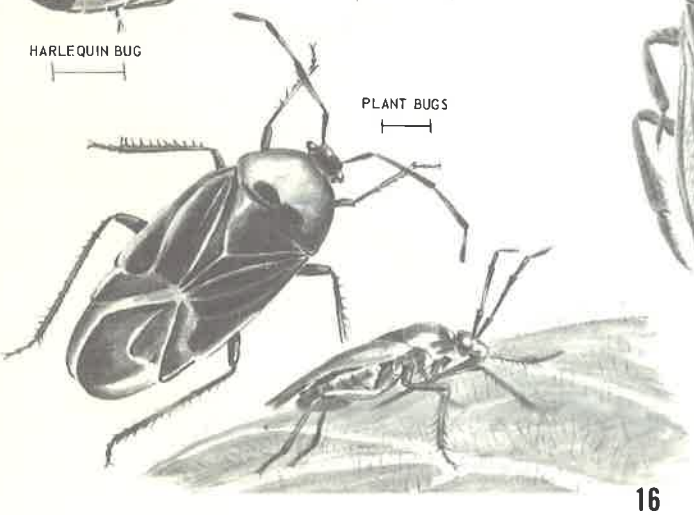


ANOPLURA (true lice or sucking lice) are small, flat, wingless, parasitic insects with mouthparts formed for piercing and sucking. The legs and antennae are short. The immature stages resemble the adults. These insects are found on man and domestic animals, but not on fowls. They feed by sucking blood.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

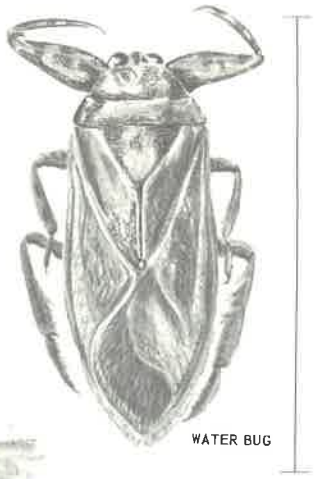


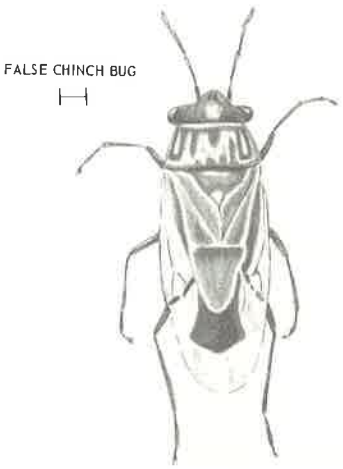
THYSANOPTERA (thrips) are mostly very small insects about $\frac{1}{8}$ inch long, usually with two pair of slender wings with few veins but fringed with long hairs. The legs and antennae are short. The mouthparts are formed for piercing and sucking, and the immature stages resemble the adults. Some 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.



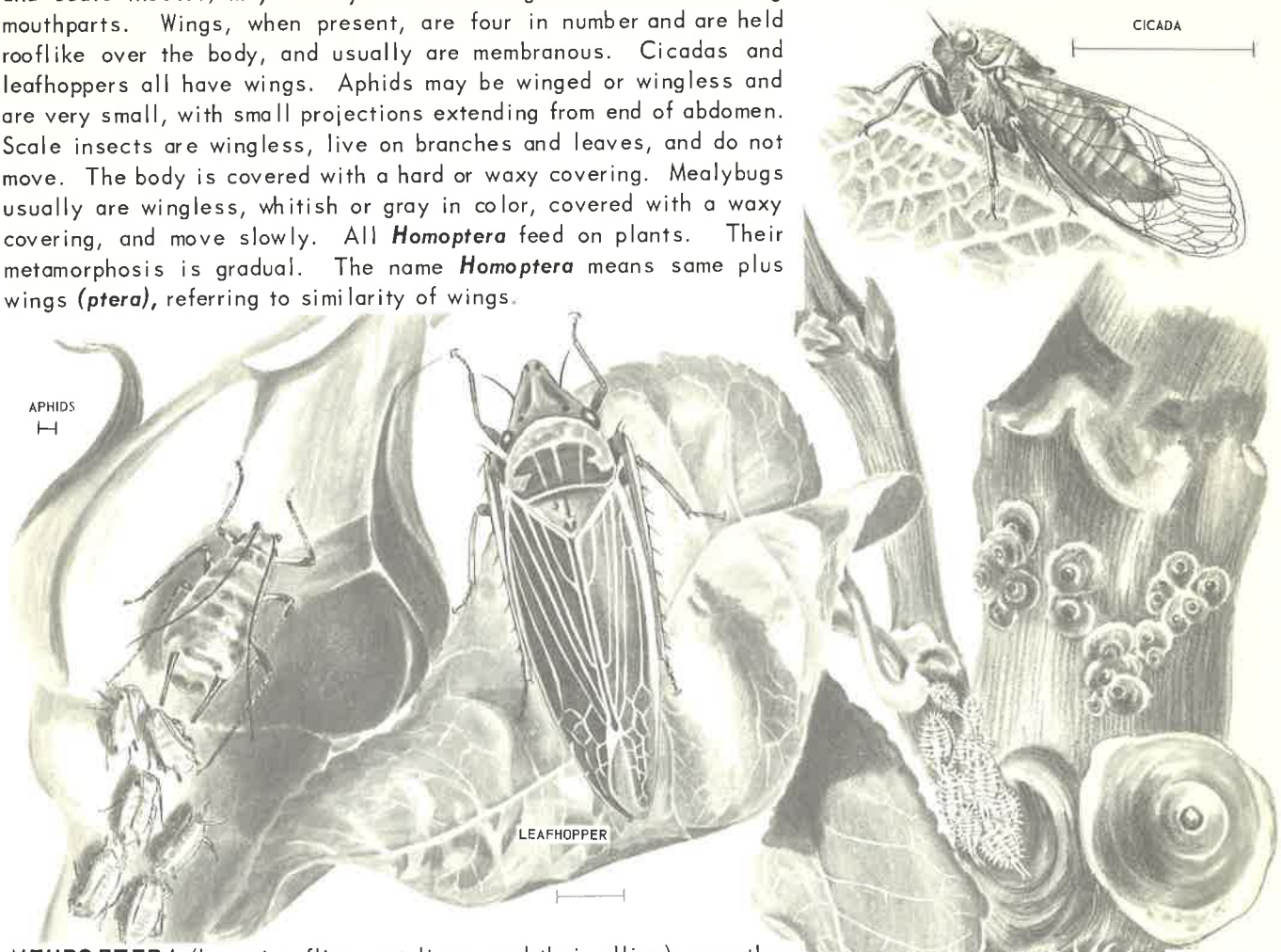


HEMIPTERA (true bugs) usually have four wings folded flat over the body. The front pair are thickened with membranous tips. The mouthparts are for sucking and are prolonged into a beak. The insects are found in water, on plants and animals, and cause considerable damage by their feeding. They go through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

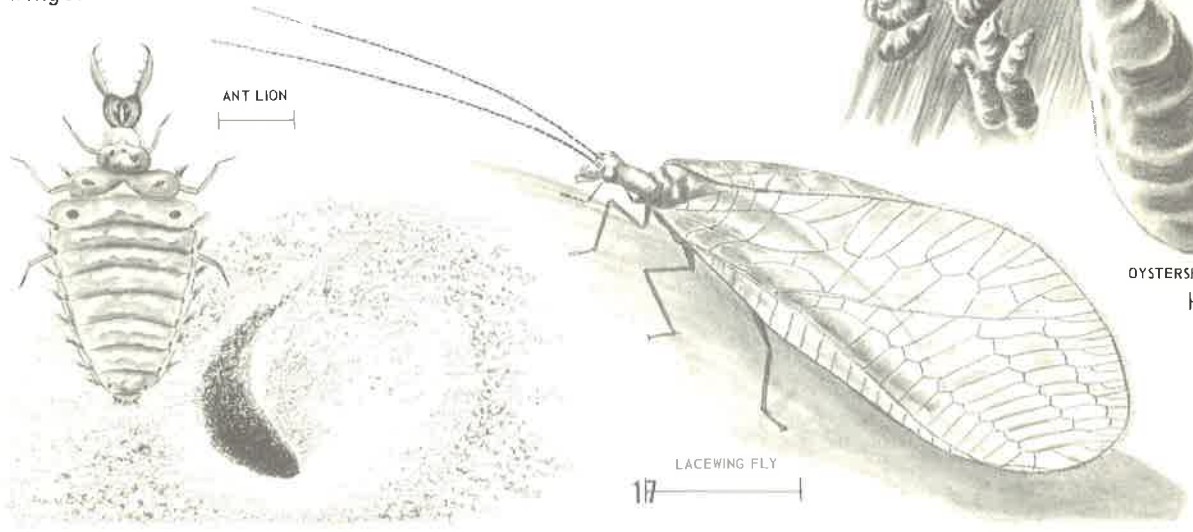




HOMOPTERA (aphids, leafhoppers, cicadas, whiteflies, mealybugs, and scale insects) may or may not have wings. All have sucking mouthparts. Wings, when present, are four in number and are held rooflike over the body, and usually are membranous. Cicadas and leafhoppers all have wings. Aphids may be winged 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.

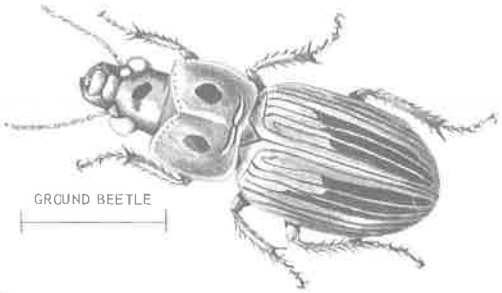


NEUROPTERA (lacewing flies, ant lions, and their allies) are rather fragile insects with two pair of many-veined wings of about the same size. The antennae are long. The mouthparts are formed for chewing. The immature stages are predaceous. These insects undergo complete metamorphosis. The commonest 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.

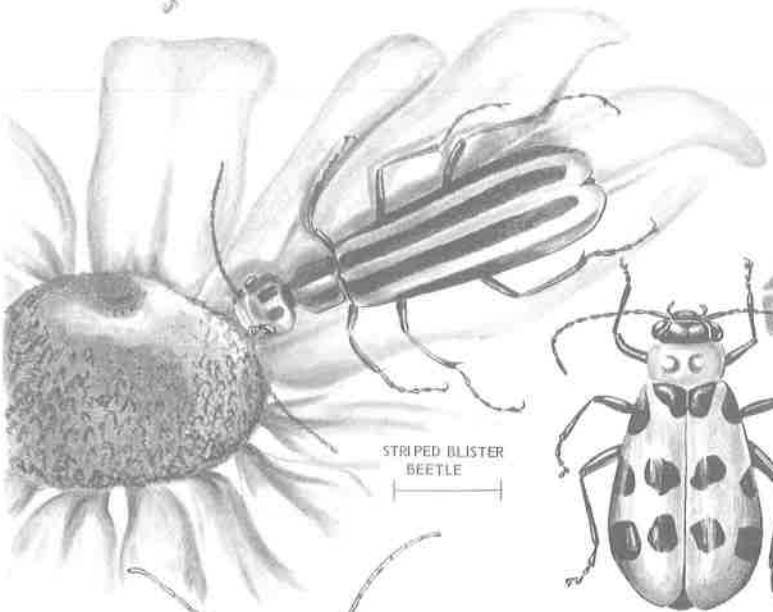


ALFALFA WEEVIL

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.



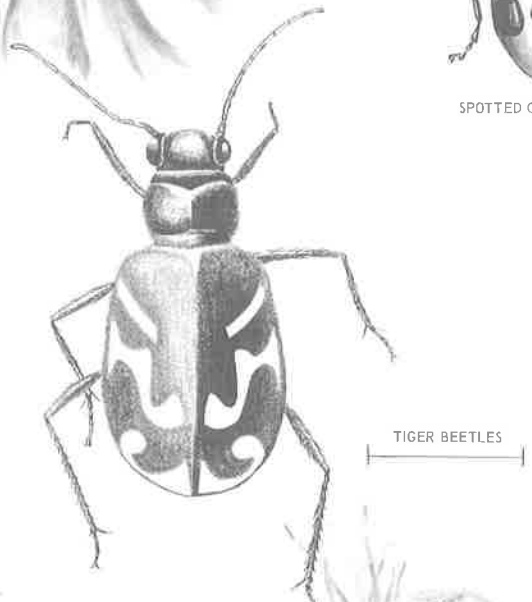
GROUND BEETLE



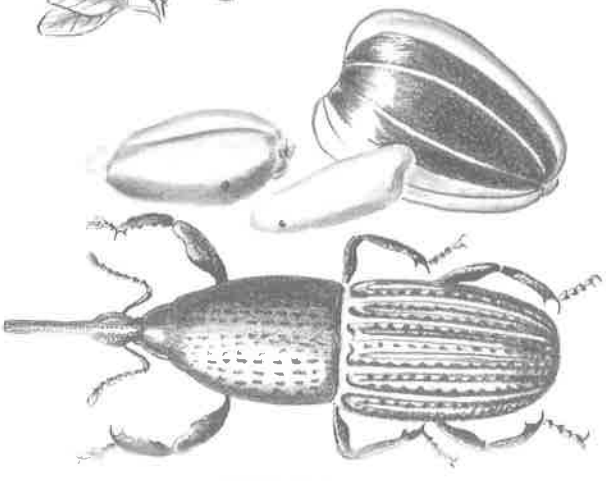
STRIPED BLISTER BEETLE

SPOTTED CUCUMBER BEETLE

LADY BEETLE



TIGER BEETLES



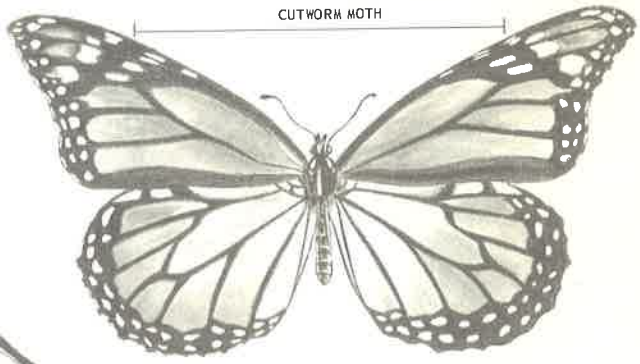
GRANARY WEEVIL

TRICHOPTERA (caddisflies) are soft-bodies 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 around streams. The name ***Trichoptera*** means hair plus wings ***(ptera)***.

CADDISFLY

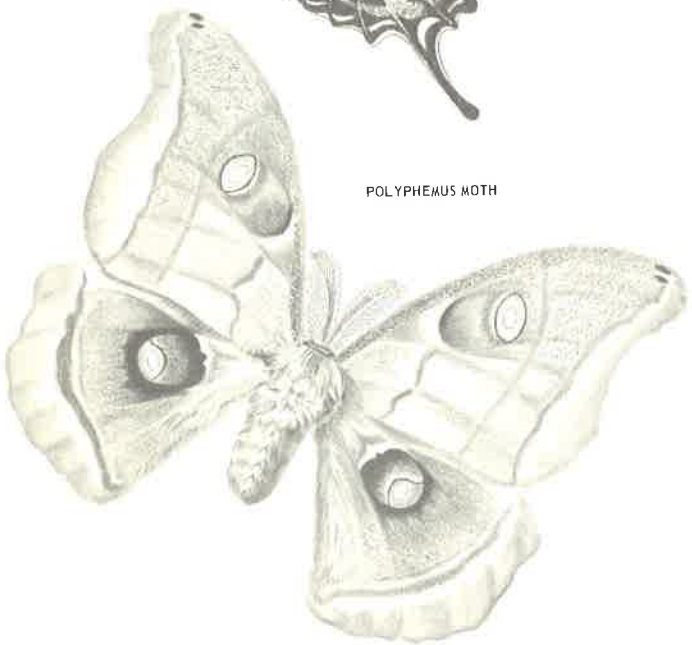
LEPIDOPTERA (butterflies, moths) usually are winged. The winged members have two pair of wings covered with overlapping scales. The mouthparts of the adults are formed for sucking. The immature stages are wormlike. Some are known as caterpillars, cutworms, or hornworms. Their mouthparts are formed for 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)***.

CUTWORM MOTH



MONARCH BUTTERFLY

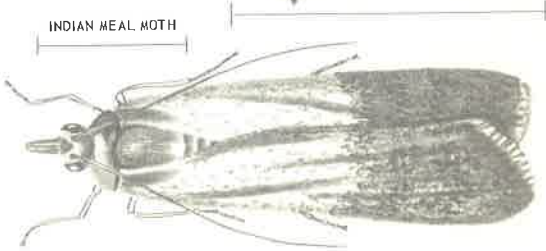
SWALLOWTAIL BUTTERFLY



POLYPHEMUS MOTH

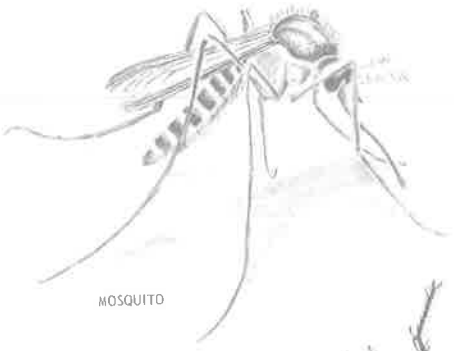
CLEARWING MOTH

INDIAN MEAL MOTH



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.

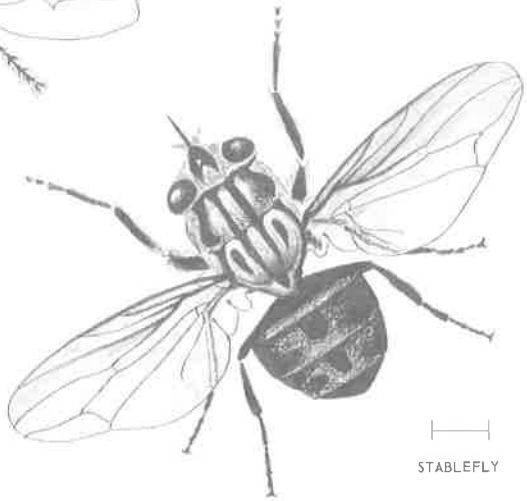


MOSQUITO

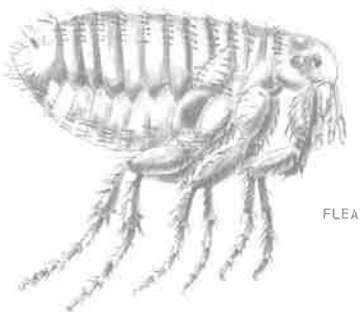
STRIPED HORSEFLY

FLESHFLY

WESTERN HORSEFLY



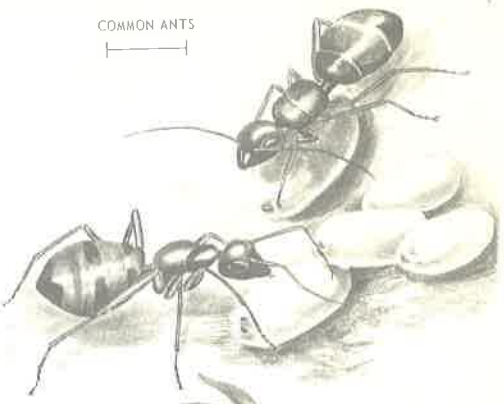
STABLEFLY



FLEA

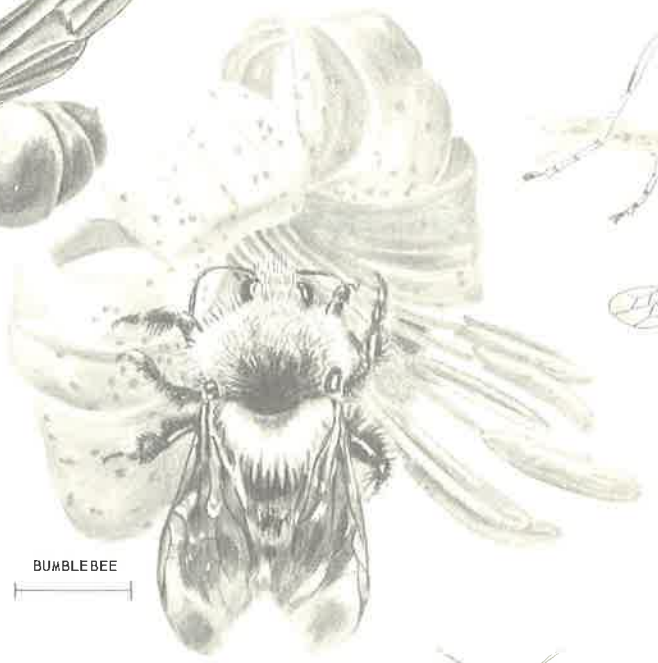
SIPHONAPTERA (fleas) are small, wingless insects with laterally compressed bodies. The legs are comparatively long. The body has numerous short bristles directed backward. The mouthparts are formed for piercing and sucking. The immature stages are wormlike, quite different from the adults, and are found 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 sucking. 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.



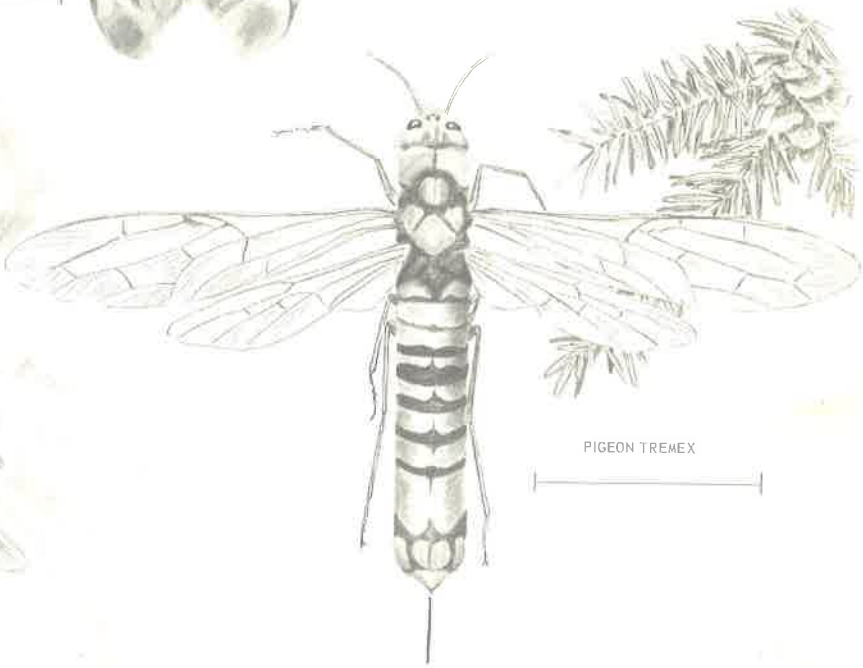
COMMON ANTS

PAPER NEST WASP



BUMBLEBEE

MUD DAUBER WASPS



PIGEON TREMEX

HONEYBEE

KEY TO ORDERS OF INSECTS

Read the first two lines of the key. You will see that you are given two choices or descriptions of parts of an insect.

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

Continue through the key in this manner, reading the two descriptions opposite each number to which you have been referred, and comparing them with the insect to be identified. Illustrations have been added to aid you in identification.

When you reach a description which fits the insect to be identified, it will be followed by a word printed in capital letters. This is the name of the order to which that insect belongs. For further information about the insect, turn to the page in the manual indicated by the number in the last column.

Words Used in the Key

Abdomen – the third body region of insects (see page 1 of the manual).

Antenna (pl., antennae) – the horns or feelers located on the heads of insects.

Cells – the areas in the wings of insects which are between or bounded by veins.

Cerci (sing., cercus) – the threadlike or sometimes forcepslike tails near the tip of the insect abdomen (usually a pair).

Conspicuous – easy to see.

Constricted – thin or narrow.

Cornicles – short, blunt horns or tubes (sometimes buttonlike) on the top and near the end of the aphid abdomen. They give off a waxy liquid which helps protect against enemies.

Elytra – the leathery or hard front wings of beetles. They usually cover the hindwings when at rest and sometimes are called "wing covers."

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

Halteres – small knoblike organs (sometimes shaped like a baseball bat or bowling pin) located on the thorax of ***DIPTERA***. They take the place of the hindwings and are used to help balance the insect in flight.

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

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

Mesothorax – the second or middle thoracic ring which bears the middle pair of legs and the first pair of wings.

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

Palpi (sing., palpus) – small "feelers" near the mouths of insects, probably used to help select food when eating.

Parasite – any animal that lives in or on another.

Pronotum – the top or upper side of the prothorax.

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

Scales – the powderlike covering which gives color to the wings of most butterflies and moths. Actually, very small scales which overlap like shingles on a roof.

Segments – joints or divisions of the insect body, leg, or antenna.

Segmented – jointed or divided into sections.

Stylet – tubular, sucking mouthparts of sucking lice or other sucking insects.

Tarsi (sing., tarsus) – the "feet" of insects. The last small segments or joints near the end of the insect leg. The number may vary from one to five.

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

Veins – the rodlike or veinlike stiffening or supporting "frame" of the insect wing.

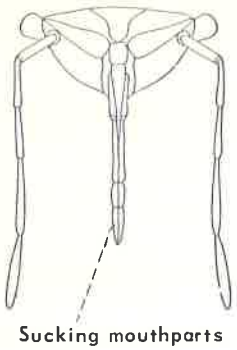


Figure 1

Figure 2

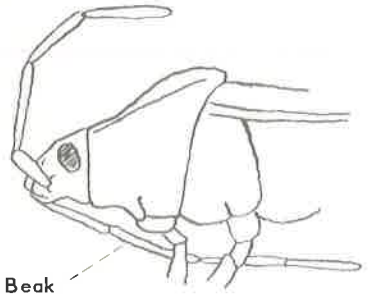


Figure 3

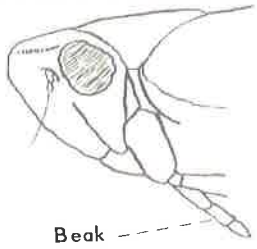


Figure 4

Steps		Refer to Step No.	Insect Order	Refer to Page No.
1.	Wings well developed	2		
	Wingless, or with small undeveloped wings .	22		
2.	Front wings (elytra) hard, leathery, at least at base; hindwings, if present, membranous (skinlike)	3		
	Wings entirely membranous (skinlike)	7		
3.	Sucking mouthparts, with beak longer than wide, and usually jointed (figure 1).	4		
	Chewing mouthparts (figure 2)	5		
4.	Beak arising from front part of head (figure 3); front wings usually leathery at base and membranous (skinlike) at tip; tips generally overlapping when at rest (true bugs)		***HEMIPTERA***	16
	Beak arising from rear underside part of head, often appearing to arise at base of front legs (figure 4); front wings of uniform texture throughout; tips not overlapping, or only slightly overlapping when at rest (leafhoppers, cicadas, aphids, treehoppers)		***HOMOPTERA***	17

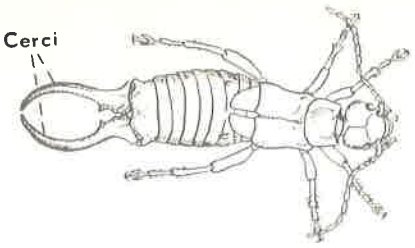


Figure 5

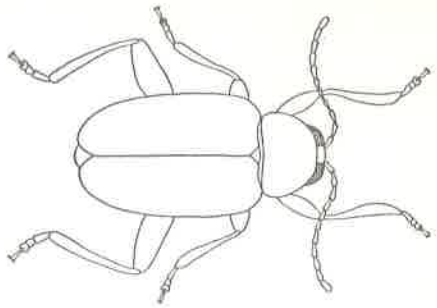


Figure 6

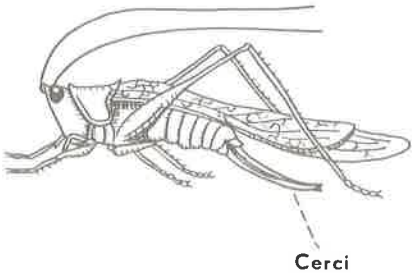


Figure 7

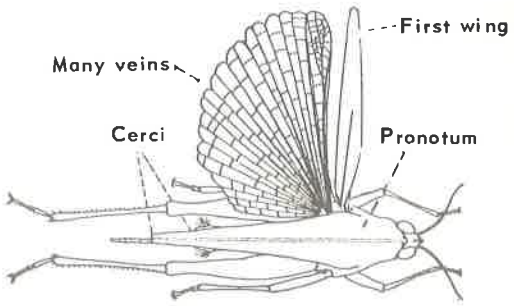


Figure 8

Steps		Refer to Step No.	Insect Order	Refer to Page No.
5.	Abdomen with forcepslike cerci (appendages near tail) (figure 5); elytra (leathery front wings) short, leaving most of the abdomen exposed (earwigs)		***DERMAPTERA***	15
	Abdomen without forcepslike cerci, or if cerci appear forcepslike, then wings cover most of abdomen	6		
6.	Front wings without veins, usually meeting in a straight line down middle of back (figure 6); antennae (feelers on head) with 11 or fewer joints; hindwings narrow, usually longer than front wings when unfolded, and with few veins (beetles)		***COLEOPTERA***	18
	Front wings with veins, either held rooflike over abdomen or overlapping over abdomen when at rest (figure 7); antennae usually with more than 12 joints; hindwings broad, usually shorter than front wings, and with many veins (figure 8) (grasshoppers, crickets, roaches, mantids)		***ORTHOPTERA***	14
7.	With 2 wings	8		
	With 4 wings	11		

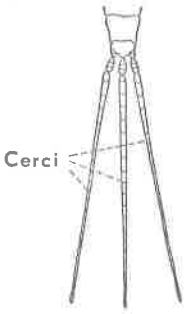


Figure 9

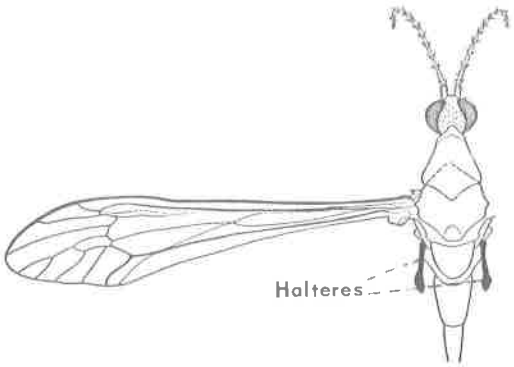


Figure 10

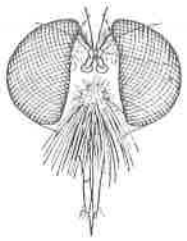


Figure 11

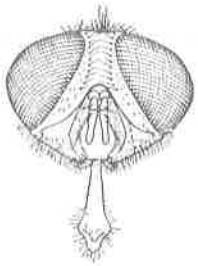


Figure 12

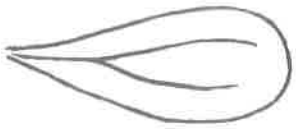


Figure 13

Steps		Refer to Step No.	Insect Order	Refer to Page No.
8.	Body grasshopperlike; pronotum (top side of prothorax) extending back over abdomen, pointed at tip (figure 8); hindlegs enlarged (grouse or pigmy locusts, family ***Tetrigidae***)		***ORTHOPTERA***	14
	Body not grasshopperlike; pronotum not as above; hindlegs not so enlarged	9		
9.	Abdomen with threadlike or spinelike tails (figure 9); mouthparts small or undeveloped; halteres (knoblike organs, taking place of hindwings) (figure 10) present or absent . . .	10		
	Abdomen without threadlike or spinelike tails; mouthparts usually well developed, forming a sucking beak (figure 11) or tongue (figure 12); halteres present (true flies, mosquitoes, gnats, midges)		***DIPTERA***	20
10.	Halteres (figure 10) present and hooklike; wings with only one forked vein (figure 13); antennae (feelers on head) long and conspicuous; very small insects, usually less than $\frac{1}{8}$ inch long (male scale insects, family ***Coccidae***)		***HOMOPTERA***	17
	Halteres absent; wings with many veins and crossveins; antennae short, bristlelike, small; usually over $\frac{1}{8}$ inch long (mayflies) . .		***EPHEMEROPTERA***	13

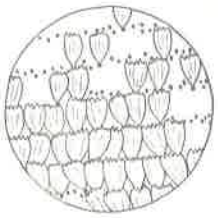
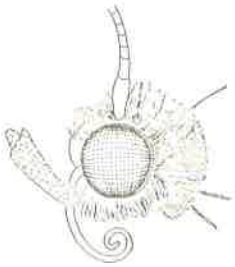


Figure 14



Coiled mouthparts

Figure 15

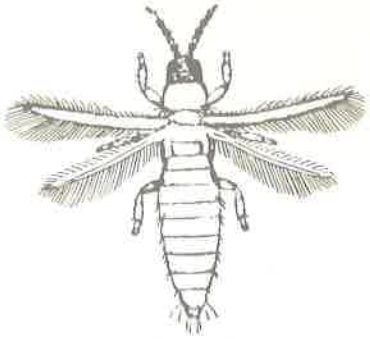


Figure 16

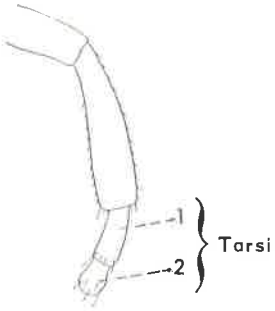


Figure 17

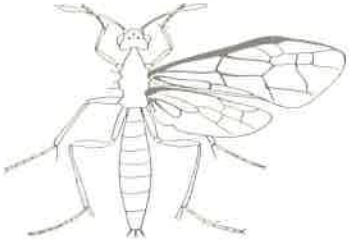


Figure 18

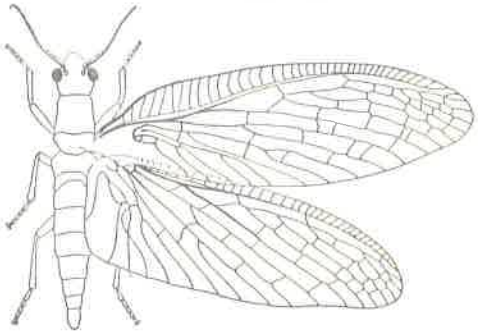


Figure 19

Steps		Refer to Step No.	Insect Order	Refer to Page No.
11.	Wings completely or almost completely covered with microscopic, powderlike scales (figure 14); mouthparts usually in the form of a long, coiled tubelike beak or tongue (figure 15); antennae (feelers on head) many-jointed (butterflies and moths)		***LEPIDOPTERA***	19
	Wings not covered with scales, though they may be hairy (figure 16); mouthparts not in form of a coiled tubelike tongue; antennae of various kinds	12		
12.	Wings long and narrow, veinless or with only 1 or 2 veins, fringed with long hairs (figure 16); tarsi (feet) (figure 17) with only 1 or 2 joints, the last segment swollen; very small insects, usually less than $\frac{1}{8}$ inch long (thrips)		***THYSANOPTERA***	16
	Wings not as above; if wings are somewhat long and narrow, then the tarsi have more than two segments	13		
13.	Hindwings smaller than front wings (figure 18), usually with fewer veins	14		
	Hindwings as large or larger than front wings, with as many or more veins (figure 19) . . .	18		

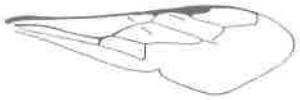


Figure 20

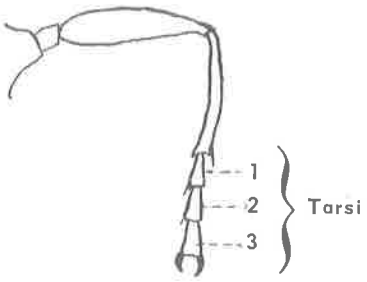


Figure 21

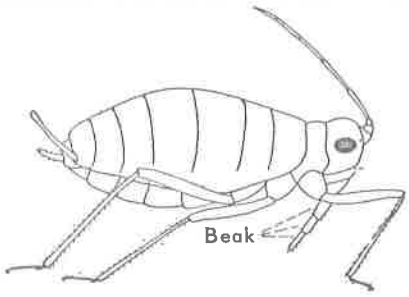


Figure 22

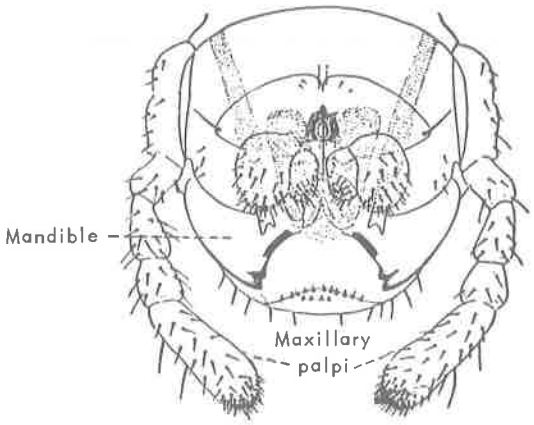


Figure 23

Steps		Refer to Step No.	Insect Order	Refer to Page No.
14.	Front wings with many crossveins and cells (areas between veins); antennae (feelers on head) short, bristlelike, small; abdomen with two or three long threadlike tails (figure 9); delicate, soft-bodied insects (mayflies)		***EPHEMEROPTERA***	13
	Front wings with few crossveins and cells (figure 20); antennae fairly long, or if short and bristlelike, then there are no threadlike tails	15		
15.	Tarsi (feet) two- or three-jointed (figure 21)	16		
	Tarsi (feet) four- or five-jointed	17		
16.	Mouthparts sucking, the beak arising at rear of head (figures 4 and 22) (leafhoppers, cicadas, aphids, treehoppers)		***HOMOPTERA***	17
	Mouthparts chewing (figure 23), very small insects (booklice, barklice, psocids)		***CORRODENTIA***	--

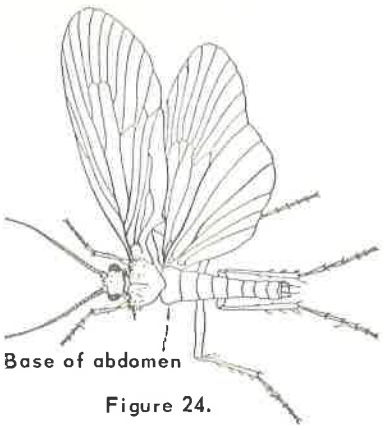


Figure 24.

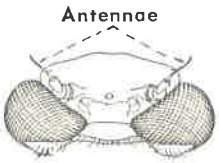


Figure 26.

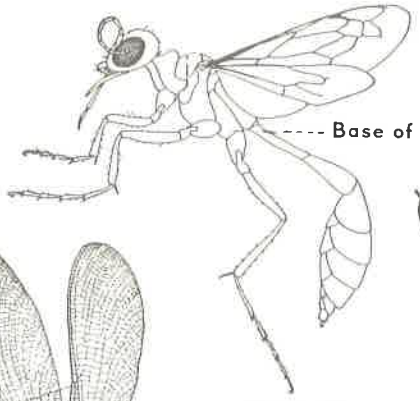


Figure 25.

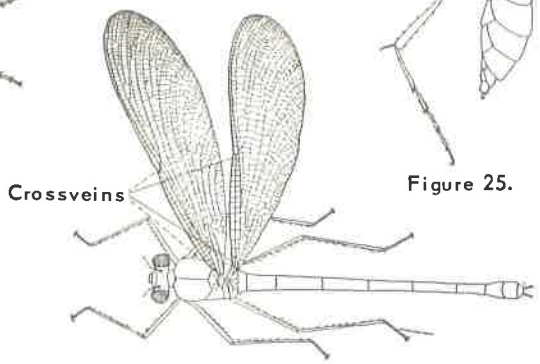


Figure 27.

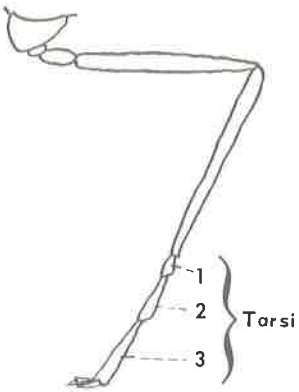


Figure 28.

Steps		Refer to Step No.	Insect Order	Refer to Page No.
17.	Wings noticeably hairy; mouthparts usually very small except for the palpi (feelers near mouth); antennae (feelers on head) usually as long as the body or longer; veins in front and hindwings similar; abdomen not narrow at the base; rather soft-bodied insects, not wasplike (figure 24) (caddisflies)		***TRICHOPTERA***	19
	Wings apparently not hairy; mandibles (chewing mouthparts) well developed; antennae shorter than the body; fewer veins in hindwings than in front wings; abdomen usually narrow at base (figure 25); rather hard-bodied, wasplike insects (sawflies, ichneumon flies, ants, wasps, and bees)		***HYMENOPTERA***	21
18.	Tarsi (feet) three- or four-jointed (figure 21)	19		
	Tarsi (feet) five-jointed	21		
19.	Antennae (feelers on head) short, bristlelike and small (figure 26); wings with many crossveins, never held flat over the abdomen when at rest (figure 27); tarsi (feet) three-jointed (figure 28); body long and slender, ¾ to 3½ inches long (dragonflies and damselflies)		***ODONATA***	14
	Antennae long and conspicuous; wing veins variable, usually held flat over abdomen when at rest; 1½ inches long or less	20		

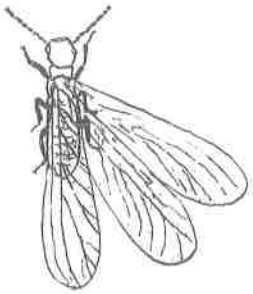


Figure 29

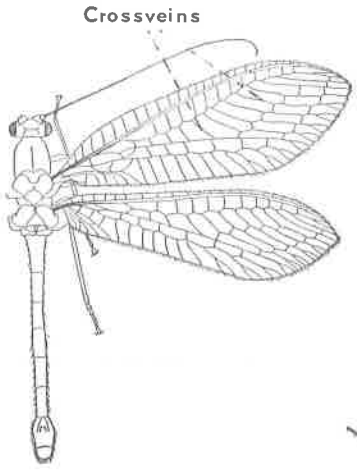


Figure 30

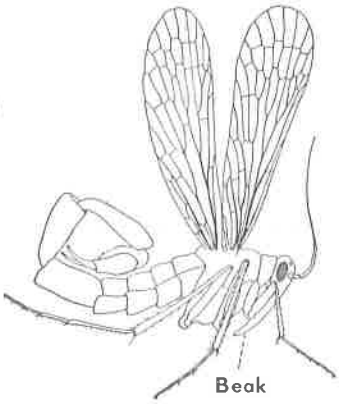
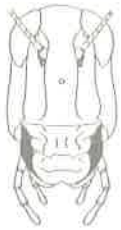


Figure 31

Steps		Refer to Step No.	Insect Order	Refer to Page No.
20.	Front and hindwings similar in shape, size, and number of veins, reaching well beyond the tip of the abdomen when at rest (figure 29); no cerci (appendages near tail); body $^{5}/_{16}$ inch long or less (termites)		*ISOPTERA*	15
	Hindwings with the rear area much enlarged and folded fanlike when at rest; cerci (appendages near tail) present; bodies mostly $^{5}/_{8}$ to 2 inches long (stoneflies)		*PLECOPTERA*	15
21.	Front edge of front wings with many crossveins (figure 30); mouthparts not formed into a beak (as in figure 31) (fishflies, dobsonflies, lacewings, ant lions)		*NEUROPTERA*	17
	Front edge of front wings with not more than one or two crossveins; mouthparts extended downward to form a "beak" (figure 31) (scorpion flies)		*MECOPTERA*	—
22.	Usually parasites living on the bodies of birds or animals; body more or less leathery, and flattened from the upper to lower sides of body or from side to side	23		
	Free-living, not parasites on bodies of birds or animals; body usually not flattened or leathery	28		



Chewing mouthparts

Figure 32

Sucking mouthparts

Figure 33

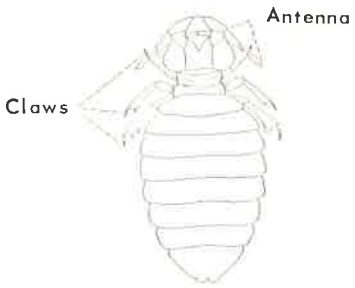


Figure 34

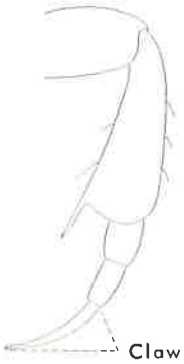


Figure 35

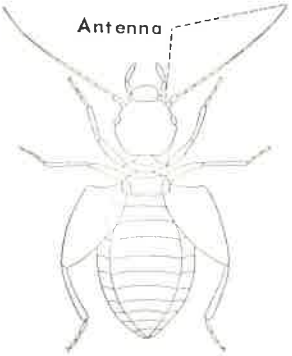


Figure 36

Figure 37

Steps		Refer to Step No.	Insect Order	Refer to Page No.
23.	Mouthparts chewing (figure 32)	24		
	Mouthparts sucking (figure 33), sometimes beak or stylet (tubular mouthpart) is drawn up into the head and cannot be seen . . .	25		
24.	Antennae (feelers on head) with five or fewer joints (figure 34); tarsi (feet) with one claw (figure 35), parasites of animals, or with two claws, parasites of birds (chewing lice)		*MALLOPHAGA*	16
	Antennae with more than five joints (figure 36); not parasitic (booklice, barklice, psocids)		*CORRODENTIA*	
25.	Body flattened on the sides (figure 37); jumping insects (fleas)		*SIPHONAPTERA*	20
	Body flattened from upper to lower sides; not jumping insects	26		

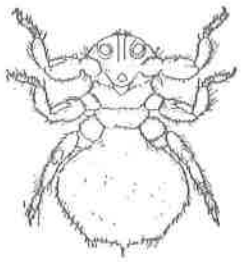


Figure 38

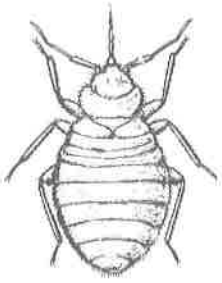


Figure 39

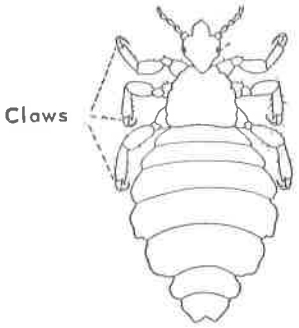


Figure 40

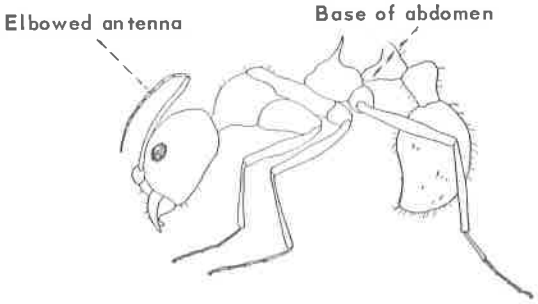


Figure 41

Steps		Refer to Step No.	Insect Order	Refer to Page No.
26.	Antennae (feelers on head) hidden in grooves beneath the head (louse flies) (figure 38)		***DIPTERA***	20
	Antennae not hidden, usually easy to see	27		
27.	Beak longer than wide, four joints, (figure 33), extending back beneath the body; tarsi (feet) with two small claws (wingless bugs) (figure 39)		***HEMIPTERA***	16
	Head with only a short snout in front, the stylet (tubular mouthpart) pulled back into the head when not in use; tarsi with one very large claw (figures 35 & 40) (sucking lice)		***ANOPLURA***	16
28.	Abdomen very thin, small or narrow at base (figure 41); antennae (feelers on head) usually elbowed (figure 41); hard-bodied, antlike insects (ants and wingless wasps, velvet ants)		***HYMENOPTERA***	21
	Abdomen not particularly thin at base; antennae not elbowed	29		

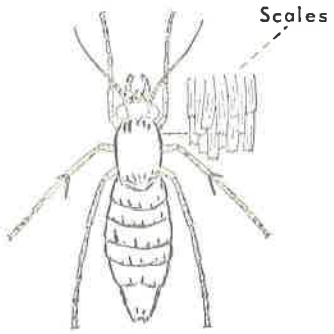


Figure 42

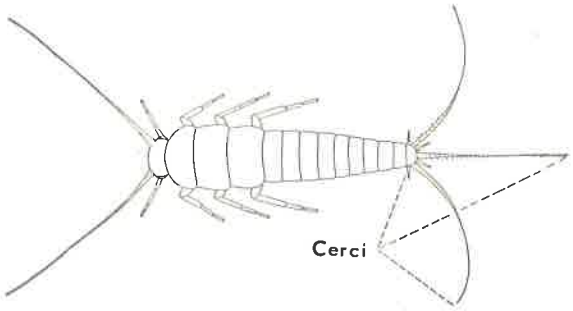


Figure 43

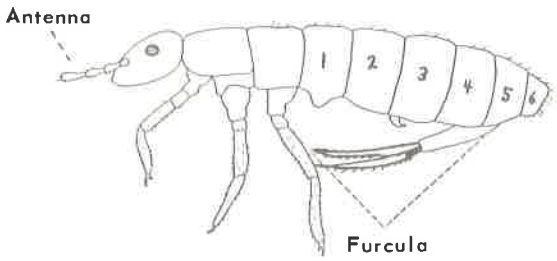


Figure 44

Steps		Refer to Step No.	Insect Order	Refer to Page No.
29.	Body covered with scales (figure 42) . . .	30		
	Body not covered with scales	31		
30.	Abdomen with three long threadlike tails (figure 43), and with spinelike hairs or spikes on some abdominal joints; mouthparts chewing (silverfish, bristletails, firebrats)		*THYSANURA*	13
	Abdomen without tails or spinelike hairs (figure 42); mouthparts sucking, usually in the form of a long, coiled threadlike tube or tongue (figure 15) (wingless moths)		*LEPIDOPTERA*	19
31.	Mouthparts hidden within the head; abdomen with spinelike hairs on some joints, or with a forked tail (furcula) near the end of the abdomen (figure 44); usually less than ¼ inch long	32		
	Mouthparts not as above, easily seen, and either sucking or chewing; size variable	33		

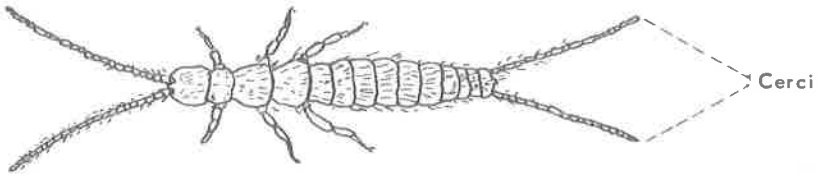


Figure 45

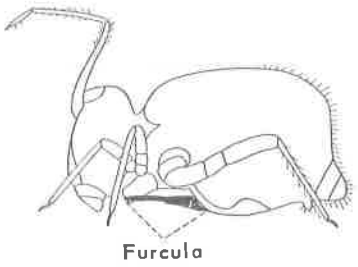


Figure 46

Chewing mouthparts

Figure 47

Steps		Refer to Step No.	Insect Order	Refer to Page No.
32.	Antennae (feelers on head) long and with many joints; abdomen with at least nine joints, with spinelike hairs on some joints; without a forked tail (furcula) near the end of abdomen, but with two, short to long, forcepslike appendages (cerci) at the end of the abdomen (figure 45) (japygids, campodeids, projapygids). These insects are light colored, about ¼ inch or less, and are found in damp places under bark, stones, or fallen trees, in rotting wood, etc.		***THYSANURA***	13
	Antennae short, with six or fewer joints; abdomen with six or fewer segments (figure 44), usually with a forked tail (furcula) beneath and near the end of the abdomen (figures 44 and 46) (springtails)		***COLLEMBOLA***	13
33.	Mouthparts sucking, with beak long and pointing backward from the head, or cone-shaped and pointing downward (figure 33)	34		
	Mouthparts chewing (figure 47); if beaklike, then the beak is fairly long and pointed downward (figure 50)	36		

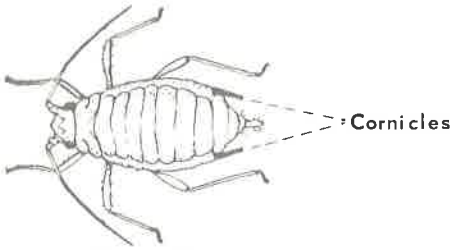


Figure 48

Figure 49

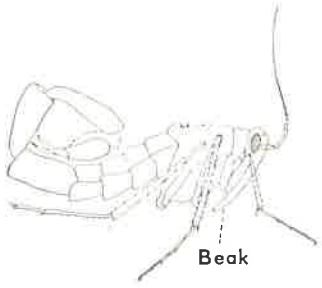


Figure 50

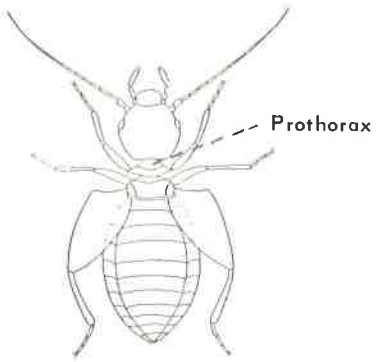
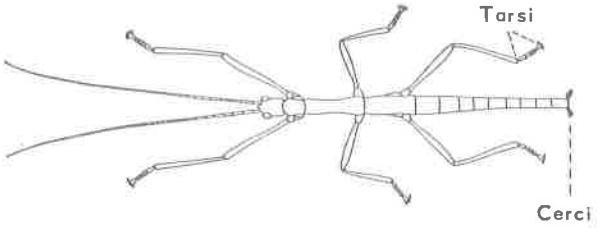


Figure 51

Steps		Refer to Step No.	Insect Order	Refer to Page No.
34.	Body long and narrow; tarsi (feet) with one or two joints and often without claws (figure 17); beak cone-shaped; very small insects, usually less than $\frac{1}{8}$ inch long (thrips) (figure 16)		*THYSANOPTERA*	16
	Body usually more or less oval; tarsi usually three-jointed (figure 28), with well-developed claws; size variable	35		
35.	Beak arising from rear under part of head (as in figures 4 and 22); abdomen often with a pair of cornicles (blunt horns or tubes) (figure 48) (aphids)		*HOMOPTERA*	17
	Beak arising from front part of head (as in figures 1 and 3); abdomen without cornicles (wingless bugs)		*HEMIPTERA*	16
36.	Cerci (appendages near tail) forcepslike (figure 49) (earwigs)		*DERMAPTERA*	15
	Cerci absent, or if present, then not forcepslike (figure 52)	37		
37.	Mouthparts in the form of a beak pointing downward (figure 50); tarsi (feet) five-jointed (figure 54); insect usually less than $\frac{5}{16}$ inch long (wingless scorpion flies) (figure 50) . .		*MECOPTERA*	—
	Mouthparts not as above; tarsi and size of insect variable	38		



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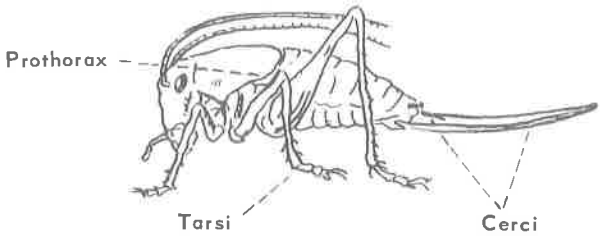

Figure 53

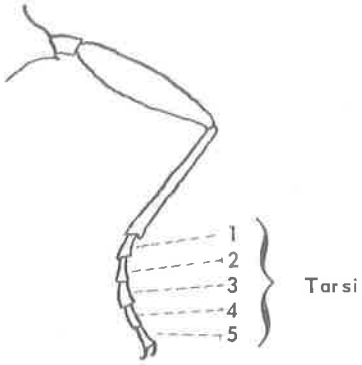

Figure 54

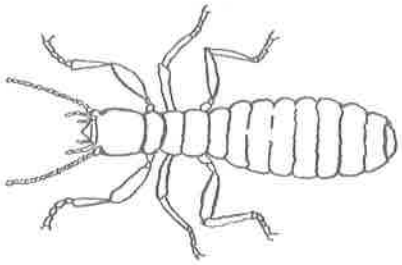

Figure 55

Steps		Refer to Step No.	Insect Order	Refer to Page No.
38.	Small louselike insects (figure 51) less than $^3/_{16}$ inch long; no cerci (appendages near tail); tarsi (feet) two- or three-jointed; prothorax (first ring of thorax) (figure 51) very small (booklice, barklice)		*CORRODENTIA*	—
	Not louselike, insect usually more than $^3/_{16}$ inch long; tarsi three- to five-jointed; cerci present (figures 52 and 53); prothorax large (figure 53)	39		
39.	Hindlegs large, fitted for jumping (figure 53); tarsi (feet) three- or four-jointed (crickets and grasshoppers)		*ORTHOPTERA*	14
	Hindlegs not large, not fitted for jumping (figure 52); tarsi four- or five-jointed . . .	40		
40.	Tarsi (feet) four-jointed; whitish, soft-bodied, living in wood or ground; insect $^5/_{16}$ inch long or less (termites) (figure 55)		*ISOPTERA*	15
	Tarsi five-jointed; appearance not as above (roaches, mantids, walkingsticks) (figure 52)		*ORTHOPTERA*	14

EXHIBITS

Exhibit your properly mounted and identified insect collection at your local or community fair. Be sure your exhibit meets the requirements of the year in entomology in which you are enrolled, and that your insects are in good condition. Remember that the primary object of an exhibit is to create interest.

BOXED INSECT COLLECTIONS (Pinned Specimens)

1. **Quantity** – First year requires a minimum of 25 insects in 9 orders. Consult **project outline** for other project year requirements.
2. **Accurate identification** – Key only to order.
3. **Correct labeling** – The stacked-labels system under a pinned insect is standard. Group related insects by order, and identify with pinned label.
4. **Quality** – Do not use broken insects.
5. **Arrangements of appendages** – After removing insects from relaxing jar, hold legs and antennae in position by pins on separate paper board mount until dry. Extend wings on grasshoppers, moths, dragonflies, and butterflies.
6. **Correct pinning** –
   a. Relate pin size to insect size. Specimens should be at uniform height, not tipped nor askew.
   b. Use card points for small beetles, bugs, leafhoppers, mosquitoes, and small flies. Tips should be bent down and cemented to the insect's right side.
   c. **Do not** pin caterpillars, grubs, mayflies, silverfish, fleas, aphids, scales, or whiteflies. Use vials.
7. **Preservative** – A mothball on a pin or paradichloro-benzene flakes are excellent.

EQUIPMENT

Nets – Label net as to type (general, aerial, aquatic, sweeping).

Killing jars – An exhibit should contain at least two jars marked **For *Lepidoptera* Only**. Label all jars **Poison – Killing Jar.** Jars must be charged, ready for use, wiped clean when exhibited.

Spreading board – Exhibit with moth or butterfly.

LIFE CYCLES

Use Riker mounts. Include a specimen of the host, showing damage if available. Label stages and damage. Include collection data. Fluid mounts can be used to show the various stages of the life cycle. Explanatory labeling and collection data should be included.

DEMONSTRATIONS

Demonstrations give club members the opportunity to show the details and methods of insect control, especially in relation to insects common in their own communities. Thus, club members become well informed and are better prepared to pass this information on to others.

Major points which should be well developed in any 4-H demonstration dealing with insect control include: the damage done by an insect, its life cycle or how it lives, its feeding habits, and methods of control. The insect, the host plant or animal, and some evidence of the damage caused by the insect should be shown in the introduction.

In presenting your demonstration, material such as models of insects or charts should be kept out of sight except when in use. When these materials are being used in the demonstration, handle them so they are plainly visible to the audience. Diagrams or charts help illustrate the feeding habits and different kinds of mouth structures and other body features of insects.

Summarize your demonstration by reviewing all the important points. Use charts, posters, and any type of illustrative material necessary.

To have your demonstration correct and complete, study all the subject matter material available about your subject. Talk with your local leader and your farm advisor for suggestions and information.

DEMONSTRATION TOPICS

Here are suggestions for topics which may be developed into demonstrations. The subheads under each topic are control methods that should be demonstrated.

CONTROLLING THE CLOTHES MOTH AND CARPET BEETLE

Spraying
Brushing, sunning, and airing
Cleaning and storing
Fumigation

CONTROLLING STORED-GRAIN INSECTS

Cleaning bins
Spraying bins
Fumigation

CONTROLLING THE CATTLE GRUB

Spraying
Dusting
Hand control
Washing

CONTROLLING THE SCREWWORM

Medication
Prevention of wounds

CONTROLLING LICE ON ANIMALS

Dipping
Spraying
Dusting

CONTROLLING VEGETABLE GARDEN INSECT PESTS

CONTROLLING FLOWER INSECT PESTS

CONTROLLING HOUSEFLIES

Sanitation
Screen
Sprays

In addition to demonstrations on insect control, many other phases of insect work can be presented as demonstrations. These items may suggest some:

- Preparing insects to be sent away for identification
- Making a collection net
- Mounting insects
- Making a killing jar
- Making a spreading board

IMBEDDING A DRY OPAQUE SPECIMEN

1. Use a thoroughly dried specimen. To reduce the chances of ruining the mount with air bubbles and "silvering" of the specimen, soak the specimen overnight in enough uncatalyzed plastic to cover it.

2. While the specimen is soaking, you can start the mount in a mold. Select a mold with square sides if possible, because they are much easier to polish. Apply a mold release compound (a hard-finish floor or furniture wax will do) to the inside of the mold and allow it to dry. Pour enough plastic into a paper cup to make a thin layer in the bottom of the mold. The depth of the layer depends on the size of the mount. A good average depth is about ⅛ inch. Pour the plastic into the mold and allow it to set overnight to jell. The base layer in the mold is then firm enough to support the specimen.

   Remove the specimen from the uncatalyzed plastic and drain it on a paper towel. Place the specimen upside down in the base layer in the mold. Start placing the specimen in on one side and work to the other side gradually. Use a probing needle or some similar instrument to remove any entrapped air bubbles. Let set for 5 or 6 hours so the specimen will adhere to the base layer; otherwise, the specimen will float when the second layer is poured.

3. When the specimen is firmly adhered to the base layer, mix enough plastic with catalyst to fill the mold. Allow this to harden about 24 hours. The surface then will still be tacky. To harden the plastic, you must shut off the air from the surface. Spread a sheet of Saranwrap or similar cellophane over the surface, working from one side to another to prevent trapping air bubbles.

4. Place the mold with the jelled plastic in an oven at about 140° F for 3 to 4 hours. You can make a satisfactory oven with a 40-watt light bulb and a small cardboard box. Cut a hole in the bottom of the box to fit a light-bulb socket, and cut two ventilation holes in the corners of the box. Insert the light bulb and invert the box over the mold. Heat the mold for 3 to 4 hours and then leave it in the box until it reaches room temperature.

Three steps in embedding an insect in plastic: 1) pour layer of catalyzed plastic into glass mold to harden; 2) place insect in center of hardened layer; 3) pour another layer, covering the insect.

5. Remove the mold and take the plastic block out of the mold. The mount is now ready to polish. Start with a fairly coarse emery cloth, about 180 grit. Lay the emery cloth on a smooth surface. Wet the cloth and work the mount back and forth on all sides until all coarse blemishes are removed. Repeat the process with a finer emery cloth. Then repeat with a very fine cloth. Dip the block in water frequently so you can see the degree of grinding. Next use a felt pad with some sort of liquid abrasive, such as wetted Ajax or Babo. To put a final polish on the mold, polish with jewelers' rouge or toothpaste or powder.

6. If an opaque background is desired, do not fill the mold full in step 3. Fill within about ⅛ inch from the top of the mold. Allow to harden 24 hours, then mix enough plastic to jell the mold, and add the opaque coloring which is available where the plastic is sold. Be sure that the opaque coloring is recommended for the plastic that you use.

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Here's how U C A E S helps your 4-H program

The Agricultural Extension Service of the University of California and the United States Department of Agriculture serve and assist 4-H Club members, their parents and leaders with professional guidance, training, and literature.

The University of California is represented in your county by farm and home advisors, one or more of whom are responsible for 4-H Club work. They bring the latest information on agriculture and home economics to you and your family. The Agricultural Extension Service prepares and distributes publications, such as this one, to help you in your 4-H work, and to help make 4-H Club work in California a success.

GUIDE FOR JUDGES OF 4-H CLUB ENTOMOLOGY EXHIBITS

INSECT COLLECTIONS

Score

Number of insects 20

Insects representing the number of orders and the number of insects required in the project.

Condition of insects 20

Antennae and legs intact.
Wings of butterflies and moths not frayed, nor scales rubbed off.
Insects free of foreign matter.
Insects not crushed or otherwise damaged.

Insects properly mounted 20

Pins inserted at proper location. (See 4-H Club Entomology Manual, page 4.)
Wings of butterflies and moths properly spread. Hind margins of forewings should form a straight line at an angle of 90^{o} with the center line of the insect. (See page 8 in Manual.)
Immature forms (larvae or nymphs) and soft-bodied insects, such as ants and termites, displayed in glass vials in preserving fluid.

Insects correctly identified as to order and labeled. 20

The top label should show the nearest city where found, date found, collector's name.
The middle label should show place found (host plant or animal, near lights, in stored products, etc.).
The bottom label should show the common name if known.
Labels for insects preserved in fluid may be narrow strips of stiff paper, printed with India ink, and inserted in the vials with the insects. If vials are fastened to a board or bottom of a box, labels may be fastened to the board or box close to the vial. Insects should not be obscured by labels.

General appearance 20

Insects in a collection should all be mounted at the same height on the pins. About 3/8 inch below the pinhead is about right.
Labels should also be at a uniform height on the pins.
Labels should be parallel to the long dimension of the insect or mount, and in line with each other on the pins.
Insects should be arranged so that those which represent each order are grouped together.
Insects should be arranged in the box in neat rows.
Display box should be neat and attractive in appearance.

Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

4-H-2024
REPRINTED NOVEMBER 1980

INSECT DISPLAYS

	Score
Completeness — Required number of insects and stages of life cycle represented.	20
Condition of insects — Antennae and legs intact. Wings of butterflies and moths not frayed, nor scales rubbed off. Insects free of foreign matter. Insects not crushed or otherwise damaged.	20
Mounting — Insects properly mounted or displayed.	20
Identification and labeling — Insects correctly identified as to order and common name. Labels and supporting information accurate, complete, and properly displayed.	20
General appearance — Neat and attractive arrangement, with eye appeal and information value.	20

EQUIPMENT

Workmanship — Complexity, quality of construction.	50
Utility — Suitability for purpose intended.	25
Appearance — Finish, completeness.	25

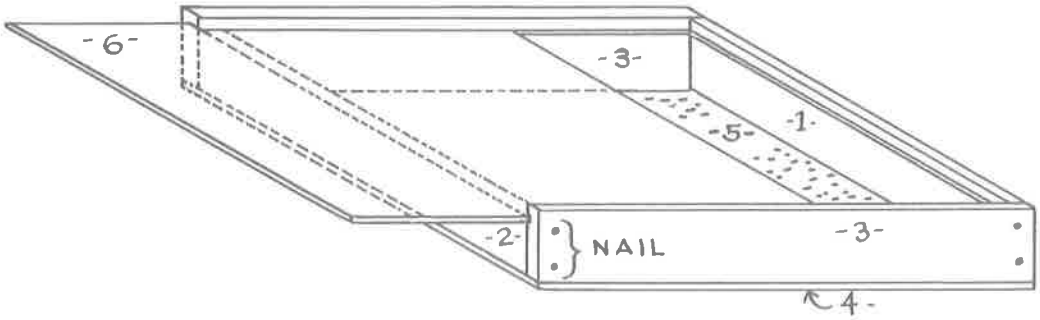
Judges may wish to group their placings and make awards as follows:
Score 92 or above might receive blue ribbons;
Score 84 to 91, red ribbons; and
Score 83 and below, white ribbons.

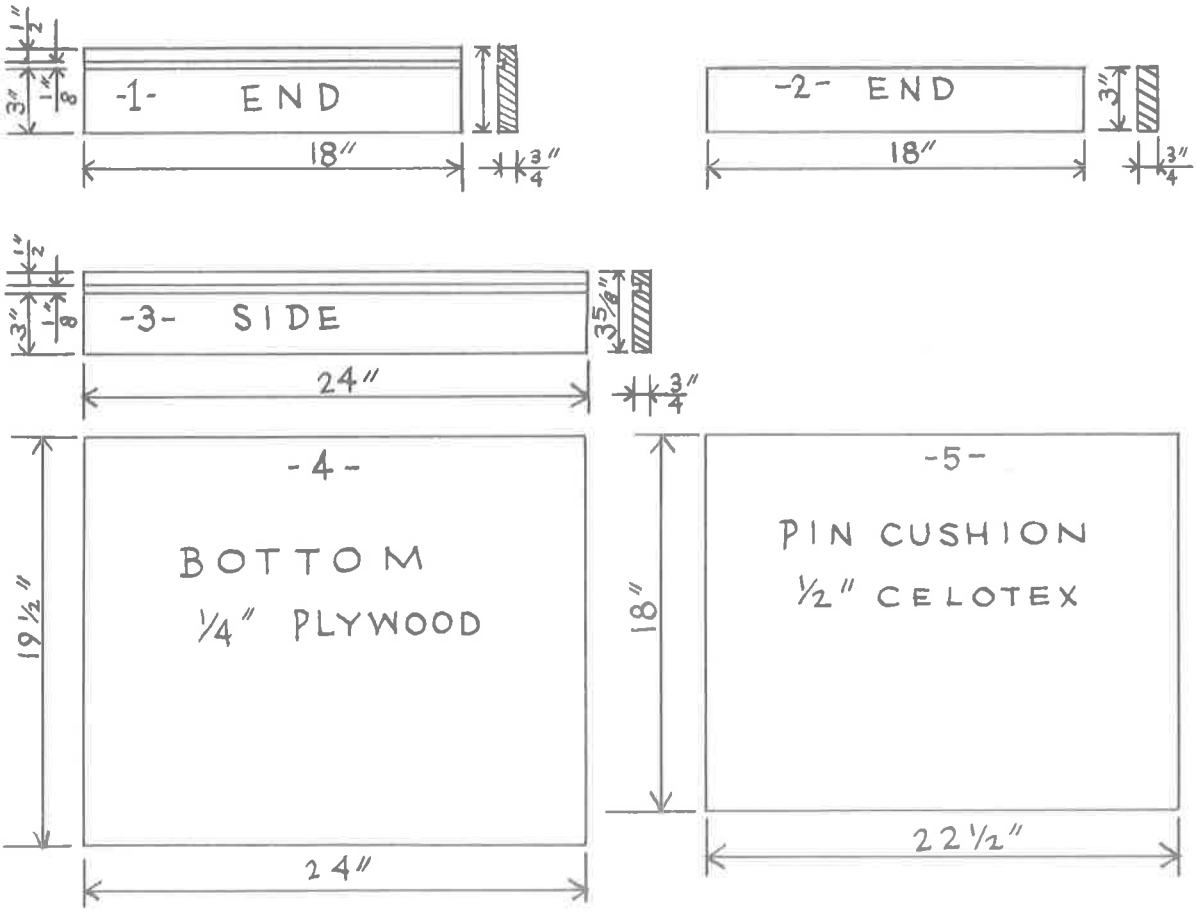
1½m–11/80–DCK/LAM

AN INSECT DISPLAY BOX

BILL OF MATERIALS			
NO.	REQ.	SIZE	MATERIAL
1	1	3/4" X 3 5/8" X 18"	WHITE PINE
2	1	3/4" X 3" X 18"	WHITE PINE
3	2	3/4" X 3 5/8" X 24"	WHITE PINE
4	1	1/4" X 19 1/2" X 24"	1/4" PLYWOOD
5	1	1/2" X 18" X 22 1/2"	1/2" CELOTEX
6	1	18 3/8" X 23 1/2"	S.S.A.GLASS

Note: Each piece is numbered so you can see the detailed dimensions below.





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OCTOBER 1964

4-H—Ag83

CALIFORNIA 4-H ENTOMOLOGY PROJECT

CUT-OUT LABELS FOR YOUR COLLECTION

Use as Directed in Manual

Examples	Orange CO. CALIF. 1-29-1958 COLL. S. MOORE	WHERE FOUND On Tomatoes	COMMON NAME Tomato Hornworm		Use these labels to show the ORDER of your insects	
CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	THYSANURA	THYSANURA
CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	COLLEMBOLA	COLLEMBOLA
CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	EPHEMEROPTERA	EPHEMEROPTERA
CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	ODONATA	ODONATA
CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	ORTHOPTERA	ORTHOPTERA
CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	ISOPTERA	ISOPTERA
CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	CO. CALIF. 19 COLL.	PLECOPTERA	PLECOPTERA
WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	DERMAPTERA	DERMAPTERA
WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	MALLOPHAGA	MALLOPHAGA
WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	ANOPLURA	ANOPLURA
WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	THYSANOPTERA	THYSANOPTERA
WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	HEMIPTERA	HEMIPTERA
WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	HOMOPTERA	HOMOPTERA
WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	WHERE FOUND	NEUROPTERA	NEUROPTERA
COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	COLEOPTERA	COLEOPTERA
COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	TRICHOPTERA	TRICHOPTERA
COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	LEPIDOPTERA	LEPIDOPTERA
COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	DIPTERA	DIPTERA
COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	SIPHONAPTERA	SIPHONAPTERA
COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	HYMENOPTERA	HYMENOPTERA
COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME	COMMON NAME		

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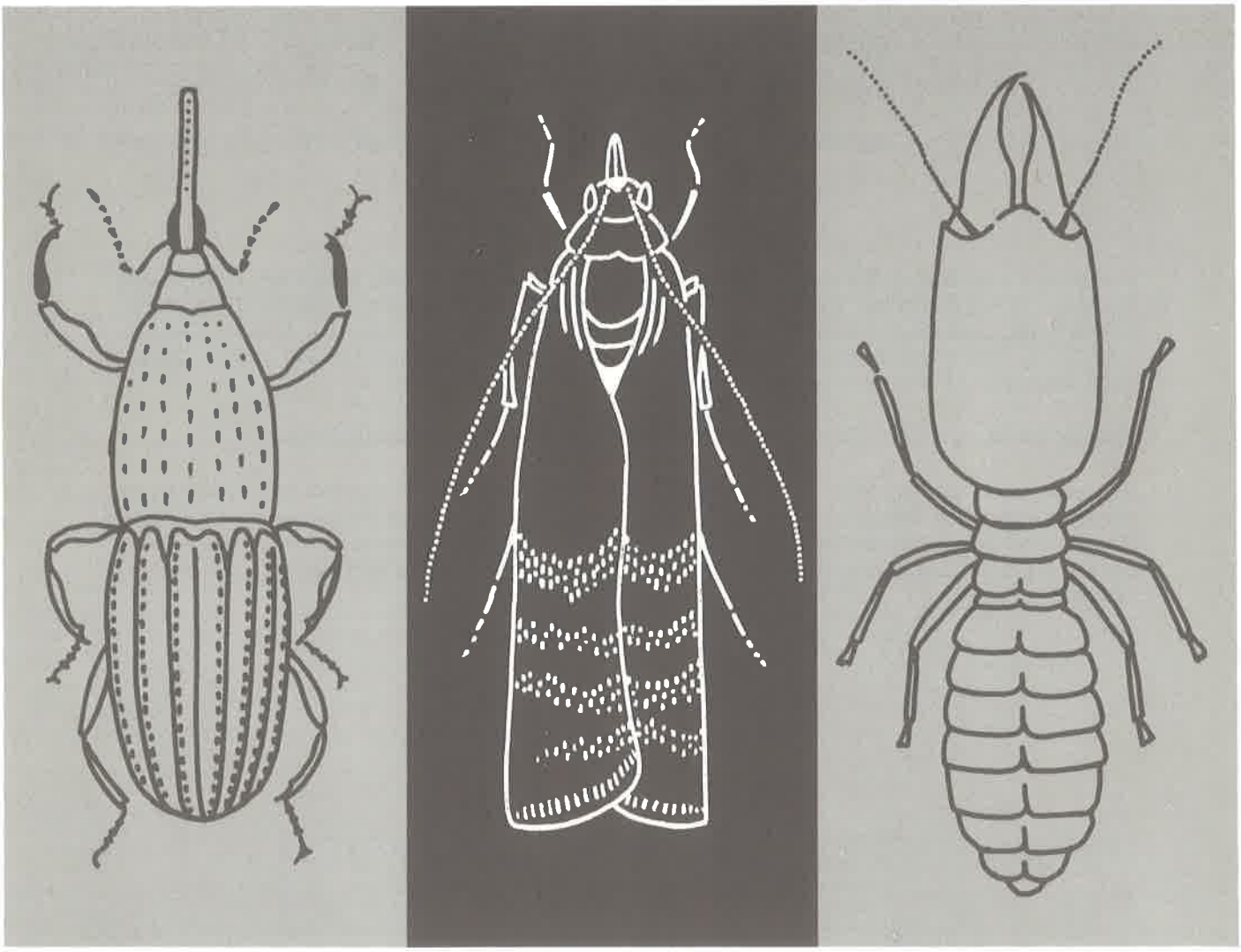
A STUDY OF INSECTS

4-H ENTOMOLOGY PROJECT



Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

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LEAFLET
2949

TABLE OF CONTENTS

The authors are Paul C. Barker, Agriculturist, Emeritus; W. Robert Bowen, Extension Entomologist, Riverside; Vernon E. Burton, Extension Entomologist, Davis; Clarence S. Davis, Extension Entomologist, Berkeley; Andrew S. Deal, Assistant Director, Parlier; the late Lonnie D. McGrew, Farm Advisor; William G. Schneeflock, 4-H Youth Specialist, Berkeley; Wallace R. Schreader, Farm Advisor, San Joaquin County; and J. Edward Swift, Statewide Coordinator of Pesticides, Berkeley.

The illustrations are by Sue Michel, with the exception of the material acknowledged below.

Acknowledgment is given to Z. P. Metcalf and C. L. Metcalf for the use of sketches from A Key to the Principal Orders and Families of Insects. *Acknowledgment is also made to the University of Michigan Cooperative Extension Service for the information on embedding insects in plastic, and to Donald J. Borror and Dwight M. DeLong for use of portions of insect keys from their book,* An Introduction to the Study of Insects.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture, James B. Kendrick, Jr., Director, Cooperative Extension, University of California.

5m–5/78–HS/LAM

WHAT IS ENTOMOLOGY?

Entomology is the study of insects. The scientist who specializes in this field is called an entomologist.

In the Entomology Project, you will learn how insects differ from other small animals; how to identify and name them; how to make and use special equipment; how to collect, preserve, label, exhibit, and rear insects; and how to control them. From all this, you will learn the economic importance of insects.

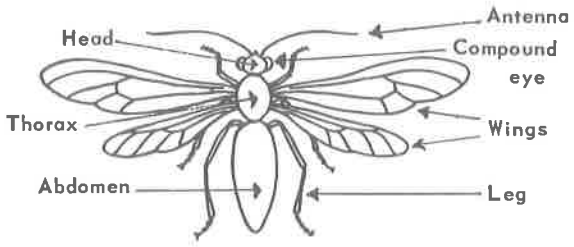
Insects

Insects are small animals. They belong to the largest group in the animal kingdom, the Arthropoda—which means joint-footed.

Arthropods have no backbones. Their bodies are jointed, and so are their legs and feet. The surfaces of their bodies are covered with an organic material called an exoskeleton.

When fully grown or in the adult stage, insects have:

- three definite body regions – head, thorax, abdomen
- three pair of jointed legs
- one pair of feelers, or antennae
- compound eyes, usually
- one or two pair of wings



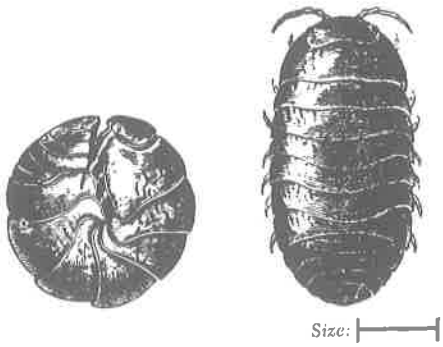
Sketch of an insect showing body parts.

Other Arthropods

In addition to insects, the arthropods include such common creatures as:

crustaceans – sow bugs, pill bugs, shrimps, crabs, lobsters

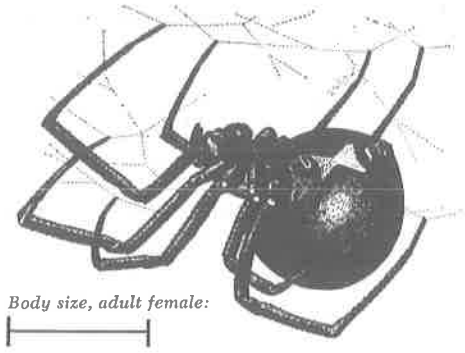
- two main body regions – head merged with thorax, abdomen
- five or more pair of jointed legs
- two pair of antennae



Pill bug, *Armadillidium vulgare* (Lat.)
Pill bug in retracted and extended positions.

arachnids – spiders, scorpions, ticks, mites

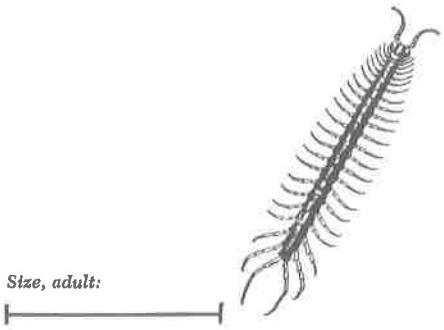
- two main body regions – head merged with thorax, abdomen
- four pair of jointed legs
- antennae and wings lacking



Black Widow Spider, *Latrodectus mactans* **(Fabr.)**

chilopods – centipedes

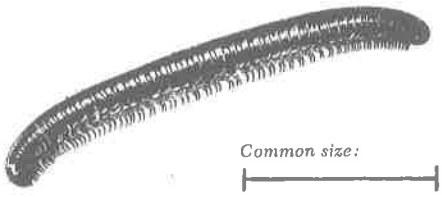
- body wormlike
- head not merged with thorax
- one pair antennae, or none
- wings lacking
- many legs, each body segment with one pair



Centipede, *Cermatia forceps* **(Raf.)**

diplopods – millipedes

- body wormlike
- head not merged with thorax
- one pair antennae, or none
- wings lacking
- many legs, each body segment with double pair of legs



Millipede

Economic Entomology

Insects play an important part in our everyday lives. The study of how they affect us and our crop production is called economic entomology.

To understand economic entomology, you must be able to recognize the most important insects and know something about their habits and life histories. You also must learn which insects are beneficial and which are harmful.

Beneficial insects. Most insects are not harmful to man, but actually benefit him. Man would be helpless without their aid.

Many insects are the only means of pollinating certain plants. Many flowers and more than 50 important crops depend on insects for pollination. Without these insects, we would not have alfalfa, figs, plums, cantaloupes, sweet cherries, some apple varieties, and many other fruits.

Insects also help destroy refuse in the soil, clean up fallen forest trees, and aerate the soil. The common honeybee gives us honey and beeswax. Other insects produce silk, lac dye, tanning materials, certain medicines, and tonics.

Harmful insects. More than 1½ million insects are known, but only a few of these are injurious pests. Most injurious insects are kept under control by other insects that feed on them.

Many insects carry diseases which affect our health. Insects spread malaria, yellow fever, bubonic plague, sleeping sickness, typhus, and other diseases. Entomologists and parasitologists have shown us how to control disease-carrying insects.

Americans are the best-fed and best-clothed people in the world because we use scientific methods to produce and protect our crops. If we did not control insect pests, many foods we eat would be hard to get or not fit to eat. But in spite of our control, fewer than 100 different insects cause losses of nearly $5 billion each year to our crops, livestock, and forests. You should know how to control insects that are pests.

Biological control is one method entomologists use to control insects. This means that beneficial insects are used to keep down the numbers of harmful insects. Sometimes this is done by using insects already present in the field. At other times, insects are raised or collected and then released in the area where the pests are present. This is one of the best and cheapest ways to keep down the population of harmful insects. It should be used whenever possible. Some common beneficial insects are ladybird beetles, aphid lions, and many of the tiny wasps found in the fields.

Chemical control of insects is familiar to us. It is done by applying a poisonous chemical to the crop when the insect is present.

Chemicals used for insect control are poisonous to us as well as to the insects, so we must use them properly. Chemical control is used when we see that insects are increasing in numbers harmful to the crop.

If you know about the habits and life history of insects, you will be able to decide which of the many kinds of chemicals to use and when to use them for controlling insects. The type you use will depend upon the habits of the insect. Some insects suck juices from

the plant; others eat leaves. For the first type you will use a chemical that kills the insect by coming into contact with its body. For those that eat plants, you will use either a contact poison or a stomach poison.

Some of the many different kinds of chemicals used are chlordane, Dibrom®*, lindane, rotenone, pyrethrum, Sevin®, and malathion. When you plan insect control, learn what kind of insect you are trying to kill; then use the best type of chemical.

SAFETY PRECAUTIONS

Always remember that these chemicals are poisonous and must be handled carefully. Read the label on the package and do as it says. Do not take chances.

HOW TO COLLECT AND PRESERVE INSECTS

With simple equipment, the amateur as well as the trained entomologist can make a worthwhile collection of insects. In late spring, summer, and early fall, insects are abundant in fields and woods. Flowers are favorite visiting places of bees, flies, beetles, and other insects. Large numbers of insects may be caught by sweeping with a strong insect net through the grass and branches in woods along the banks of streams, open glades in deep woods, and brush along the forest edges.

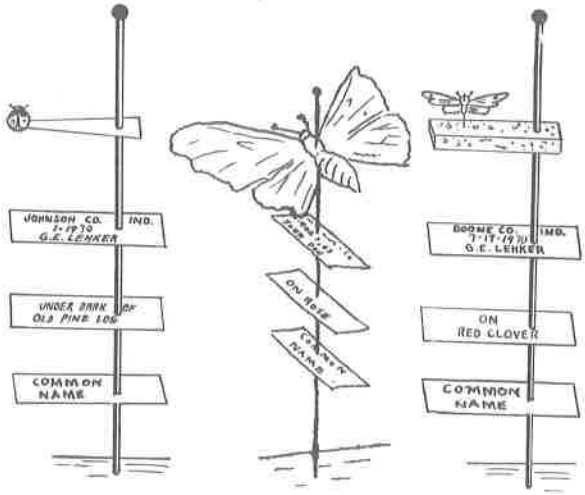
Not all insects are caught in nets. You may find rarer insects in obscure places, such as leaf mold and debris on the surface of the soil, particularly in the woods. Turn over rotten logs and stumps and search carefully under them. Then tear them apart to find other insects that live inside.

Lights attract large numbers of insects, such as June beetles and moths. At night these insects may be collected at street or porch lights or on windows and screens of lighted rooms. You may catch other insects by putting a jar over them as they rest on foliage or flowers.

Insects must be killed quickly without breaking or otherwise damaging them. Place them in the killing jar and mount within a few hours after they are caught. Caterpillars, larval stages of insects, aphids, silverfish, and other softbodied specimens should be preserved immediately in alcohol. Place butterflies on the spreading board until they are dry.

Records

Each time you catch an insect, make a record of the plant or animal from which it came, the place found, the date, and the common name, if known. You will need this information to label your insects.



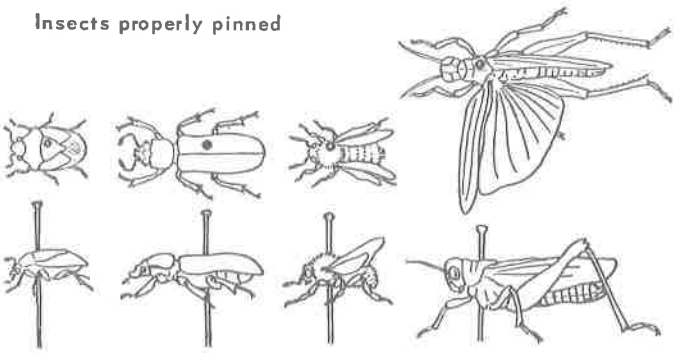
Insects properly mounted and labeled.

*® Registered trade name.

Insects should be mounted on pins, labeled, and placed in your collecting box as soon after they die as possible. Place them in neat rows with heads toward the rear of the box, and with all insects of the same kind placed next to each other. Insects too small to mount on pins should be glued to small pieces of paper and then mounted on pins. Push the pin straight through the insect. The illustrations show the correct places on the insect's body to insert the pin.

Be sure that all insects are mounted the same distance from the heads of the pins, and that labels are arranged on the pins the same way. Labels should parallel the longitudinal body axis of the insect on the mount, except those insects that are mounted on card points. Stick pins straight through the insects. Remember that neatness and uniformity make a more attractive insect collection.

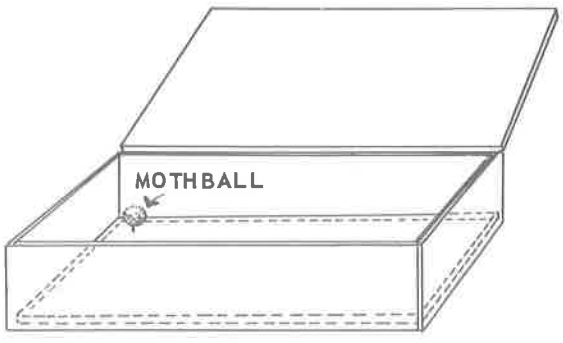
Insects properly pinned



EQUIPMENT YOU WILL NEED

Simple Collection Box

You will need a safe place to keep your collection of insects after you mount them. An inexpensive container can be made from a cigarbox. This will be large enough for the ten orders of insects to be collected in the first unit of work.



Cigarbox for insect collecting

YOU WILL NEED THESE MATERIALS:

- Cigarbox, 2 by 6 by 8 inches preferred
- Piece of smooth-faced, corrugated cardboard, or soft fiberboard
- Glue, or rubber cement
- Mothball
- Number 3 insect pins
- Matches

MAKE YOUR BOX THIS WAY:

Cut cardboard or fiberboard to fit the box bottom.

Smear glue or rubber cement on bottom of box and insert cardboard or fiberboard.

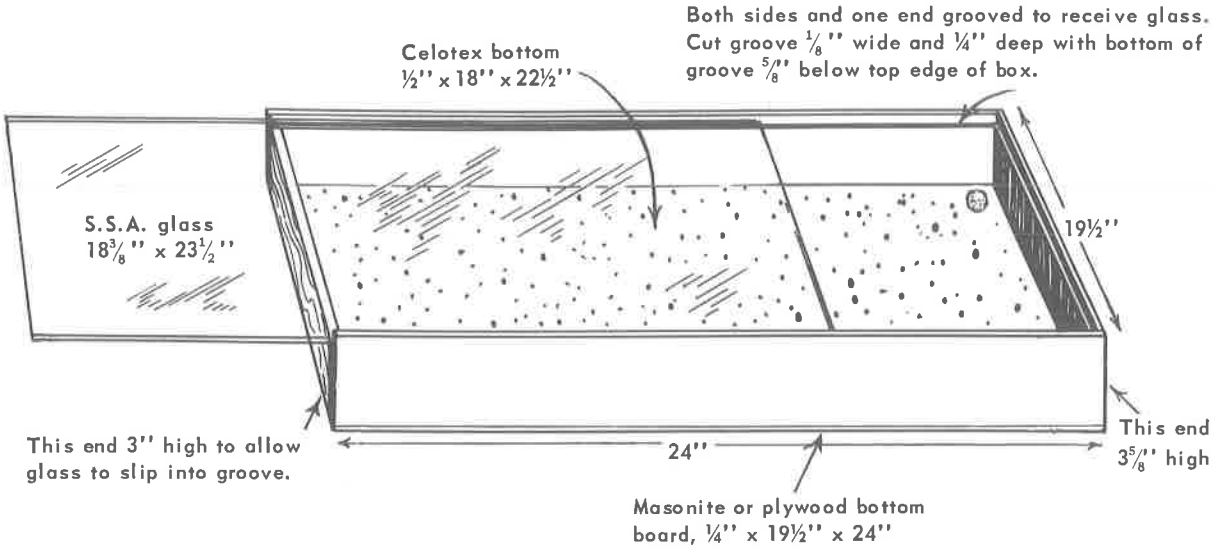
Heat head of pin with lighted match.

Stick head of pin into mothball, and allow to cool.

Stick mothball on pin into cardboard in one corner of the box.

Display Box

As you continue in the Entomology Project and your collection grows, you will need more than one collection box. You can use several cigarboxes, or you can make a display box. The display box holds more insects and makes a more attractive and safer container when you exhibit your collection. Use clear white pine, ¾ inch thick, for the ends and sides, and double-strength glass for the top.



Collecting Net

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

MAKE YOUR NET THIS WAY:

The handle: Drill two holes (approximately $^{3}/_{16}$ inch in diameter) on opposite sides near one end of a 3-foot piece of broom handle, or 1-inch Douglas-fir doweling. Use straight-grained material. The holes should be offset to correspond with the ends of the wire loop. Make them just deep enough to accommodate the ends of the wire.

Cut a groove on each side of the handle, from each hole to the end of the handle, deep enough for the wire to fit snugly (see diagram).

If a ferrule is to be used to fasten the wire loop to the handle, use brass or aluminum tubing, 1-inch inside diameter. Otherwise, use fine wire or heavy cord.

The loop: Bend a 54-inch piece of No. 8 galvanized iron wire into a 15-inch loop, as in the diagram.

The bag: Make the bag from a single piece of cloth – 30 by 48 inches.

Fold the material so that the doubled cloth is 24 inches across and 30 inches long.

Make a pattern as shown by dotted lines in diagram.

Pin the pattern to the material with the top of the pattern along the selvage where possible.

Cut the material, ¼ inch beyond the edges of the pattern. This allows for a seam on the lower part of the bag only. Do not cut the folded edge of the material on the upper 6 inches of the bag.

Remove the pattern.

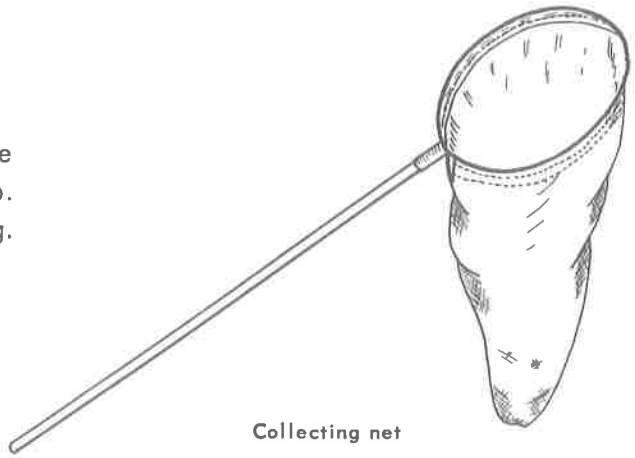
Make a ¼-inch seam along the edges of the bag up to a point 6 inches below the top. Trim material to within ⅛ inch of stitching.

Turn the bag and make a French seam. Then stitch French seam flat to bag, making a fell seam.

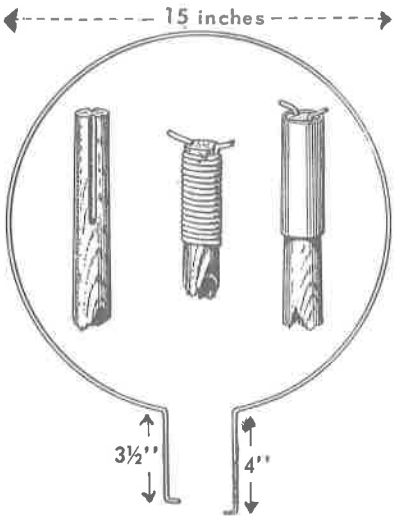
Fold and crease the top of the bag, making a 3-inch hem. Turn under the open ends of the hem and stitch.

Double the hem back over itself, making a finished hem 1½ inches wide and stitch.

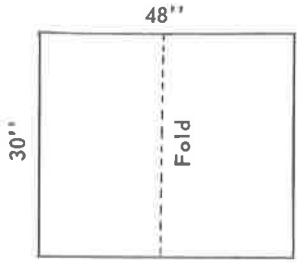
<u>To assemble the bag</u>: Insert the wire loop through the hem at the top of the bag. Attach the loop to the handle by sliding the ferrule over the ends of the loop.

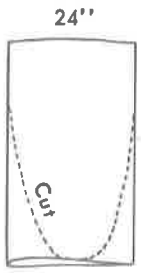


Collecting net



Loop





Killing Jar

After insects have been collected, they must be killed quickly. Any fairly heavy glass jar with a wide mouth and tight screw cap can be used. You will want several – one for moths and butterflies, and one or more for beetles or other small insects. Various chemicals may be used, but ethyl acetate is recommended.

Pour ½ inch of plaster of paris into the jar and allow it to harden. Dry it thoroughly in the oven. Then pour ethyl acetate into the jar. Allow the plaster of paris to become thoroughly saturated. Pour off the excess liquid. The jar is now ready for use and will last for months if kept tightly closed. When it no longer kills insects, recharge it with ethyl acetate.

— Plaster of paris

Relaxing Jar

Insects that have dried after being killed must be relaxed or made limber before they are mounted. This can be done easily in a relaxing jar.

MAKE THE JAR THIS WAY:

Put an inch or two of clean sand into a wide-mouth jar or can with a tight cover. Saturate the sand with water to which you have added a few drops of phenol (carbolic acid) to keep mold from growing. Cover the sand with a piece or two of cardboard cut to fit the jar. It is then ready for use. Specimens must not come in direct contact with the water. Do not leave them in the relaxer too long or they will be spoiled. From 1 to 3 days usually is sufficient. Do not leave relaxer where it will get too warm, or it will sweat on the inside.

Preserving Vials

Soft-bodied insects, such as caterpillars, grubs, and maggots, must be preserved immediately in a fluid such as 70 percent rubbing alcohol. Place the fluid and the insect in a small vial, size 00, which you can purchase from a drugstore. Fasten the vial in your collecting box with scotch tape, and pin a label near the cork. Place another label inside the vial, stating – **Where Collected, Date, and Collector's Name.** This will prevent your data from becoming lost if the outside label is separated from the vial.

Insect preserved in vial

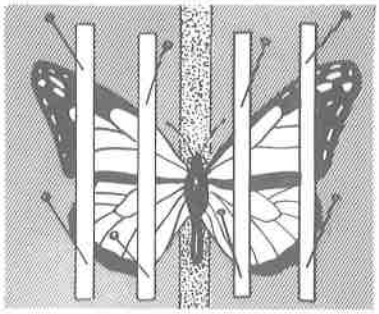
TWEEZERS

Tweezers, 4 or 5 inches long, will help you to handle insects with less chance of damage. There are several kinds.

Tweezers for ordinary specimens

Tweezers for unmounted *Lepidoptera*

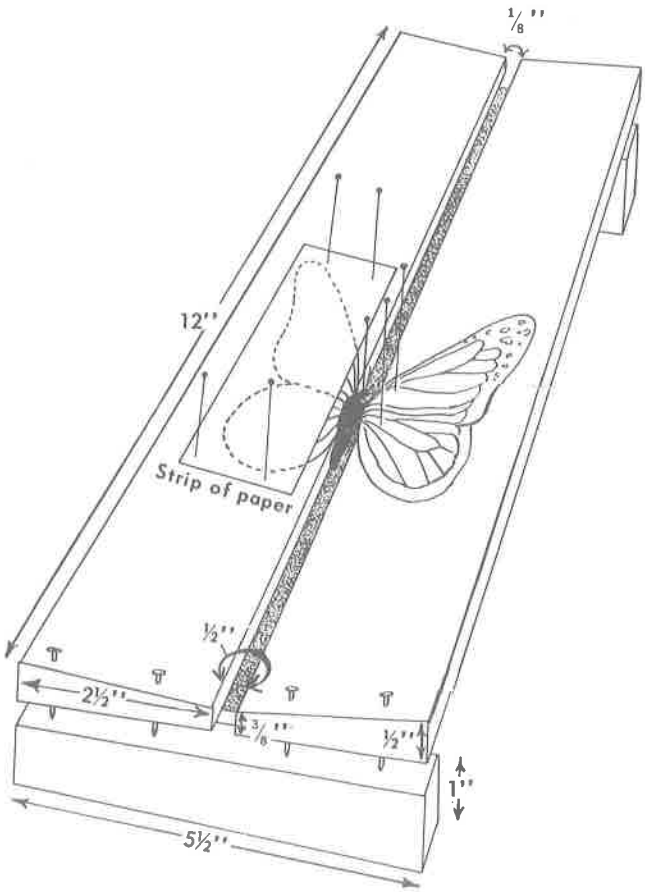
Spreading Board



Butterfly properly spread

YOU WILL NEED THESE MATERIALS:

- 2 end blocks, 1 inch square and 5½ inches long
- 2 top pieces, 2½ inches wide, 12 inches long, and ½ inch thick, planed down to ⅜ inch on the inside edge
- 1 flat strip of corrugated cardboard, 1½ inches wide, 14 inches long, and ¼ to ½ inch thick



The complete spreading board with dimensions

MAKE YOUR BOARD THIS WAY:

Nail the two top pieces to the end blocks, leaving a space between the two pieces. Tack the strip of cardboard beneath the open space left by the top pieces. This gives you something to pin to while the insects are drying.

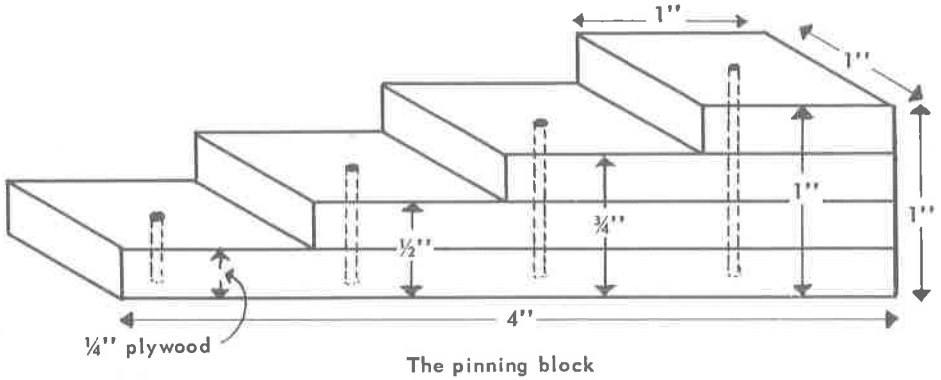
After the insect is pinned, insert the pin into the cardboard so that the body of the specimen rests in the groove. Pull the wings forward and hold them temporarily with pins while you permanently secure them with a strip of paper.

Pins, Pinning Block, and Labels

Special pins that do not rust or corrode are used for pinning insects. They are long, very sharp, and come in various sizes. The most useful size is No. 3. These pins can be bought from biological supply houses.

The appearance of a collection of insects is improved if all the specimens and labels are placed at a uniform height upon the pins. This is easily done by using a wooden pinning block. The pinning block may be made from a piece of soft wood 1 inch square and 4 inches long, cut into four steps which are ¼, ½, ¾, and 1 inch high. Or it can be made by fastening together four pieces of ¼-inch plywood, 4, 3, 2, and 1 inches in length. Drill a small hole in each step. After the insect is placed upon a pin, place either the point or the head of the pin in the desired hole and adjust the specimen or label to the right height. The pinning block will function better if you nail or glue a piece of Masonite® or sheet metal to the bottom of it.

If your collection is to be of value, **every insect must be marked with certain information.** This is done on small paper or cardboard labels. Follow the directions on page 4 and 5 which tell you how to collect and preserve insects.



The pinning block

Rearing Cage

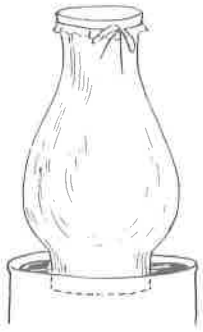
Most insects are easy to rear if you provide them with an environment similar to that in which they were found. Many kinds of rearing cages are used. Most of them are constructed of screen to prevent escape of the adults as they emerge. If you wish to rear a caterpillar you found feeding on oak leaves, place it in your cage with oak leaves to eat. Unless you are familiar with the habits of the insect being reared, it is best to provide a few inches of soil in the bottom of the rearing cage, as many insects must have soil in which to pupate or transform from the larval to the adult stage.

YOU'LL NEED THESE MATERIALS:

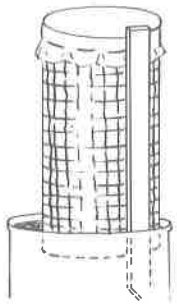
Glass container with open bottom and top, such as a lamp chimney
Piece of cheesecloth
Can to set chimney in
Screen wire
Small sticks of wood to support screen cage
Carpet tacks

MAKE THE GLASS CAGE THIS WAY:

Place globe in the can and firm it in the soil. Then fasten cheesecloth over the top.



Glass
insect-rearing cage



Screened
insect-rearing cage

MAKE THE SCREEN CAGE THIS WAY:

Roll screen to make cylinder desired size. Tack stick to fold in screen. Leave the stick 2 or 3 inches longer than the screen. Fasten cloth or screen over the top. Insert point of stick in soil until screen rests in dirt. Firm soil around base of cage. Drinking water can be supplied by placing cotton in a small bottle of water. The insects will get all the water they need from the cotton. Do not tip the bottle sideways or the water will come out too fast.

LIFE HISTORY OF INSECTS

We study insect biology to learn where an insect lives, what it eats, what its habits are, and how it reproduces. Most of these questions can be answered by a study of the insect's life cycle. The LIFE CYCLE begins with the egg stage and continues through the reproducing adult stage.

An insect needs certain things to complete its life cycle. These include:

Water	Heat
Air	Other insects of its kind
Soil	Food

These biological requirements change as an insect passes from one stage of growth to another in its metamorphosis.

Life Cycle Studies

As part of the study of insects you will want to keep your specimen in a rearing cage so that the different stages of growth you observe will be of the same insect.

An insect must be kept in as natural a condition as possible for it to get all of its biological requirements. Therefore, you will need a cage that holds not only the insect but also all of its biological requirements.

Observations

Everything you can observe about an insect will be of value in understanding and predicting what it will do in the future.

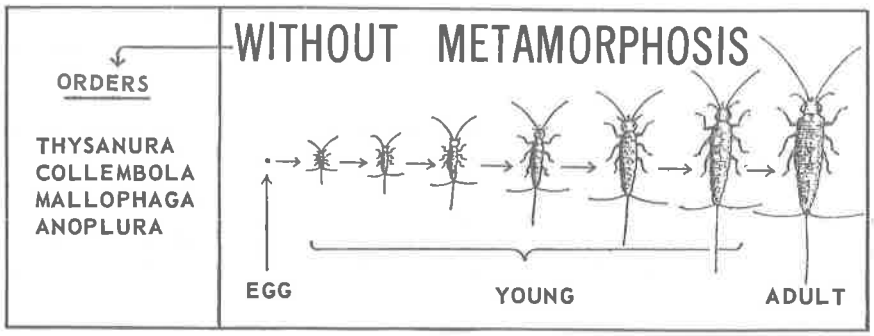
Observations, such as those you will make, help entomologists know when and where to spray and dust for insect control. Observe these vital points:

- How long does an insect stay in one particular stage of growth?
- Where does it spend its time?
- What does it eat?

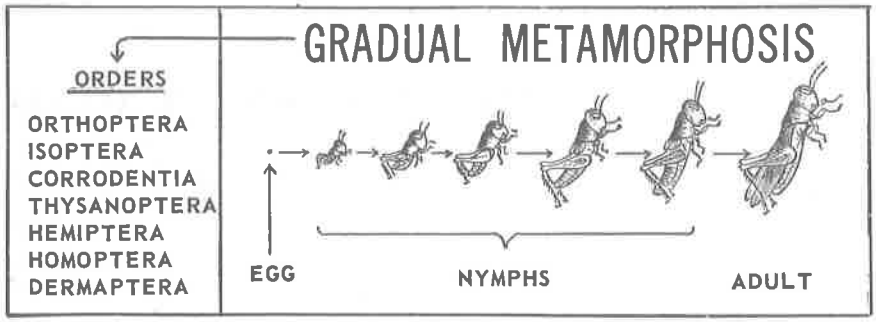
Preservation of the different stages is also very important.

METAMORPHOSIS is the name given to the change in the shape of an insect as it grows. Insects are divided into four groups depending upon their method of metamorphosis.

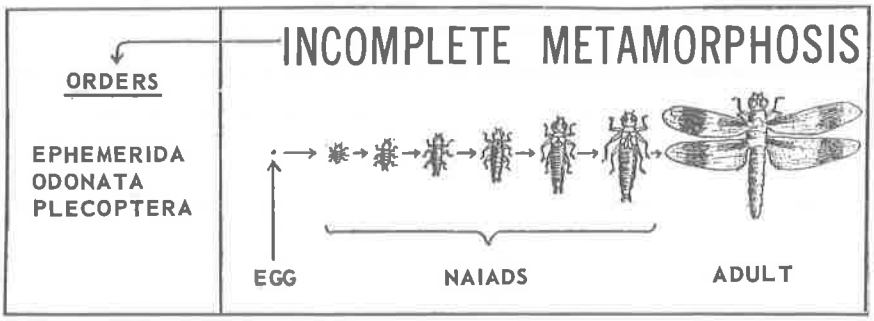
In GROUP 1 the insect that comes from the egg looks exactly like it will when grown, except that it will then be larger.



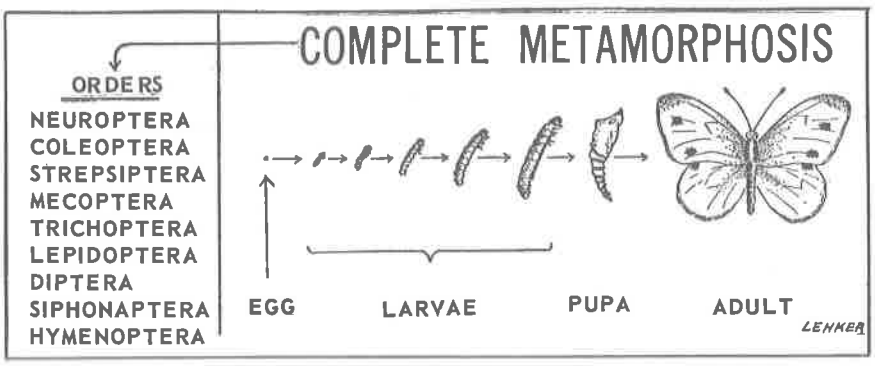
Insects in GROUP 2 change shape gradually. There are three stages of growth, each looking more like an adult.



The young insects in GROUP 3 change shape gradually. They do not look like adults until shedding their last skin. Then there is a quick change.

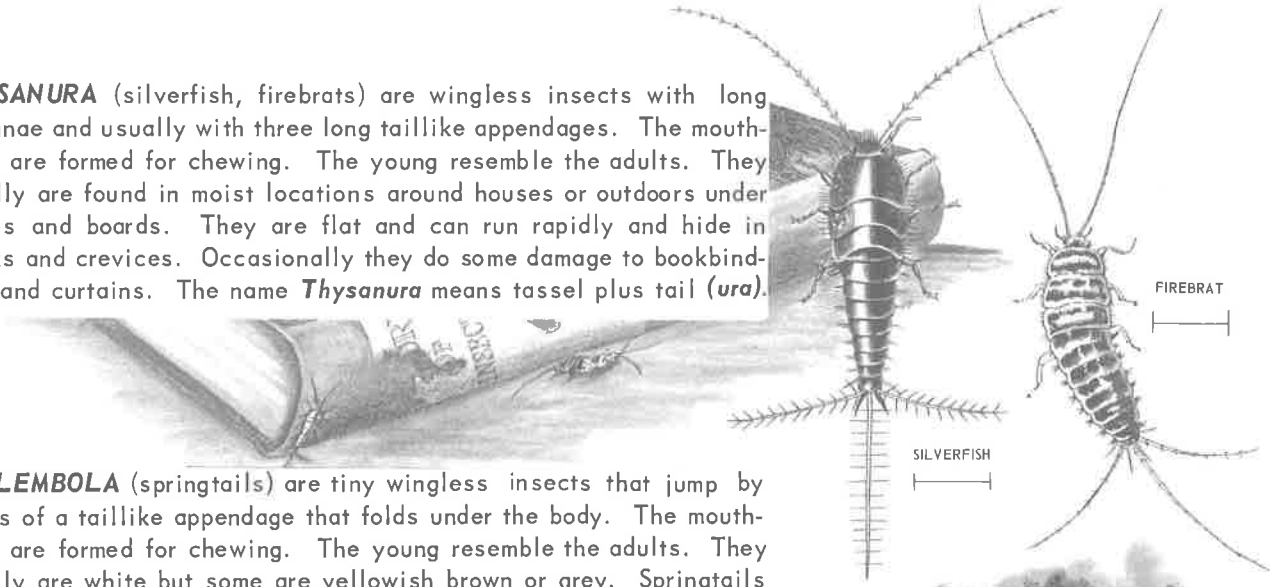


All insects in GROUP 4 go through four stages of growth. None of the young looks like the adult. There is a great change in shape when the adult emerges from the pupal stage.



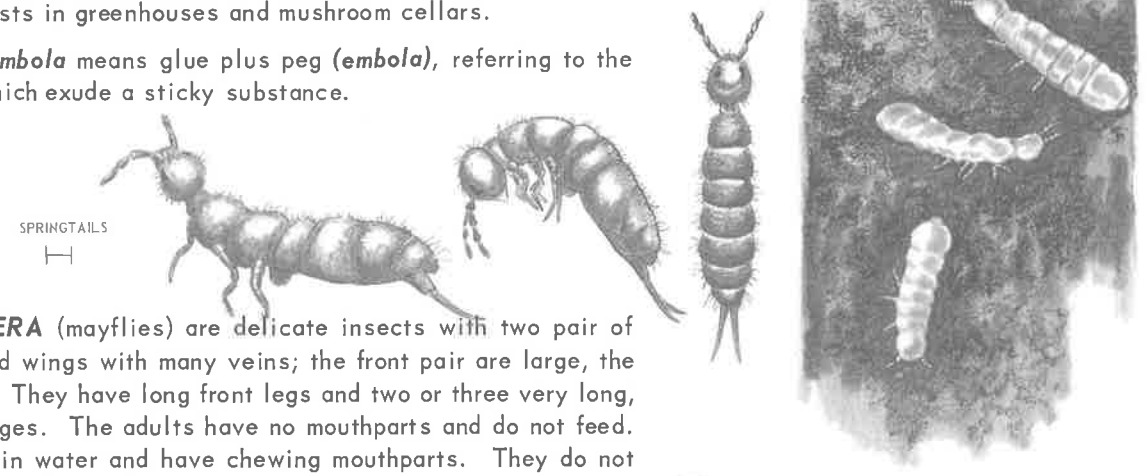
IDENTIFICATION OF INSECTS BY ORDER

THYSANURA (silverfish, firebrats) are wingless insects with long antennae and usually with three long taillike 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 tassel plus tail ***(ura)***.

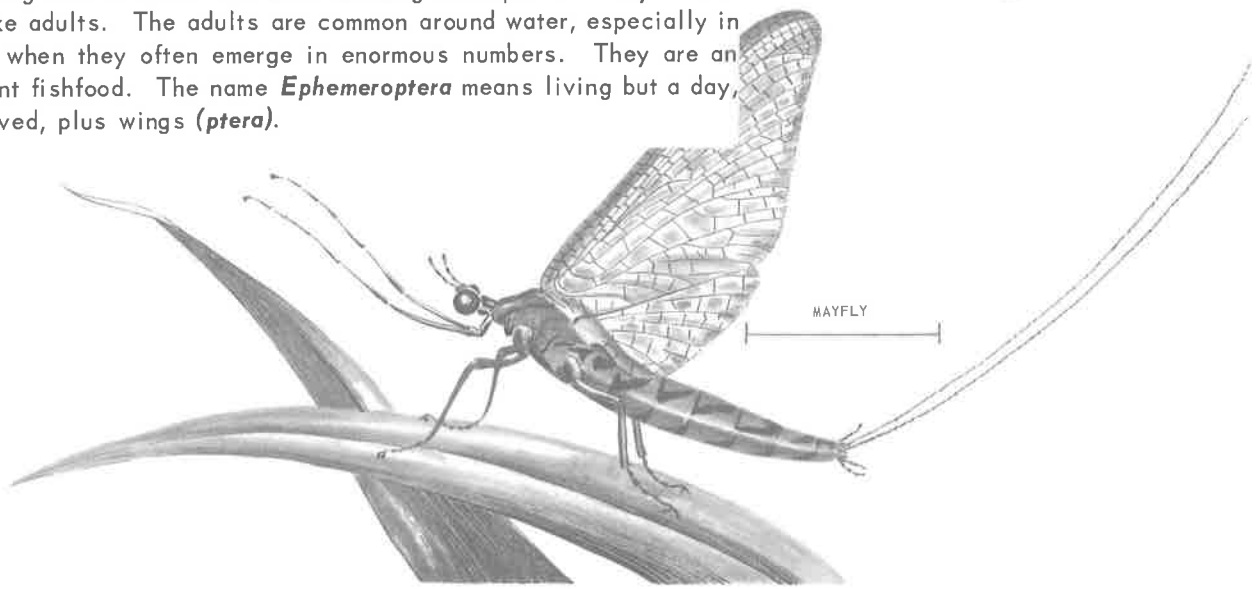


COLLEMBOLA (springtails) are tiny wingless insects that jump by means of a taillike appendage that folds under the body. The mouthparts are formed for chewing. The young resemble the adults. They usually are white but some are yellowish brown or grey. Springtails are common in moist locations and in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

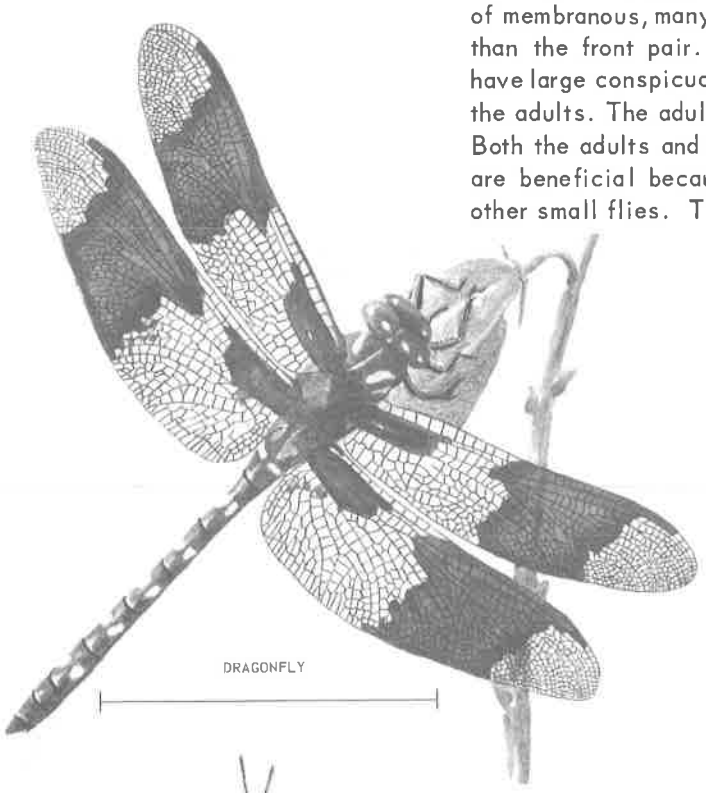
The name ***Collembola*** means glue plus peg ***(embola)***, referring to the ventral tubes which exude a sticky substance.



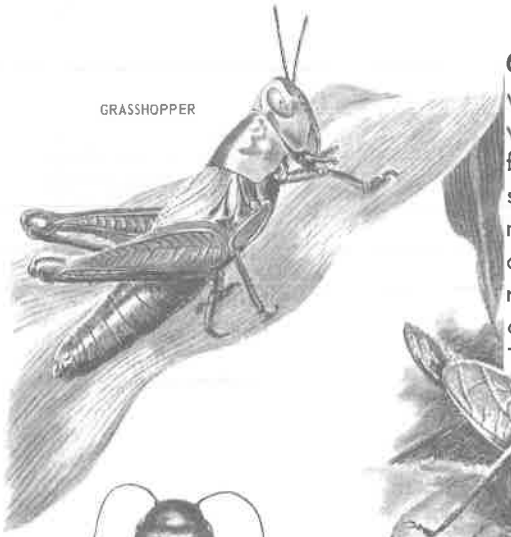
EPHEMEROPTERA (mayflies) are delicate insects with two pair of triangular-shaped wings with many veins; the front pair are large, the hind pair small. They have long front legs and two or three very long, taillike appendages. The adults have no mouthparts and do not feed. The young live in water and 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)***.

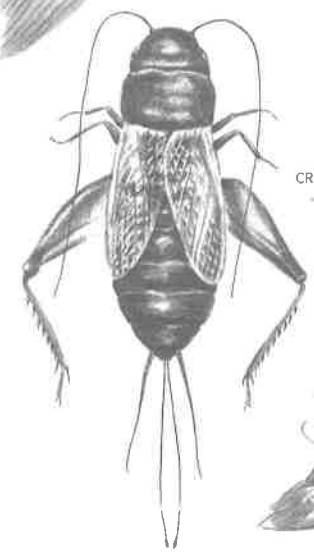


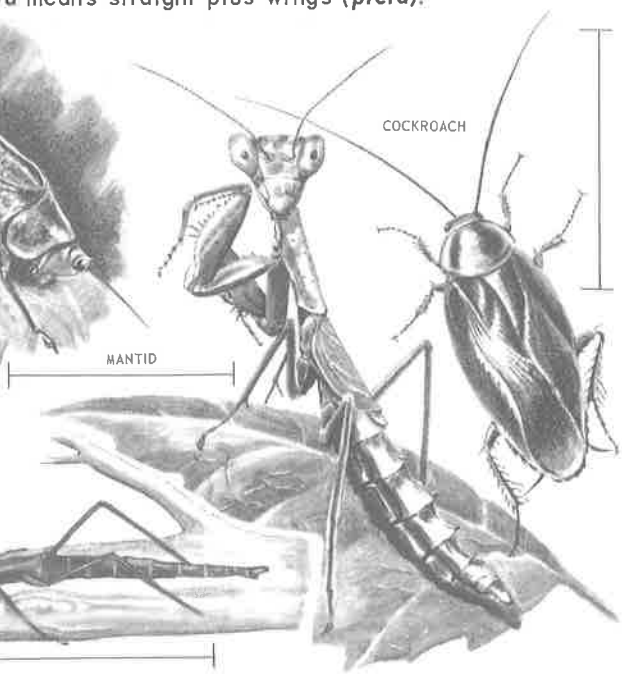
ODONATA (dragonflies, damselflies) are large insects with two pair of membranous, many-veined wings, the hind pair as large as or larger than the front pair. The mouthparts are formed for chewing. They have large conspicuous eyes. The young live in water and are not like the adults. The adults are common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

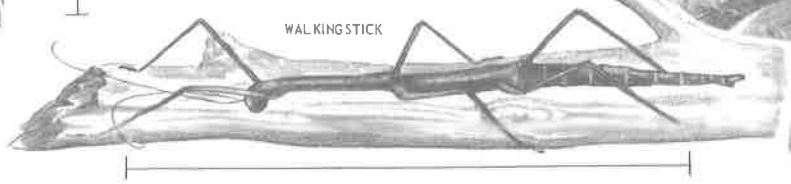


ORTHOPTERA (grasshoppers, crickets, katydids, roaches, mantids, walkingsticks) generally have two pair of wings which have many veins. The front pair usually are slender and the hind pair broad and fanlike. The mouthparts are formed for chewing. The nymphs resemble the adults. Several groups in this order have adults that 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)***.

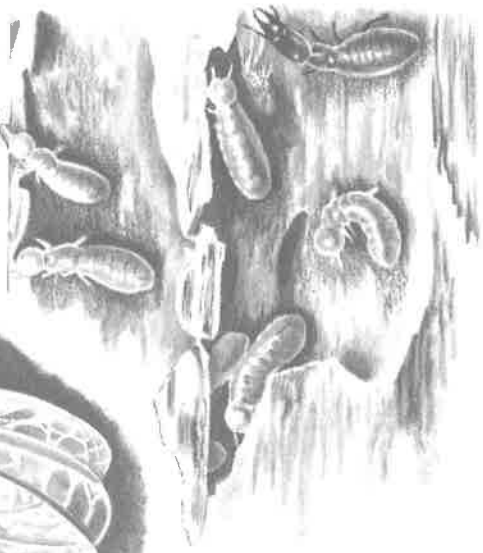


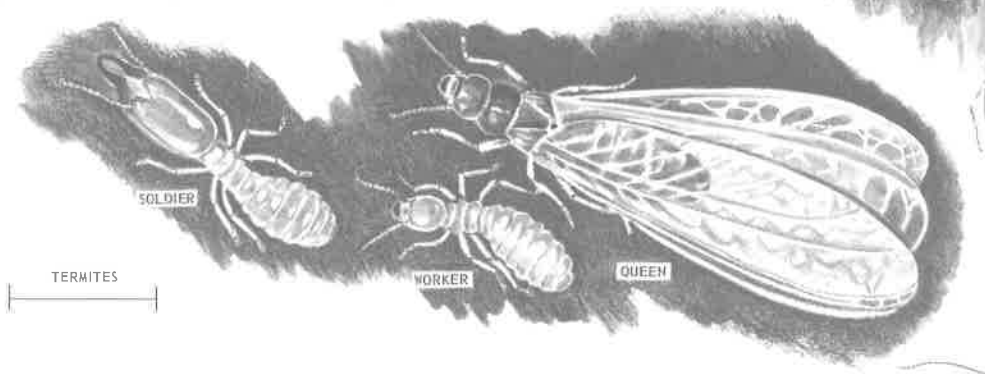




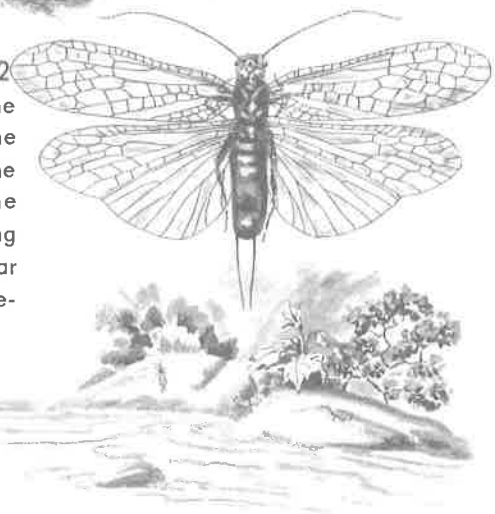


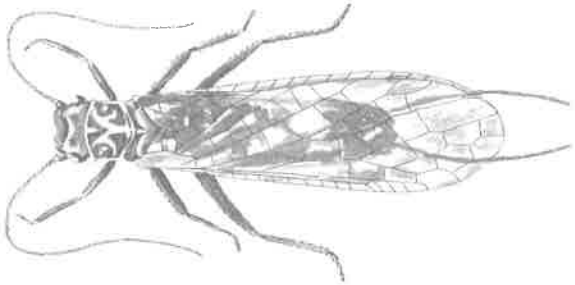
ISOPTERA (termites) are small, soft-bodied yellowish or whitish insects that live in colonies in wood. Colonies consist of three classes —workers, soldiers, and swarmers. The workers and soldiers are wingless and never leave the colony. The swarmers are reproductive forms having dark bodies and four 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.



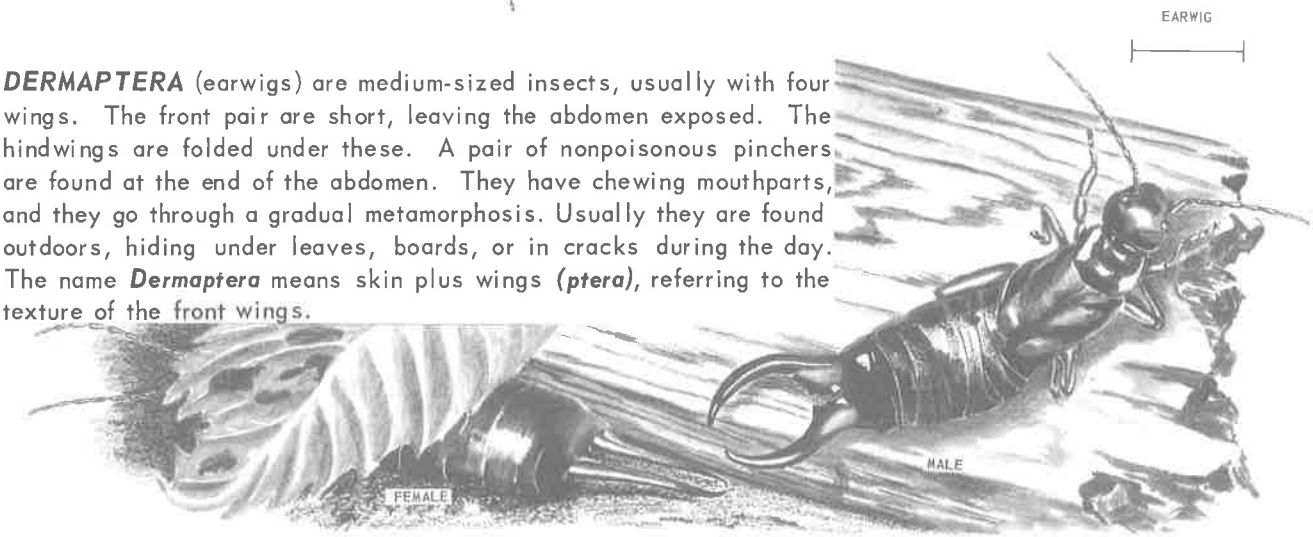


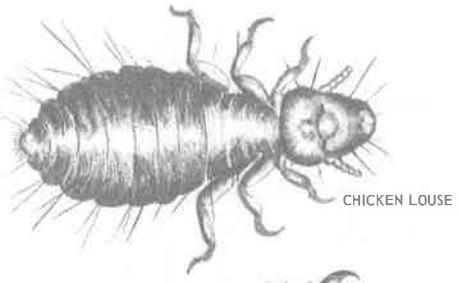
PLECOPTERA (stoneflies) are large soft-bodies insects, ½ to 2 inches long. They have four wings that fold flat over the back; the hind pair fold like a fan and are much larger than the front wings. The antennae are long, and there are two long taillike appendages at the tip of the abdomen. They have 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.



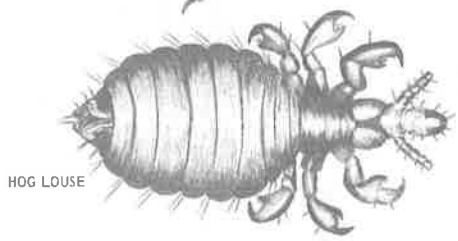


DERMAPTERA (earwigs) are medium-sized insects, usually with four wings. The front pair are short, leaving the abdomen exposed. The hindwings are folded under these. A pair of nonpoisonous pinchers are found at the end of the abdomen. They have chewing mouthparts, and they go through a gradual metamorphosis. 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.

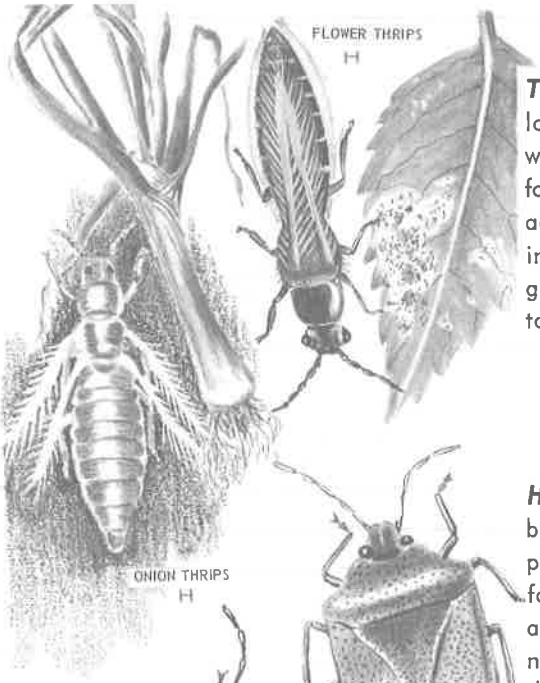




MALLOPHAGA (biting lice or bird lice) are small, flat, wingless, parasitic insects with mouthparts formed for chewing. The legs and antennae are short. The immature stages resemble the adults. They feed upon feathers, hair, wool, and skin scales. They are frequently important pests of domestic fowls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

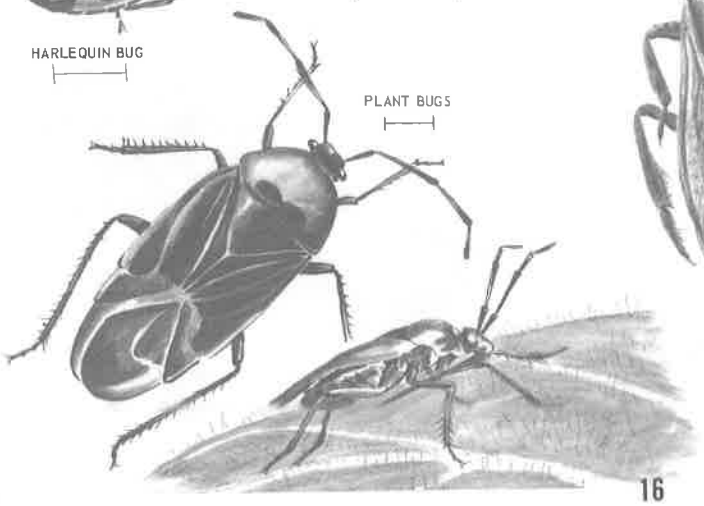


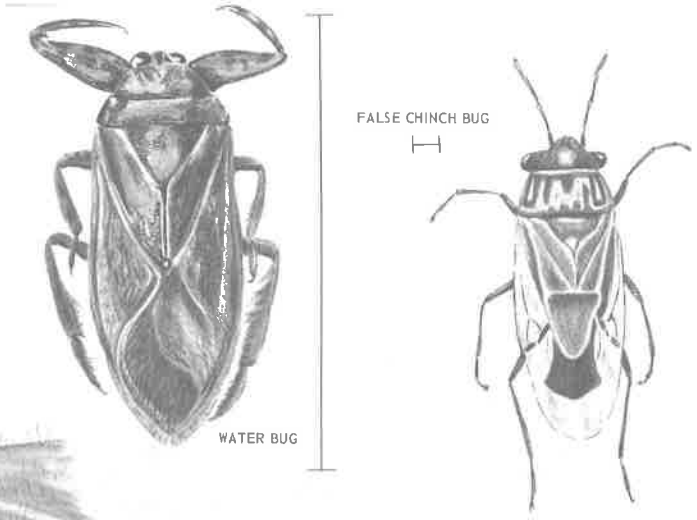
ANOPLURA (true lice or sucking lice) are small, flat, wingless, parasitic insects with mouthparts formed for piercing and sucking. The legs and antennae are short. The immature stages resemble the adults. These insects are found on man and domestic animals, but not on fowls. They feed by sucking blood.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



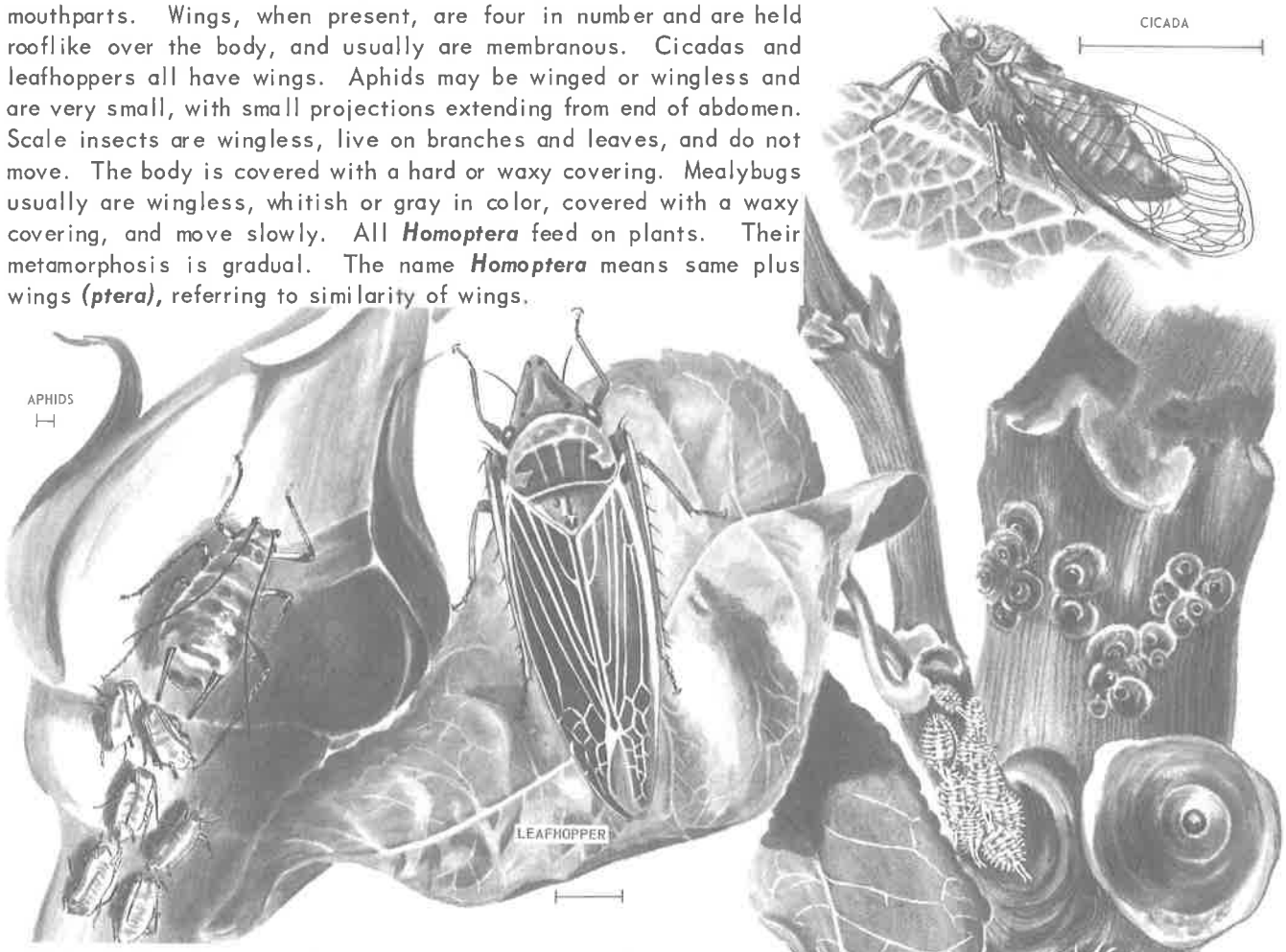
THYSANOPTERA (thrips) are mostly very small insects about $\frac{1}{8}$ inch long, usually with two pair of slender wings with few veins but fringed with long hairs. The legs and antennae are short. The mouthparts are formed for piercing and sucking, and the immature stages resemble the adults. Some 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.

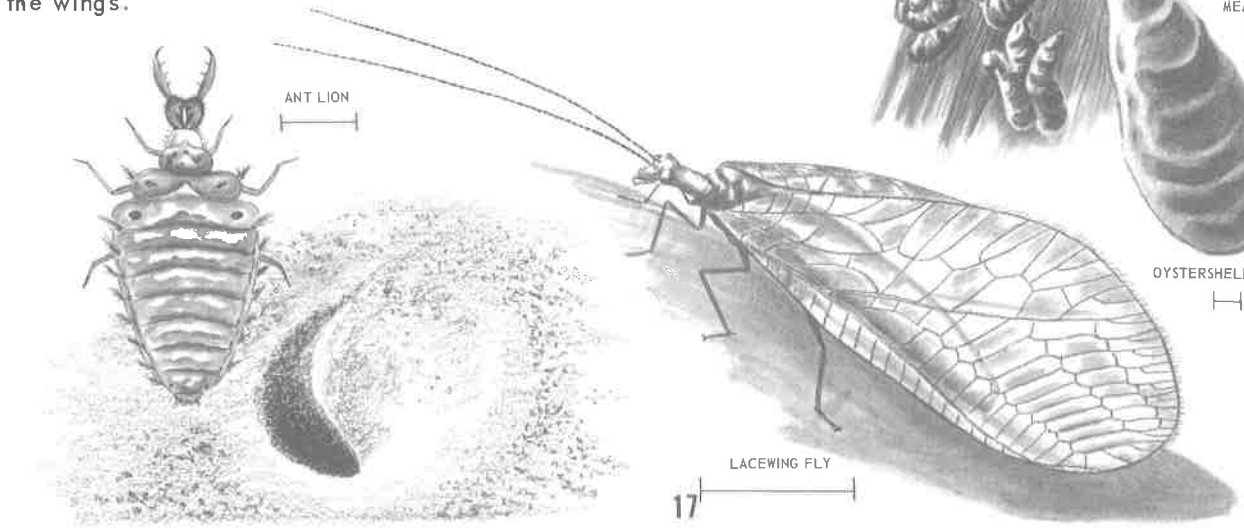




HOMOPTERA (aphids, leafhoppers, cicadas, whiteflies, mealybugs, and scale insects) may or may not have wings. All have sucking mouthparts. Wings, when present, are four in number and are held rooflike over the body, and usually are membranous. Cicadas and leafhoppers all have wings. Aphids may be winged 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.

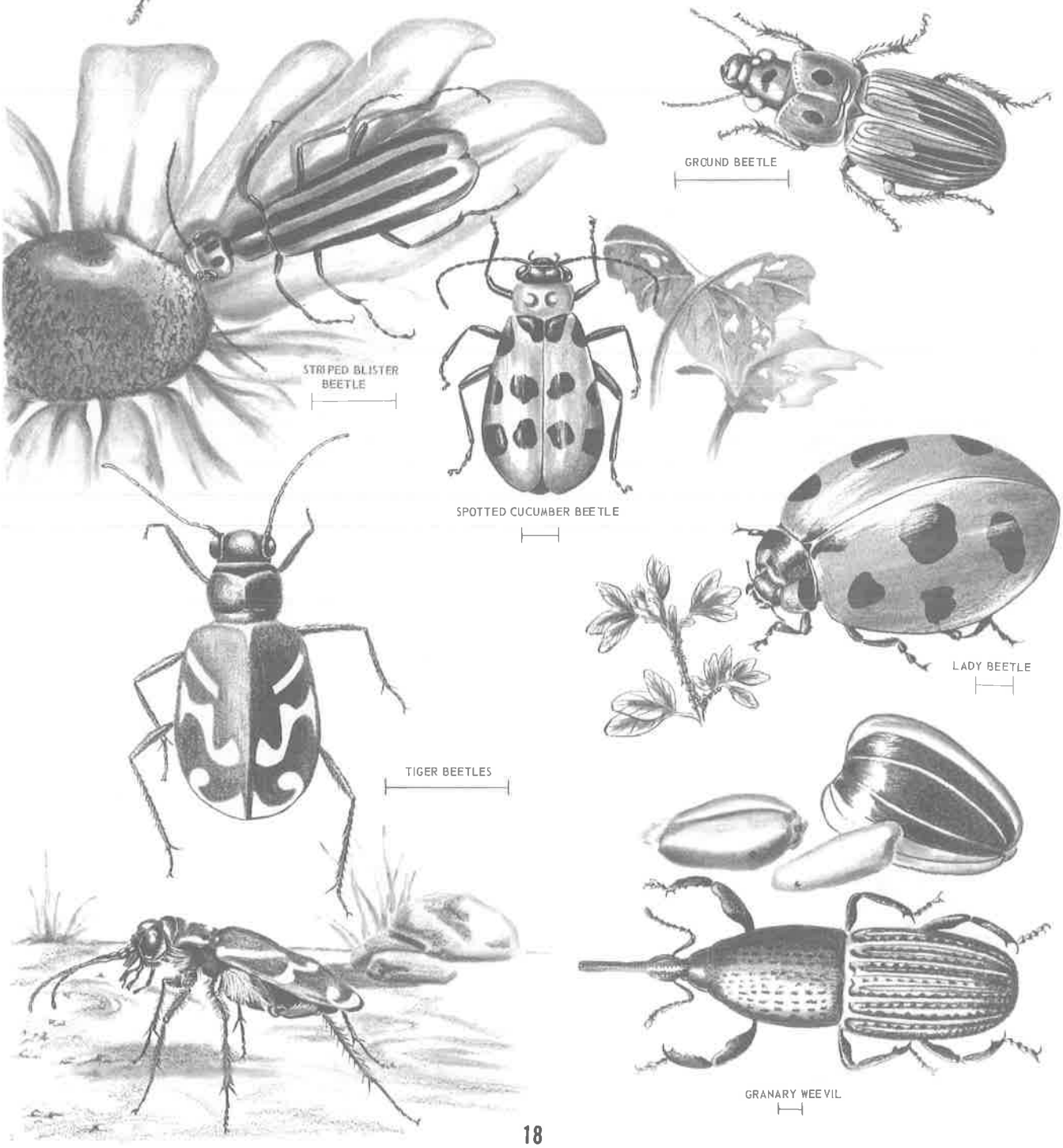


NEUROPTERA (lacewing flies, ant lions, and their allies) are rather fragile insects with two pair of many-veined wings of about the same size. The antennae are long. The mouthparts are formed for chewing. The immature stages are predaceous. These insects undergo complete metamorphosis. The commonest 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.



ALFALFA WEEVIL

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.



GROUND BEETLE

STRIPED BLISTER BEETLE

SPOTTED CUCUMBER BEETLE

LADY BEETLE

TIGER BEETLES

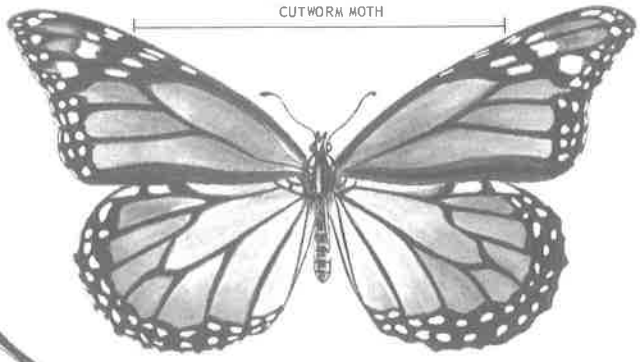
GRANARY WEEVIL

TRICHOPTERA (caddisflies) are soft-bodies 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 around streams. The name ***Trichoptera*** means hair plus wings ***(ptera)***.

CADDISFLY

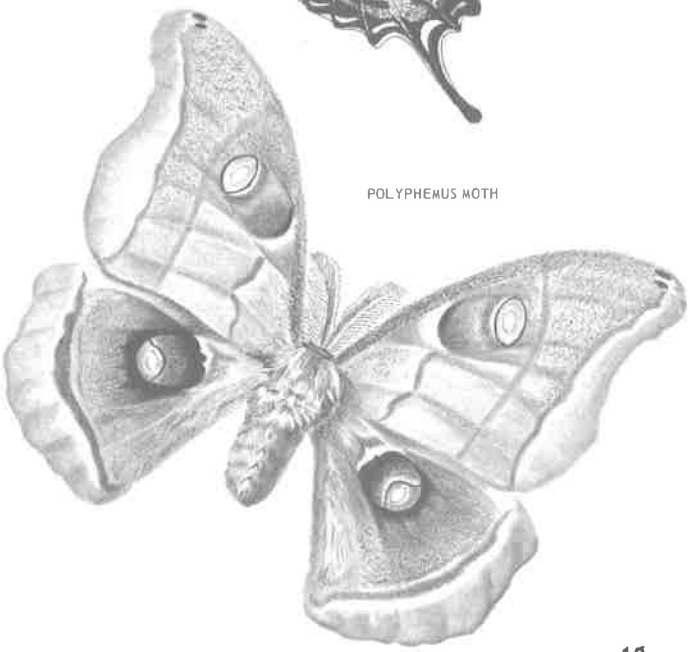
LEPIDOPTERA (butterflies, moths) usually are winged. The winged members have two pair of wings covered with overlapping scales. The mouthparts of the adults are formed for sucking. The immature stages are wormlike. Some are known as caterpillars, cutworms, or hornworms. Their mouthparts are formed for 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)***.

CUTWORM MOTH

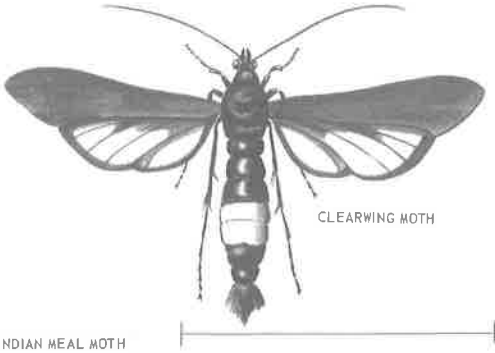


MONARCH BUTTERFLY

SWALLOWTAIL BUTTERFLY

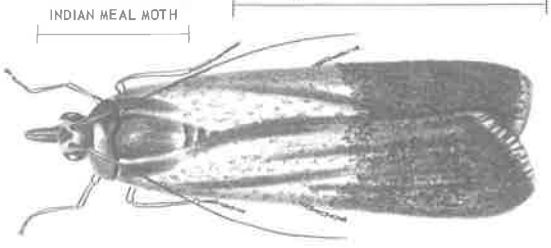


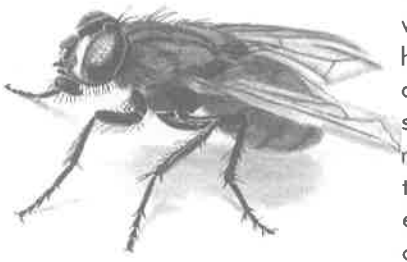
POLYPHEMUS MOTH



CLEARWING MOTH

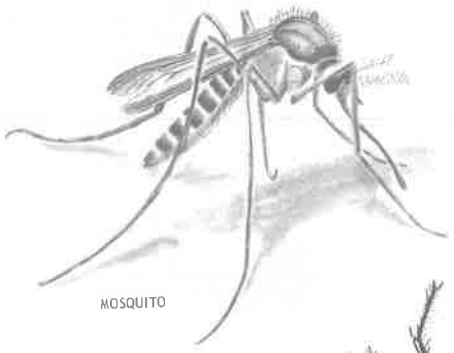
INDIAN MEAL MOTH





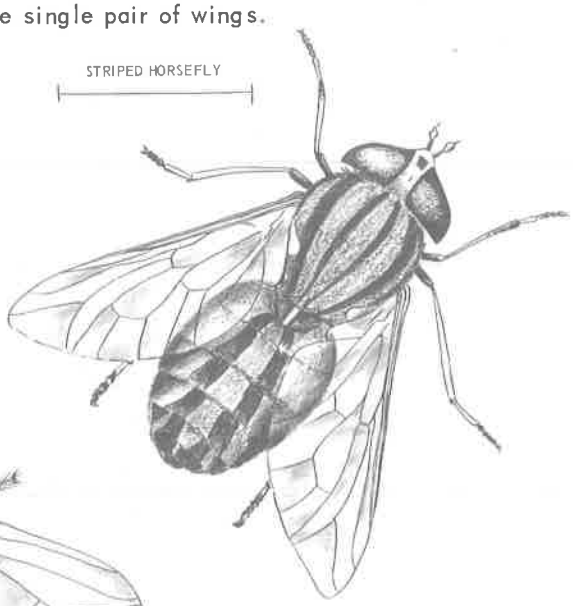
HOUSEFLY

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.



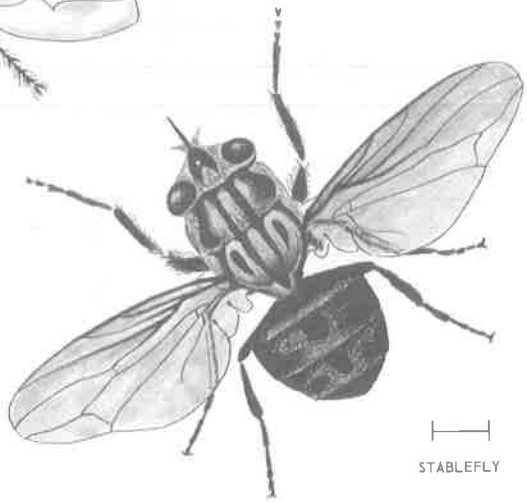
MOSQUITO

STRIPED HORSEFLY

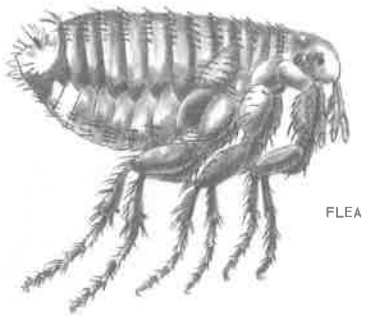


FLESHFLY

WESTERN HORSEFLY



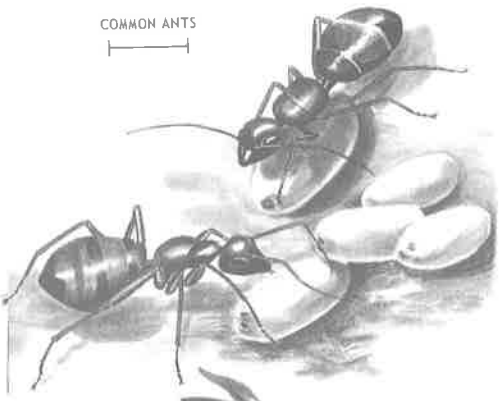
STABLEFLY



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 sucking. 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.

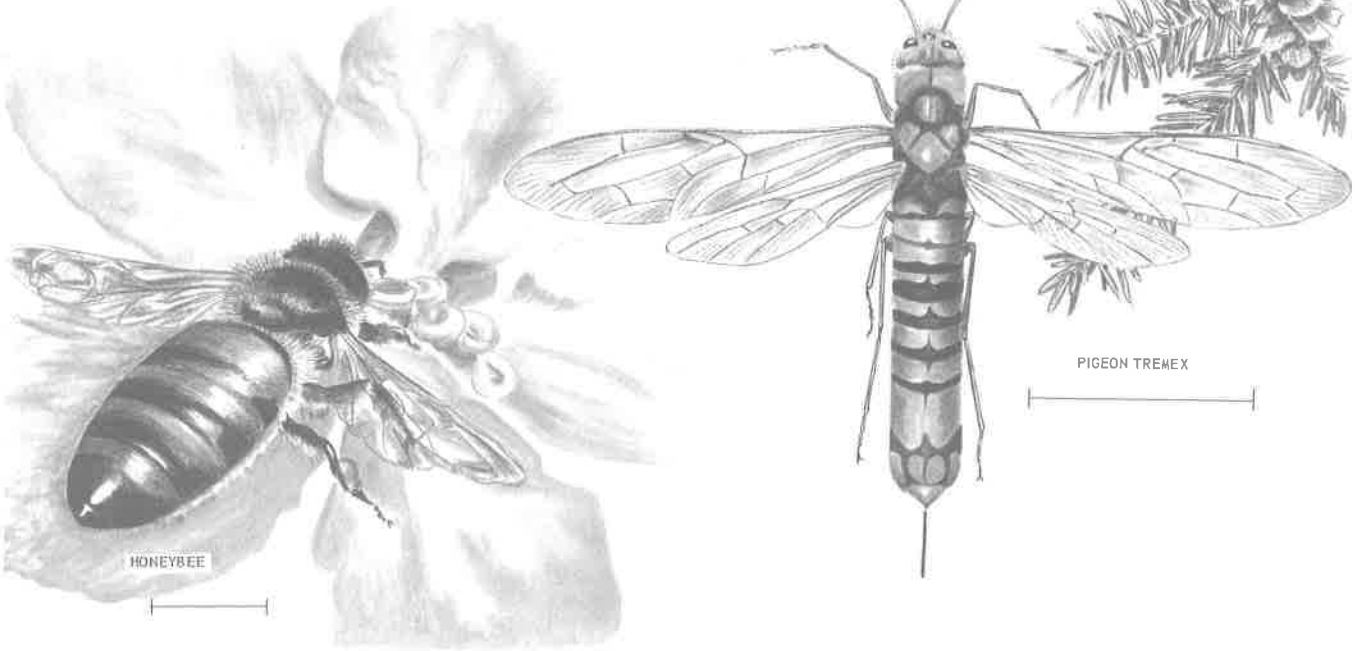


COMMON ANTS

PAPER NEST WASP

BUMBLEBEE

MUD DAUBER WASPS



HONEYBEE

PIGEON TREMEX

KEY TO ORDERS OF INSECTS

Read the first two lines of the key. You will see that you are given two choices or descriptions of parts of an insect.

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

Continue through the key in this manner, reading the two descriptions opposite each number to which you have been referred, and comparing them with the insect to be identified. Illustrations have been added to aid you in identification.

When you reach a description which fits the insect to be identified, it will be followed by a word printed in capital letters. This is the name of the order to which that insect belongs. For further information about the insect, turn to the page in the manual indicated by the number in the last column.

Words Used in the Key

Abdomen – the third body region of insects (see page 1 of the manual).

Antenna (pl., antennae) – the horns or feelers located on the heads of insects.

Cells – the areas in the wings of insects which are between or bounded by veins.

Cerci (sing., cercus) – the threadlike or sometimes forcepslike tails near the tip of the insect abdomen (usually a pair).

Conspicuous – easy to see.

Constricted – thin or narrow.

Cornicles – short, blunt horns or tubes (sometimes buttonlike) on the top and near the end of the aphid abdomen. They give off a waxy liquid which helps protect against enemies.

Elytra – the leathery or hard front wings of beetles. They usually cover the hindwings when at rest and sometimes are called "wing covers."

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

Halteres – small knoblike organs (sometimes shaped like a baseball bat or bowling pin) located on the thorax of ***DIPTERA***. They take the place of the hindwings and are used to help balance the insect in flight.

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

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

Mesothorax – the second or middle thoracic ring which bears the middle pair of legs and the first pair of wings.

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

Palpi (sing., palpus) – small "feelers" near the mouths of insects, probably used to help select food when eating.

Parasite – any animal that lives in or on another.

Pronotum – the top or upper side of the prothorax.

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

Scales – the powderlike covering which gives color to the wings of most butterflies and moths. Actually, very small scales which overlap like shingles on a roof.

Segments – joints or divisions of the insect body, leg, or antenna.

Segmented – jointed or divided into sections.

Stylet – tubular, sucking mouthparts of sucking lice or other sucking insects.

Tarsi (sing., tarsus) – the "feet" of insects. The last small segments or joints near the end of the insect leg. The number may vary from one to five.

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

Veins – the rodlike or veinlike stiffening or supporting "frame" of the insect wing.

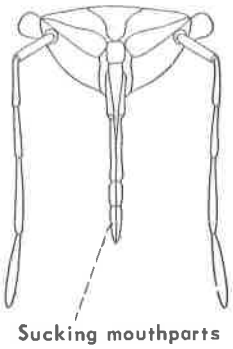


Figure 1

Figure 2

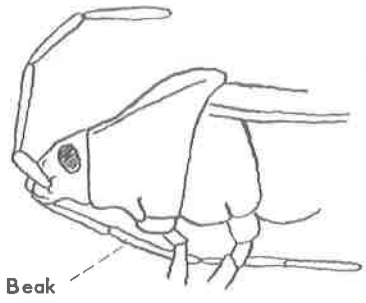


Figure 3

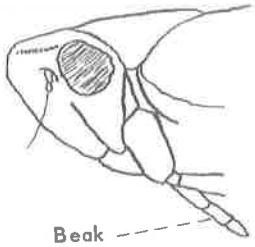


Figure 4

Steps		Refer to Step No.	Insect Order	Refer to Page No.
1.	Wings well developed	2		
	Wingless, or with small undeveloped wings .	22		
2.	Front wings (elytra) hard, leathery, at least at base; hindwings, if present, membranous (skinlike)	3		
	Wings entirely membranous (skinlike)	7		
3.	Sucking mouthparts, with beak longer than wide, and usually jointed (figure 1).	4		
	Chewing mouthparts (figure 2)	5		
4.	Beak arising from front part of head (figure 3); front wings usually leathery at base and membranous (skinlike) at tip; tips generally overlapping when at rest (true bugs)		***HEMIPTERA***	16
	Beak arising from rear underside part of head, often appearing to arise at base of front legs (figure 4); front wings of uniform texture throughout; tips not overlapping, or only slightly overlapping when at rest (leafhoppers, cicadas, aphids, treehoppers)		***HOMOPTERA***	17

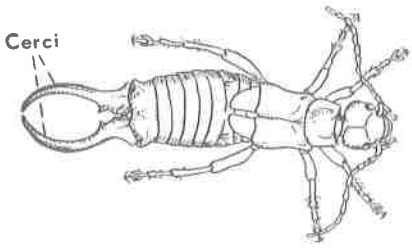


Figure 5

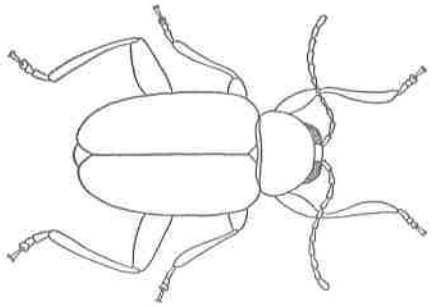


Figure 6

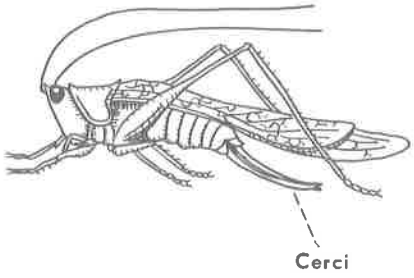


Figure 7

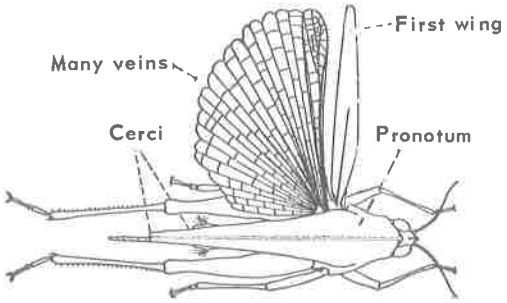


Figure 8

Steps	Refer to Step No.	Insect Order	Refer to Page No.
5. Abdomen with forcepslike cerci (appendages near tail) (figure 5); elytra (leathery front wings) short, leaving most of the abdomen exposed (earwigs)		***DERMAPTERA***	15
Abdomen without forcepslike cerci, or if cerci appear forcepslike, then wings cover most of abdomen	6		
6. Front wings without veins, usually meeting in a straight line down middle of back (figure 6); antennae (feelers on head) with 11 or fewer joints; hindwings narrow, usually longer than front wings when unfolded, and with few veins (beetles)		***COLEOPTERA***	18
Front wings with veins, either held rooflike over abdomen or overlapping over abdomen when at rest (figure 7); antennae usually with more than 12 joints; hindwings broad, usually shorter than front wings, and with many veins (figure 8) (grasshoppers, crickets, roaches, mantids)		***ORTHOPTERA***	14
7. With 2 wings	8		
With 4 wings	11		

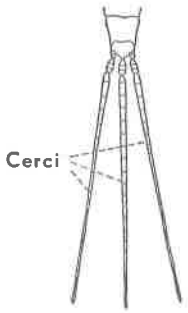


Figure 9

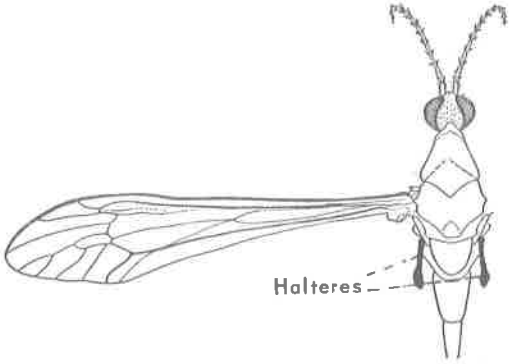


Figure 10

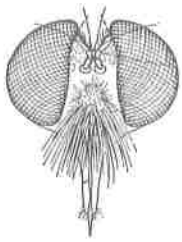


Figure 11

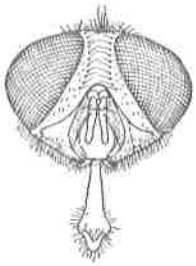


Figure 12

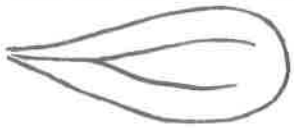


Figure 13

Steps		Refer to Step No.	Insect Order	Refer to Page No.
8.	Body grasshopperlike; pronotum (top side of prothorax) extending back over abdomen, pointed at tip (figure 8); hindlegs enlarged (grouse or pigmy locusts, family ***Tetrigidae***)		***ORTHOPTERA***	14
	Body not grasshopperlike; pronotum not as above; hindlegs not so enlarged	9		
9.	Abdomen with threadlike or spinelike tails (figure 9); mouthparts small or undeveloped; halteres (knoblike organs, taking place of hindwings) (figure 10) present or absent . . .	10		
	Abdomen without threadlike or spinelike tails; mouthparts usually well developed, forming a sucking beak (figure 11) or tongue (figure 12); halteres present (true flies, mosquitoes, gnats, midges)		***DIPTERA***	20
10.	Halteres (figure 10) present and hooklike; wings with only one forked vein (figure 13); antennae (feelers on head) long and conspicuous; very small insects, usually less than ⅛ inch long (male scale insects, family ***Coccidae***)		***HOMOPTERA***	17
	Halteres absent; wings with many veins and crossveins; antennae short, bristlelike, small; usually over ⅛ inch long (mayflies) . .		***EPHEMEROPTERA***	13

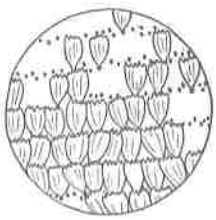
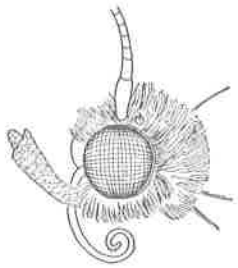


Figure 14



Coiled mouthparts

Figure 15

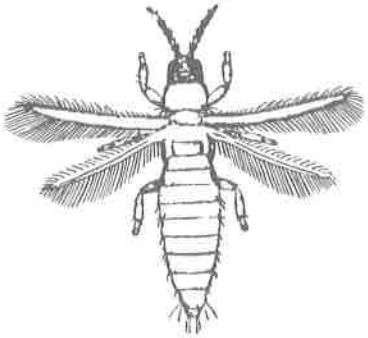


Figure 16

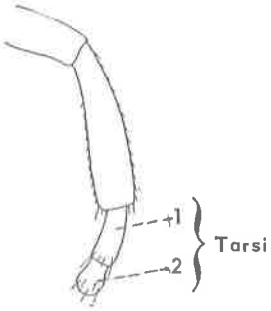


Figure 17

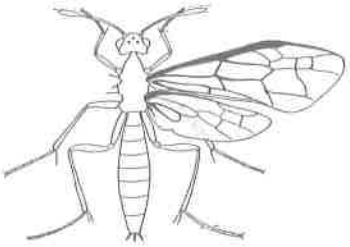


Figure 18

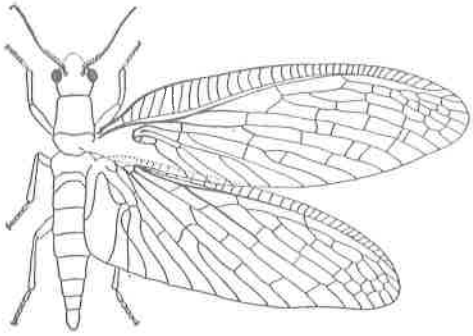


Figure 19

Steps		Refer to Step No.	Insect Order	Refer to Page No.
11.	Wings completely or almost completely covered with microscopic, powderlike scales (figure 14); mouthparts usually in the form of a long, coiled tubelike beak or tongue (figure 15); antennae (feelers on head) many-jointed (butterflies and moths)		***LEPIDOPTERA***	19
	Wings not covered with scales, though they may be hairy (figure 16); mouthparts not in form of a coiled tubelike tongue; antennae of various kinds	12		
12.	Wings long and narrow, veinless or with only 1 or 2 veins, fringed with long hairs (figure 16); tarsi (feet) (figure 17) with only 1 or 2 joints, the last segment swollen; very small insects, usually less than 1/8 inch long (thrips)		***THYSANOPTERA***	16
	Wings not as above; if wings are somewhat long and narrow, then the tarsi have more than two segments	13		
13.	Hindwings smaller than front wings (figure 18), usually with fewer veins	14		
	Hindwings as large or larger than front wings, with as many or more veins (figure 19) . . .	18		

Figure 20

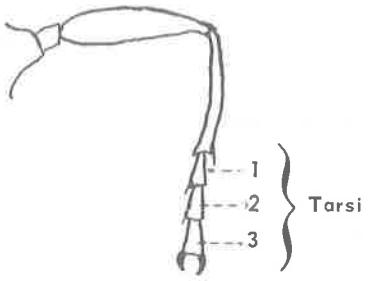


Figure 21

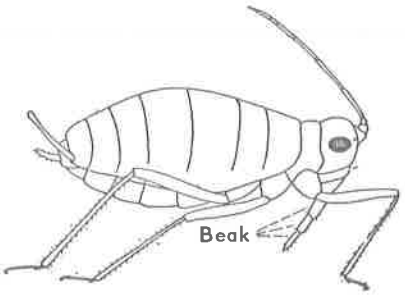


Figure 22

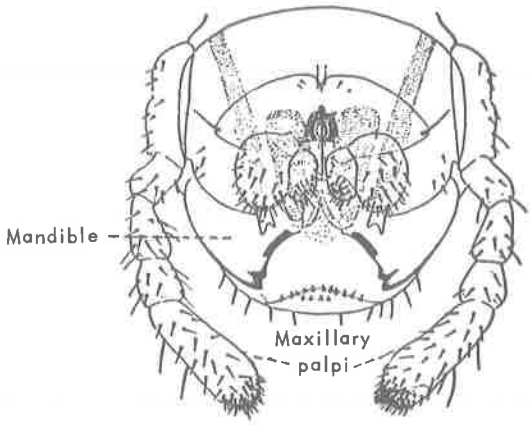
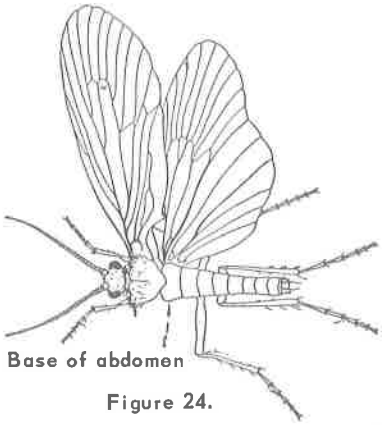


Figure 23

Steps		Refer to Step No.	Insect Order	Refer to Page No.
14.	Front wings with many crossveins and cells (areas between veins); antennae (feelers on head) short, bristlelike, small; abdomen with two or three long threadlike tails (figure 9); delicate, soft-bodied insects (mayflies)		***EPHEMEROPTERA***	13
	Front wings with few crossveins and cells (figure 20); antennae fairly long, or if short and bristlelike, then there are no threadlike tails	15		
15.	Tarsi (feet) two- or three-jointed (figure 21)	16		
	Tarsi (feet) four- or five-jointed	17		
16.	Mouthparts sucking, the beak arising at rear of head (figures 4 and 22) (leafhoppers, cicadas, aphids, treehoppers)		***HOMOPTERA***	17
	Mouthparts chewing (figure 23), very small insects (booklice, barklice, psocids)		***CORRODENTIA***	--



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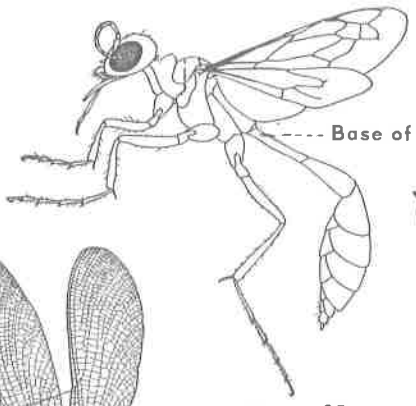


Figure 25.

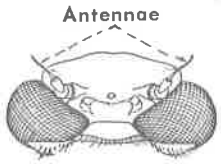


Figure 26.

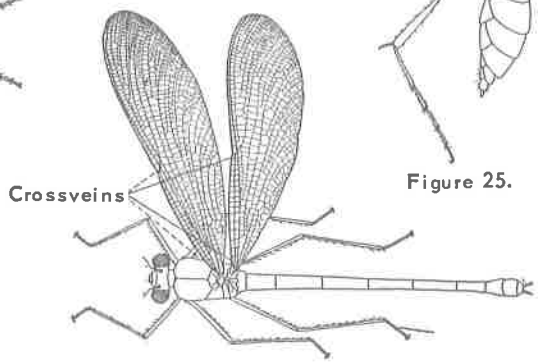


Figure 27.

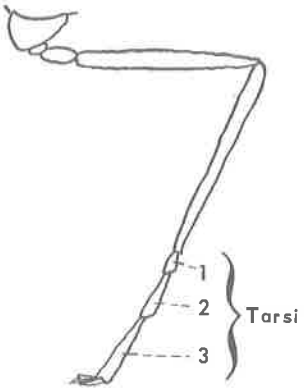


Figure 28.

Steps		Refer to Step No.	Insect Order	Refer to Page No.
17.	Wings noticeably hairy; mouthparts usually very small except for the palpi (feelers near mouth); antennae (feelers on head) usually as long as the body or longer; veins in front and hindwings similar; abdomen not narrow at the base; rather soft-bodied insects, not wasplike (figure 24) (caddisflies)		*TRICHOPTERA*	19
	Wings apparently not hairy; mandibles (chewing mouthparts) well developed; antennae shorter than the body; fewer veins in hindwings than in front wings; abdomen usually narrow at base (figure 25); rather hard-bodied, wasplike insects (sawflies, ichneumon flies, ants, wasps, and bees)		*HYMENOPTERA*	21
18.	Tarsi (feet) three- or four-jointed (figure 21)	19		
	Tarsi (feet) five-jointed	21		
19.	Antennae (feelers on head) short, bristlelike and small (figure 26); wings with many crossveins, never held flat over the abdomen when at rest (figure 27); tarsi (feet) three-jointed (figure 28); body long and slender, ¾ to 3½ inches long (dragonflies and damselflies)		*ODONATA*	14
	Antennae long and conspicuous; wing veins variable, usually held flat over abdomen when at rest; 1½ inches long or less	20		

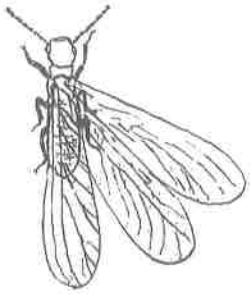


Figure 29

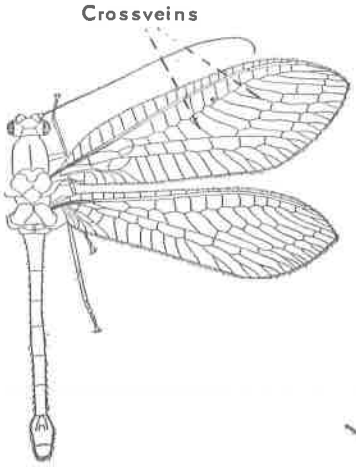


Figure 30

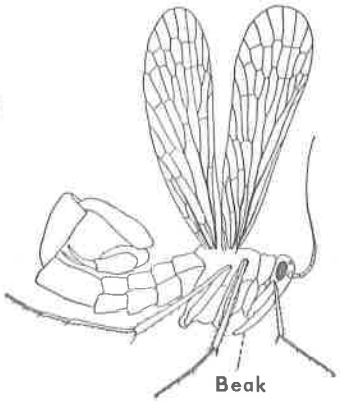
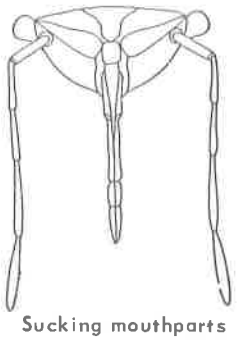


Figure 31

Steps		Refer to Step No.	Insect Order	Refer to Page No.
20.	Front and hindwings similar in shape, size, and number of veins, reaching well beyond the tip of the abdomen when at rest (figure 29); no cerci (appendages near tail); body $^{5}/_{16}$ inch long or less (termites)		*ISOPTERA*	15
	Hindwings with the rear area much enlarged and folded fanlike when at rest; cerci (appendages near tail) present; bodies mostly $^{5}/_{8}$ to 2 inches long (stoneflies)		*PLECOPTERA*	15
21.	Front edge of front wings with many crossveins (figure 30); mouthparts not formed into a beak (as in figure 31) (fishflies, dobsonflies, lacewings, ant lions)		*NEUROPTERA*	17
	Front edge of front wings with not more than one or two crossveins; mouthparts extended downward to form a "beak" (figure 31) (scorpion flies)		*MECOPTERA*	—
22.	Usually parasites living on the bodies of birds or animals; body more or less leathery, and flattened from the upper to lower sides of body or from side to side	23		
	Free-living, not parasites on bodies of birds or animals; body usually not flattened or leathery	28		

Chewing mouthparts

Figure 32



Sucking mouthparts

Figure 33

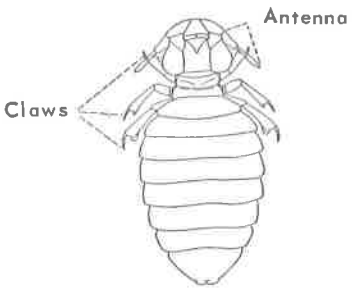


Figure 34

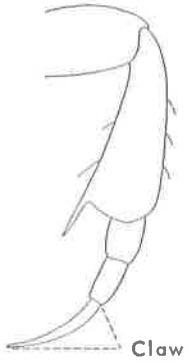


Figure 35

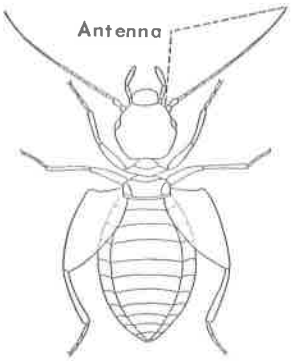


Figure 36

Figure 37

Steps		Refer to Step No.	Insect Order	Refer to Page No.
23.	Mouthparts chewing (figure 32)	24		
	Mouthparts sucking (figure 33), sometimes beak or stylet (tubular mouthpart) is drawn up into the head and cannot be seen . . .	25		
24.	Antennae (feelers on head) with five or fewer joints (figure 34); tarsi (feet) with one claw (figure 35), parasites of animals, or with two claws, parasites of birds (chewing lice)		*MALLOPHAGA*	16
	Antennae with more than five joints (figure 36); not parasitic (booklice, barklice, psocids)		*CORRODENTIA*	
25.	Body flattened on the sides (figure 37); jumping insects (fleas)		*SIPHONAPTERA*	20
	Body flattened from upper to lower sides; not jumping insects	26		

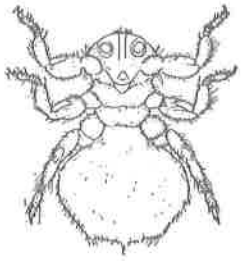


Figure 38

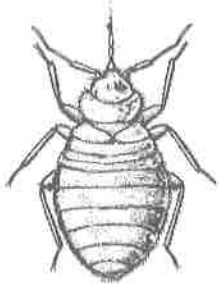


Figure 39

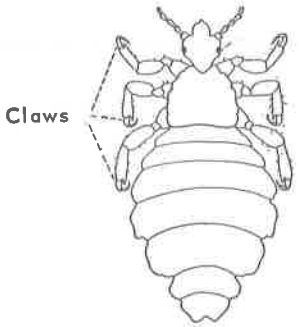


Figure 40

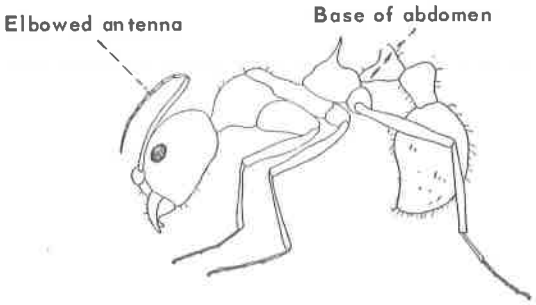


Figure 41

Steps		Refer to Step No.	Insect Order	Refer to Page No.
26.	Antennae (feelers on head) hidden in grooves beneath the head (louse flies) (figure 38)		***DIPTERA***	20
	Antennae not hidden, usually easy to see	27		
27.	Beak longer than wide, four joints, (figure 33), extending back beneath the body; tarsi (feet) with two small claws (wingless bugs) (figure 39)		***HEMIPTERA***	16
	Head with only a short snout in front, the stylet (tubular mouthpart) pulled back into the head when not in use; tarsi with one very large claw (figures 35 & 40) (sucking lice)		***ANOPLURA***	16
28.	Abdomen very thin, small or narrow at base (figure 41); antennae (feelers on head) usually elbowed (figure 41); hard-bodied, antlike insects (ants and wingless wasps, velvet ants)		***HYMENOPTERA***	21
	Abdomen not particularly thin at base; antennae not elbowed	29		

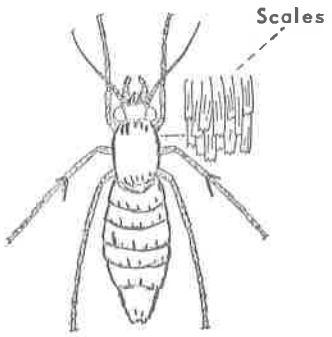


Figure 42

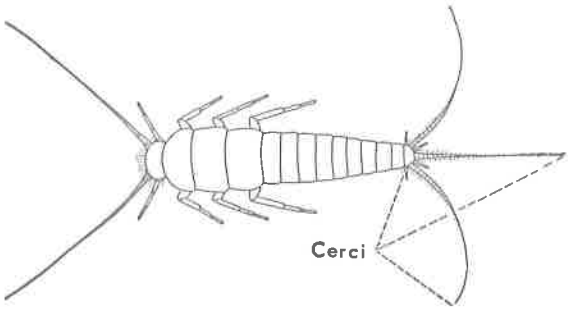


Figure 43

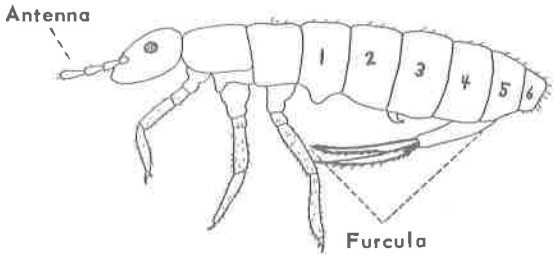


Figure 44

Steps		Refer to Step No.	Insect Order	Refer to Page No.
29.	Body covered with scales (figure 42) . . .	30		
	Body not covered with scales	31		
30.	Abdomen with three long threadlike tails (figure 43), and with spinelike hairs or spikes on some abdominal joints; mouthparts chewing (silverfish, bristletails, firebrats)		***THYSANURA***	13
	Abdomen without tails or spinelike hairs (figure 42); mouthparts sucking, usually in the form of a long, coiled threadlike tube or tongue (figure 15) (wingless moths)		***LEPIDOPTERA***	19
31.	Mouthparts hidden within the head; abdomen with spinelike hairs on some joints, or with a forked tail (furcula) near the end of the abdomen (figure 44); usually less than ¼ inch long	32		
	Mouthparts not as above, easily seen, and either sucking or chewing; size variable	33		

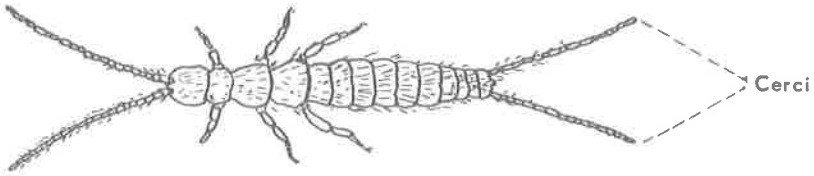


Figure 45

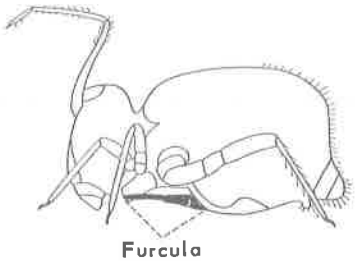


Figure 46

Chewing mouthparts

Figure 47

Steps		Refer to Step No.	Insect Order	Refer to Page No.
32.	Antennae (feelers on head) long and with many joints; abdomen with at least nine joints, with spinelike hairs on some joints; without a forked tail (furcula) near the end of abdomen, but with two, short to long, forcepslike appendages (cerci) at the end of the abdomen (figure 45) (japygids, campodeids, projapygids). These insects are light colored, about ¼ inch or less, and are found in damp places under bark, stones, or fallen trees, in rotting wood, etc.		***THYSANURA***	13
	Antennae short, with six or fewer joints; abdomen with six or fewer segments (figure 44), usually with a forked tail (furcula) beneath and near the end of the abdomen (figures 44 and 46) (springtails)		***COLLEMBOLA***	13
33.	Mouthparts sucking, with beak long and pointing backward from the head, or cone-shaped and pointing downward (figure 33)	34		
	Mouthparts chewing (figure 47); if beaklike, then the beak is fairly long and pointed downward (figure 50)	36		

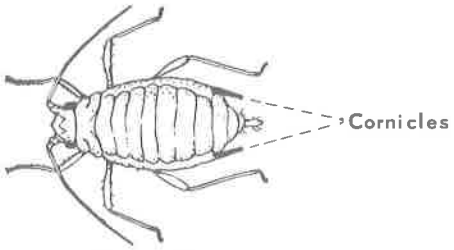


Figure 48

Figure 49

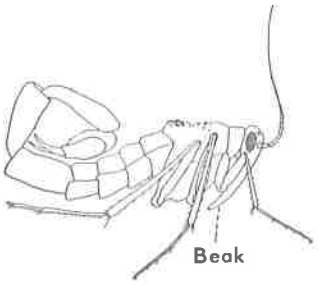


Figure 50

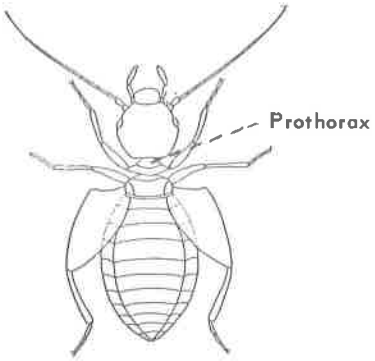


Figure 51

Steps		Refer to Step No.	Insect Order	Refer to Page No.
34.	Body long and narrow; tarsi (feet) with one or two joints and often without claws (figure 17); beak cone-shaped; very small insects, usually less than $\frac{1}{8}$ inch long (thrips) (figure 16)		***THYSANOPTERA***	16
	Body usually more or less oval; tarsi usually three-jointed (figure 28), with well-developed claws; size variable	35		
35.	Beak arising from rear under part of head (as in figures 4 and 22); abdomen often with a pair of cornicles (blunt horns or tubes) (figure 48) (aphids)		***HOMOPTERA***	17
	Beak arising from front part of head (as in figures 1 and 3); abdomen without cornicles (wingless bugs)		***HEMIPTERA***	16
36.	Cerci (appendages near tail) forcepslike (figure 49) (earwigs)		***DERMAPTERA***	15
	Cerci absent, or if present, then not forceps-like (figure 52)	37		
37.	Mouthparts in the form of a beak pointing downward (figure 50); tarsi (feet) five-jointed (figure 54); insect usually less than $\frac{5}{16}$ inch long (wingless scorpion flies) (figure 50) . .		***MECOPTERA***	—
	Mouthparts not as above; tarsi and size of insect variable	38		

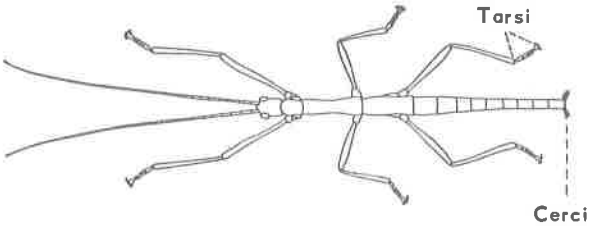


Figure 52

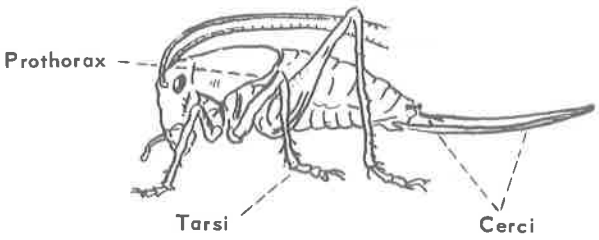


Figure 53

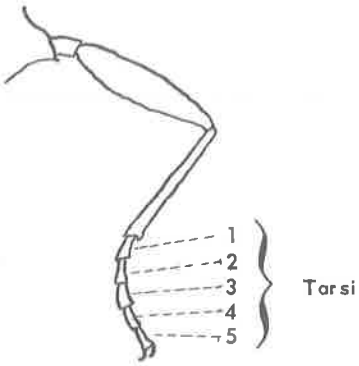


Figure 54

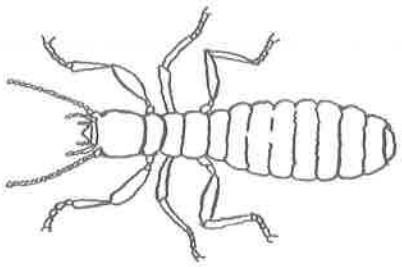


Figure 55

Steps		Refer to Step No.	Insect Order	Refer to Page No.
38.	Small louselike insects (figure 51) less than $^3/_{16}$ inch long; no cerci (appendages near tail); tarsi (feet) two- or three-jointed; prothorax (first ring of thorax) (figure 51) very small (booklice, barklice)		***CORRODENTIA***	—
	Not louselike, insect usually more than $^3/_{16}$ inch long; tarsi three- to five-jointed; cerci present (figures 52 and 53); prothorax large (figure 53)	39		
39.	Hindlegs large, fitted for jumping (figure 53); tarsi (feet) three- or four-jointed (crickets and grasshoppers)		***ORTHOPTERA***	14
	Hindlegs not large, not fitted for jumping (figure 52); tarsi four- or five-jointed . . .	40		
40.	Tarsi (feet) four-jointed; whitish, soft-bodied, living in wood or ground; insect $^5/_{16}$ inch long or less (termites) (figure 55)		***ISOPTERA***	15
	Tarsi five-jointed; appearance not as above (roaches, mantids, walkingsticks) (figure 52)		***ORTHOPTERA***	14

EXHIBITS

Exhibit your properly mounted and identified insect collection at your local or community fair. Be sure your exhibit meets the requirements of the year in entomology in which you are enrolled, and that your insects are in good condition. Remember that the primary object of an exhibit is to create interest.

BOXED INSECT COLLECTIONS (Pinned Specimens)

1. **Quantity** – First year requires a minimum of 25 insects in 9 orders. Consult project outline for other project year requirements.
2. **Accurate identification** – Key only to order.
3. **Correct labeling** – The stacked-labels system under a pinned insect is standard. Group related insects by order, and identify with pinned label.
4. **Quality** – Do not use broken insects.
5. **Arrangements of appendages** – After removing insects from relaxing jar, hold legs and antennae in position by pins on separate paper board mount until dry. Extend wings on grasshoppers, moths, dragonflies, and butterflies.
6. **Correct pinning** –
   a. Relate pin size to insect size. Specimens should be at uniform height, not tipped nor askew.
   b. Use card points for small beetles, bugs, leafhoppers, mosquitoes, and small flies. Tips should be bent down and cemented to the insect's right side.
   c. **Do not** pin caterpillars, grubs, mayflies, silverfish, fleas, aphids, scales, or whiteflies. Use vials with alcohol.
7. **Preservative** – A mothball on a pin or paradichloro-benzene flakes are excellent.

EQUIPMENT

Nets – Label net as to type (general, aerial, aquatic, sweeping).

Killing jars – An exhibit should contain at least two jars marked **For *Lepidoptera* Only**. Label all jars **Poison – Killing Jar.** Jars must be charged, ready for use, wiped clean when exhibited.

Spreading board – Exhibit with moth or butterfly.

LIFE CYCLES

Use Riker mounts. Include a specimen of the host, showing damage if available. Label stages and damage. Include collection data. Fluid mounts can be used to show the various stages of the life cycle. Explanatory labeling and collection data should be included.

DEMONSTRATIONS

Demonstrations give club members the opportunity to show the details and methods of insect control, especially in relation to insects common in their own communities. Thus, club members become well informed and are better prepared to pass this information on to others.

Major points which should be well developed in any 4-H demonstration dealing with insect control include: the damage done by an insect, its life cycle or how it lives, its feeding habits, and methods of control. The insect, the host plant or animal, and some evidence of the damage caused by the insect should be shown in the introduction.

In presenting your demonstration, material such as models of insects or charts should be kept out of sight except when in use. When these materials are being used in the demonstration, handle them so they are plainly visible to the audience. Diagrams or charts help illustrate the feeding habits and different kinds of mouth structures and other body features of insects.

Summarize your demonstration by reviewing all the important points. Use charts, posters, and any type of illustrative material necessary.

To have your demonstration correct and complete, study all the subject matter material available about your subject. Talk with your local leader and your farm advisor for suggestions and information.

DEMONSTRATION TOPICS

Here are suggestions for topics which may be developed into demonstrations. The subheads under each topic are control methods that should be demonstrated.

CONTROLLING THE CLOTHES MOTH AND CARPET BEETLE

Spraying
Brushing, sunning, and airing
Cleaning and storing
Fumigation

CONTROLLING STORED-GRAIN INSECTS

Cleaning bins
Spraying bins
Fumigation

CONTROLLING THE CATTLE GRUB

Spraying
Dusting
Hand control
Washing

CONTROLLING THE SCREWWORM

Medication
Prevention of wounds

CONTROLLING LICE ON ANIMALS

Dipping
Spraying
Dusting

CONTROLLING VEGETABLE GARDEN INSECT PESTS

CONTROLLING FLOWER INSECT PESTS

CONTROLLING HOUSEFLIES

Sanitation
Screen
Sprays

In addition to demonstrations on insect control, many other phases of insect work can be presented as demonstrations. These items may suggest some:

- Preparing insects to be sent away for identification
- Making a collection net
- Mounting insects
- Making a killing jar
- Making a spreading board

EMBEDDING A DRY OPAQUE SPECIMEN

1. Use a thoroughly dried specimen. To reduce the chances of ruining the mount with air bubbles and "silvering" of the specimen, soak the specimen overnight in enough uncatalyzed plastic to cover it.

2. While the specimen is soaking, you can start the mount in a mold. Select a mold with square sides if possible, because they are much easier to polish. Apply a mold release compound (a hard-finish floor or furniture wax will do) to the inside of the mold and allow it to dry. Pour enough plastic into a paper cup to make a thin layer in the bottom of the mold. The depth of the layer depends on the size of the mount. A good average depth is about ⅛ inch. Pour the plastic into the mold and allow it to set overnight to jell. The base layer in the mold is then firm enough to support the specimen.

   Remove the specimen from the uncatalyzed plastic and drain it on a paper towel. Place the specimen upside down in the base layer in the mold. Start placing the specimen in on one side and work to the other side gradually. Use a probing needle or some similar instrument to remove any entrapped air bubbles. Let set for 5 or 6 hours so the specimen will adhere to the base layer; otherwise, the specimen will float when the second layer is poured.

3. When the specimen is firmly adhered to the base layer, mix enough plastic with catalyst to fill the mold. Allow this to harden about 24 hours. The surface then will still be tacky. To harden the plastic, you must shut off the air from the surface. Spread a sheet of Saranwrap® or similar cellophane over the surface, working from one side to another to prevent trapping air bubbles.

4. Place the mold with the jelled plastic in an oven at about 140° F for 3 to 4 hours. You can make a satisfactory oven with a 40-watt light bulb and a small cardboard box. Cut a hole in the bottom of the box to fit a light-bulb socket, and cut two ventilation holes in the corners of the box. Insert the light bulb and invert the box over the mold. Heat the mold for 3 to 4 hours and then leave it in the box until it reaches room temperature.

Three steps in embedding an insect in plastic: 1) pour layer of catalyzed plastic into glass mold to harden; 2) place insect in center of hardened layer; 3) pour another layer, covering the insect.

5. Remove the mold and take the plastic block out of the mold. The mount is now ready to polish. Start with a fairly coarse emery cloth, about 180 grit. Lay the emery cloth on a smooth surface. Wet the cloth and work the mount back and forth on all sides until all coarse blemishes are removed. Repeat the process with a finer emery cloth. Then repeat with a very fine cloth. Dip the block in water frequently so you can see the degree of grinding. Next use a felt pad with some sort of liquid abrasive, such as wetted Ajax® or Babo®. To put a final polish on the mold, polish with jewelers' rouge or toothpaste or powder.

6. If an opaque background is desired, do not fill the mold full in step 3. Fill within about ⅛ inch from the top of the mold. Allow to harden 24 hours, then mix enough plastic to jell the mold, and add the opaque coloring which is available where the plastic is sold. Be sure that the opaque coloring is recommended for the plastic that you use.

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