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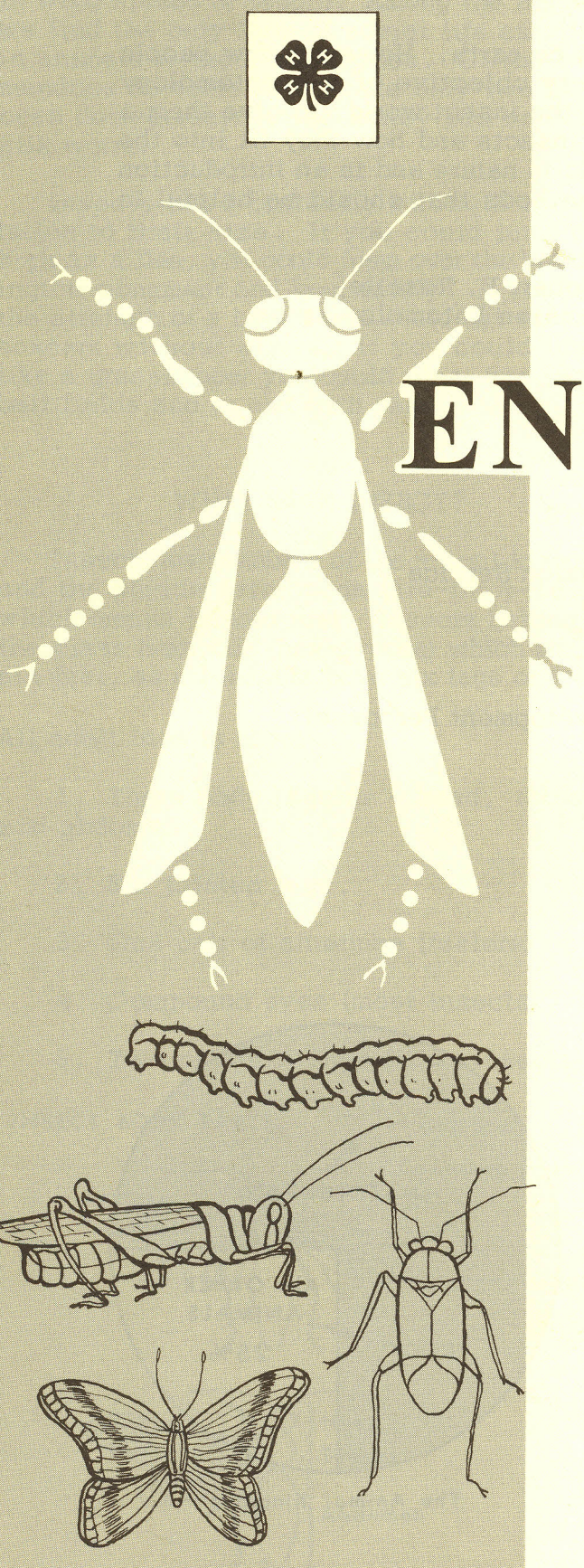

4-H ENTOMOLOGY MANUAL

EXTENSION SERVICE
UNIVERSITY OF NEBRASKA COLLEGE OF AGRICULTURE
COOPERATING WITH THE U.S. DEPARTMENT OF AGRICULTURE
AND THE COLLEGE OF HOME ECONOMICS.
E. F. FROLIK, DEAN; J. L. ADAMS, DIRECTOR

OBJECTIVE

Insects are the most numerous animals on earth. However, few people know and understand insects. The primary objective of 4-H entomology projects is to acquaint young people with the insect world, to give them a better understanding of the importance of insects and how they fit into the living landscape. This project is scientific in nature and is an introduction to scientific study, observation, and methods that should be helpful in years to come.

Robert E. Roselle
Extension Entomologist

ACKNOWLEDGMENTS

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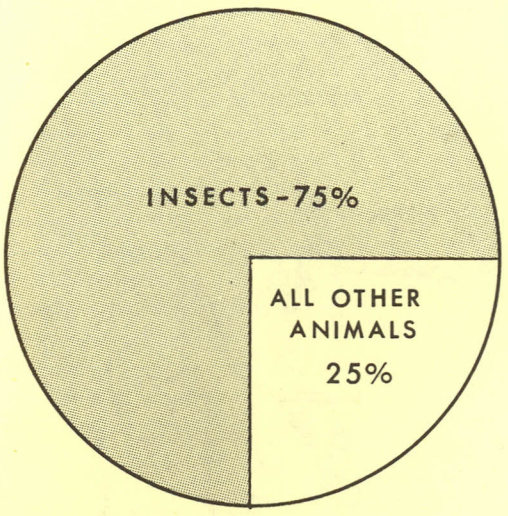
University of Nebraska 4-H and Youth Development Personnel

ENTOMOLOGY

Entomology (en-toe-mol-o-gee) is from the Greek work entomon meaning insect. Entomology is the science of insects. The scientist who specializes in insect life is called an Entomologist.

Insects have probably been present on earth longer than most other living animals as we know them today. The numbers of species (kinds) make up more than 70 percent of all the named kinds of animals in the world.



The Animal Kingdom

Insects vary in size from microscopic organisms to the great moths (and grasshoppers) of the tropics measuring nearly 12 inches in wing spread or length. Among the insects we find the only form of social life existing in animals without backbones. Of the tremendous numbers of insects only two have been domesticated, the honey bee and the silk worm.

Insects have fantastic strength in relation to their size. If you could jump as high as a flea, you could jump over the Washington monument and land safely. If you had the strength of a beetle you could lift several boxcars without effort. If you could jump like a grasshopper you could clear two football fields end to end with ease.

WHAT IS AN INSECT?

Insects are members of the animal kingdom and the phylum arthropoda (are-throp-od-da) which means jointed feet. Insects belong to the class hexapoda (hex-a-poda) which means six feet, as all insects have six legs or feet.

All adult insects have:

1. Three body regions - head, thorax, and abdomen.

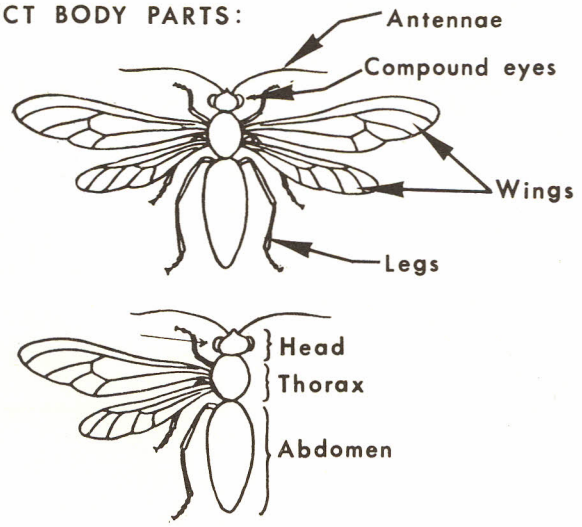
2. Six jointed legs.

3. One pair of antennae (feelers).

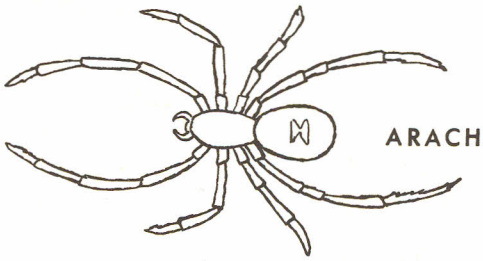
4. Compound eyes (most insects).

5. Two or four wings (most insects).

INSECT BODY PARTS:

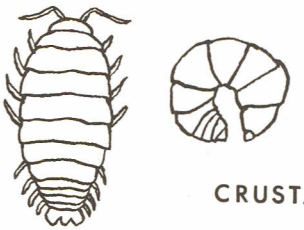


Other animals closely related to insects that belong to the phylum arthropoda are: spiders, ticks, mites, and scorpions. These animals belong to the class arachnida (a-rak-nu-da). Arachnids have two body regions, eight legs, and do not have wings or antennae.



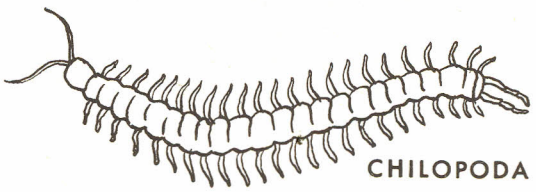
ARACHNIDA class

Sow bugs, pill bugs, shrimp, and crayfish belong to the class crustacea (crus-ta-she-a). Crustaceans have two body regions, 10 or more legs, two pair of antennae, and do not have wings.



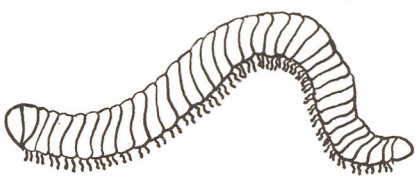
CRUSTACEA class

Centipedes belong to the class chilopoda (ki-lop-a-da). They have one pair of legs on each body segment, worm-like bodies, one pair of antennae, or none, and usually are very active.



CHILOPODA class

Millipedes (thousand-legged worms) belong to the class diplopoda (de-plop-a-da). This class has worm-like bodies, each body segment has 2 pairs of legs and they have one pair of antennae or none.

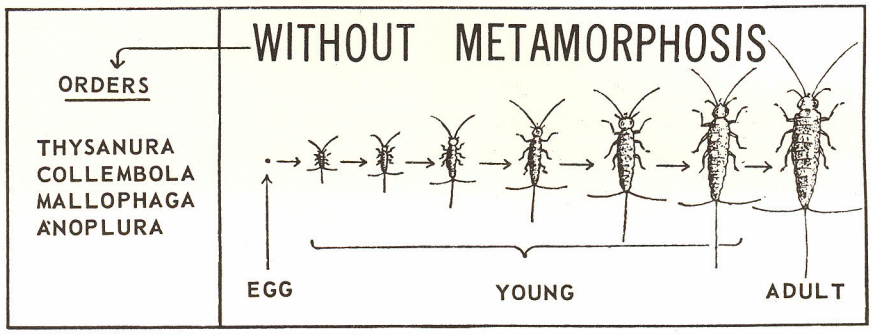


DIPLOPODA class

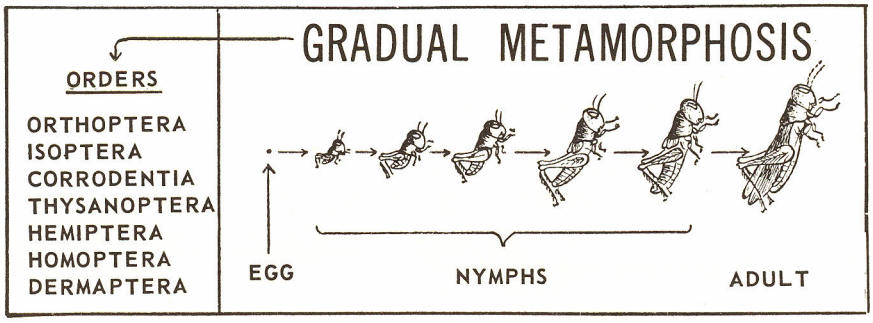
HOW INSECTS GROW

Insects go through changes as they develop after hatching from eggs. The changes they pass through are called metamorphosis (change in form). The kinds of metamorphosis are illustrated below.

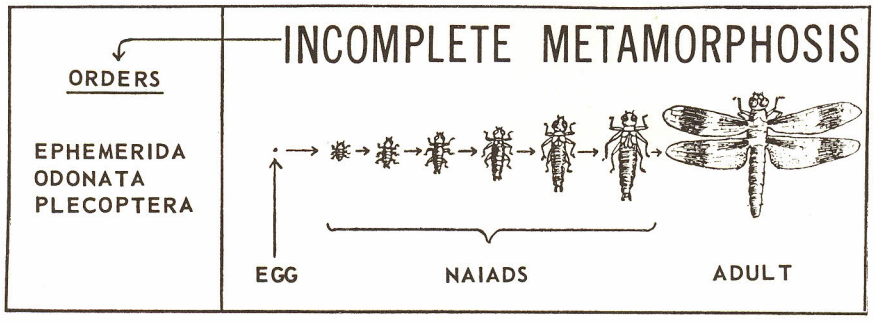
In GROUP 1 the insect that comes from the egg looks exactly like it will when grown, except that it will then be larger.



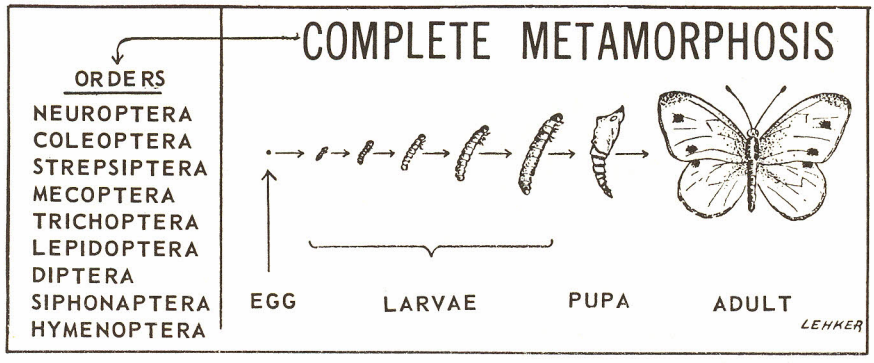
Insects in GROUP 2 change shape gradually. There are three stages of growth, each looking more like an adult.



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.



COLLECTING INSECTS

Insects may be collected all year. They are numerous during the warm days of spring, summer and fall. Favorite places to look for insects are:

1. Flowers--for butterflies, moths, and bees.

2. Under rocks and boards--for beetles and many other kinds.

3. On trees and shrubs--for leaf hoppers, treehoppers, and leaf beetles.

4. On fermenting fruits--for many kinds of bees, beetles, and butterflies.

5. Dead animals--for scavenger beetles.

6. In the vegetable garden--for the many pests of the garden.

7. Legumes--for a never-ending variety of bugs and bees.

8. Corn fields--for rootworm beetles, corn borers, aphids, and aphid lions.

9. Grasses and weeds--(a wonderful source of insect specimens when a sweep net is used).

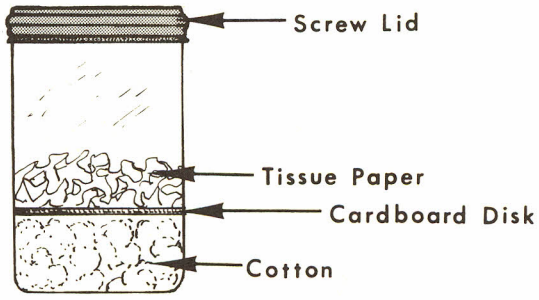
10. Everywhere!--Insects may be found in almost every place. Do not overlook the insects that live in the home, in water, or on animals.

KILLING BOTTLES

After an insect is collected it should be placed in a special killing bottle to kill it quickly, thus preventing damage to the specimen.

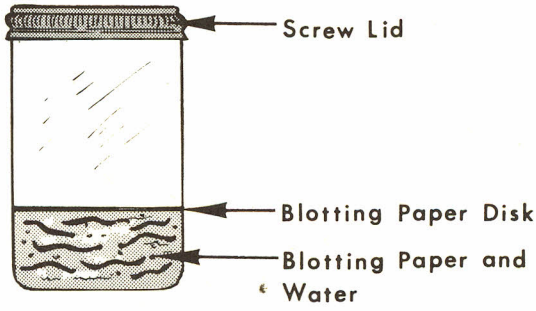
A safe and effective killing bottle is made by placing several layers of cardboard in the bottom of a glass jar, or a layer of cotton covered with a cardboard disk.

Saturate the cotton or cardboard with NON FLAMABLE spot remover, or fingernail polish remover. Pour off the excess and keep the lid screwed on tightly to prevent loss of fumes. As the bottle is used it will lose its strength so the killing fluid must be replenished from time to time.



RELAXING JARS

When insects become dry before pinning they should be relaxed so they will not break. To relax dried insects place a bit of cotton or blotting paper in the bottom of a pint jar. Moisten the cotton or paper with water and add a drop or two of Lysol to prevent mold. Place insect specimens in this jar for two days, or until they have become relaxed so that the legs, body, and wings may be moved without breaking.



COLLECTING NET

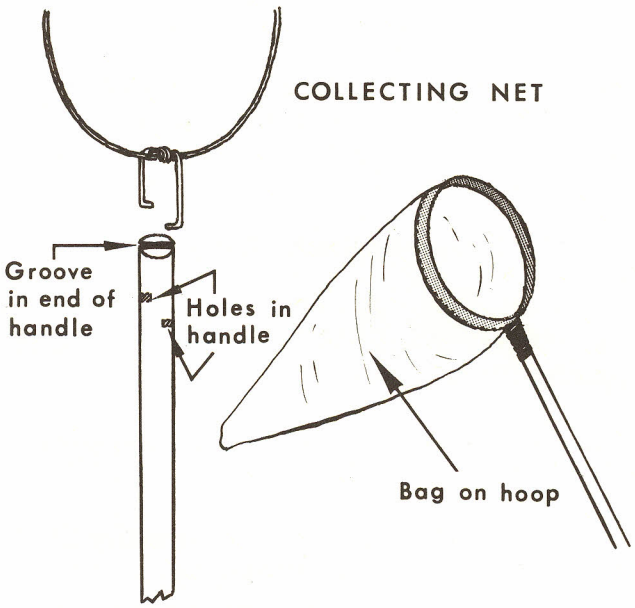
Aerial nets for collecting butterflies, moths, and other flying insects can be made from a broom handle, clothesline wire, and nylon or orlon curtain material

The handle should be about four feet long. Cut a groove across one end of the handle then bore a hole one-half inch deep on one side of the handle three inches from the end, and a second hole one-half inch deep on the opposite side four inches from the end.

With a heavy wire about four feet long, bend a loop and attach it to the handle as shown in the diagram. Bind the ends of the wire tightly to the handle with fine wire, heavy twine, or electrical tape.

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

Sweeping nets to collect insects from grass, trees, and shrubs by quickly swinging the net over the plants can be made like the aerial net using a muslin bag instead of net.



COLLECTING NET

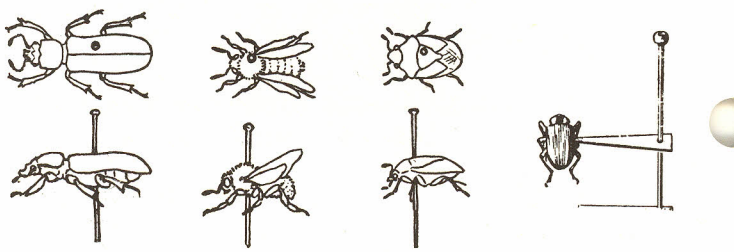
PINNING INSECTS

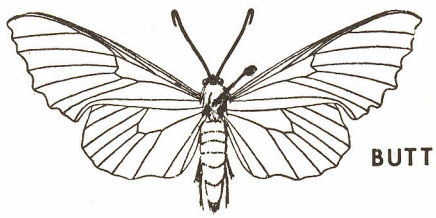
Most insects are pinned directly through the body using a special insect pin. Ask your county agent where insect pins can be obtained.

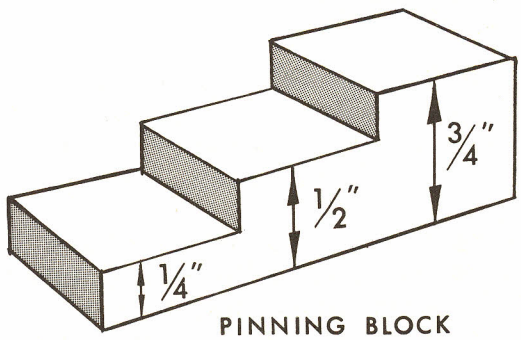
The place of pinning depends upon the type of insect. The following diagram illustrates correct methods of pinning various orders of insects.

Very small insects should be glued to small cardboard triangles which may be obtained from your Extension entomologist without charge. Ask your county agent to order them for you.

The distance from the head of the pin to the body of the insect should be the same on all specimens. This may be done with a pinning block. First place the pin through the body of the insect to within 1/4 inch of the head of the pin. Place the head of the pin in the hole of the shortest section of the pinning block to measure the distance from the pin head. The other 1/4 inch sections are for label spacing.


BEETLES FLIES, BEES BUGS On Triangles

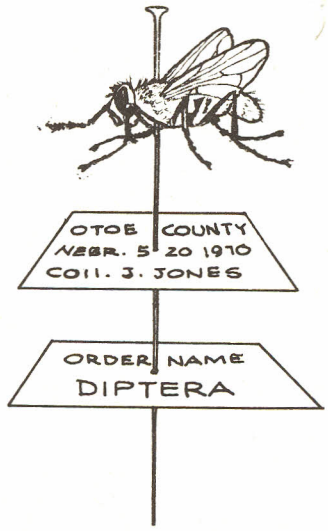

BUTTERFLIES and MOTHS



PINNING BLOCK

LABELING INSECTS

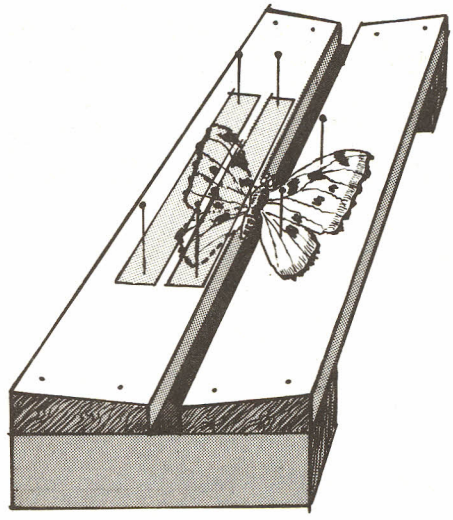
Two labels should be placed on the pin below the specimen. The top label should show the county in which the specimen was collected, the date it was collected, and the name of the collector. The lower label should show the order name of the insect. Specially printed labels are available from your county agent.



SPREADING BOARDS

The wings of butterflies and moths should be spread before they dry. This preserves them in a position most attractive for displays.

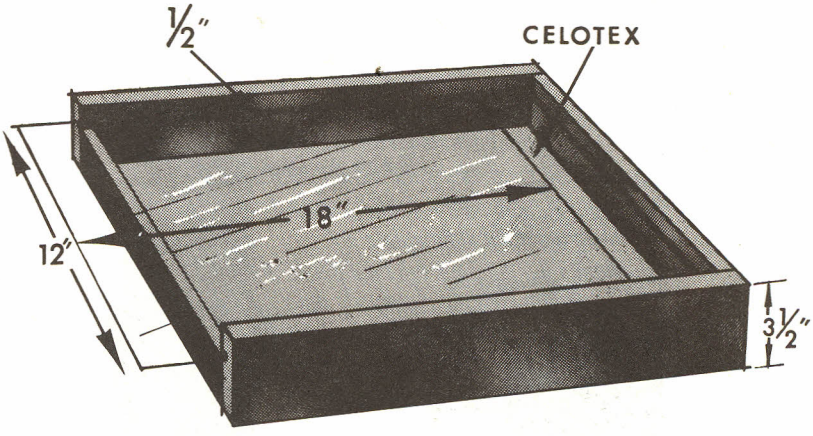
Place the body of the butterfly or moth (or other insects if you wish) in the slot between the two boards, the wings spread and held in place with narrow strips of paper pinned to the surface of the boards. They should remain on the board about three days to allow the wings to set. Larger bodied specimens may require a longer time to dry. The pin should be placed through the insect before it is spread. If pinned after drying the specimen will break



DISPLAY BOXES

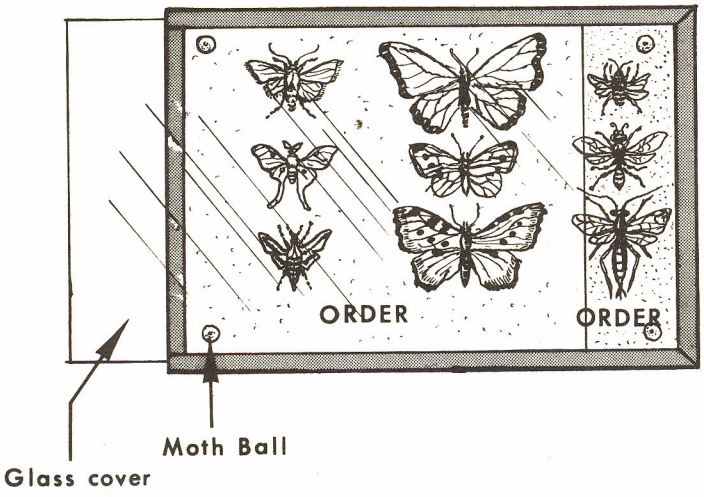
Cigar boxes with soft, corrugated cardboard bottoms are good collecting boxes for first year projects or for storing insects.

A better display box for exhibiting insects can be made at small cost. A glass top box should be 12 x 18 x 2 1/2 to 3 1/2 inches deep. Groove the sides of the box so that the glass will slide out the narrow end of the box. Use celotex, corn board, or other soft material for the bottom so that pins can be inserted easily. Most hardware stores or lumber yards have standard window glass 12" x 18". It is easier to build the box around the standard size glass than to cut glass to fit a box.



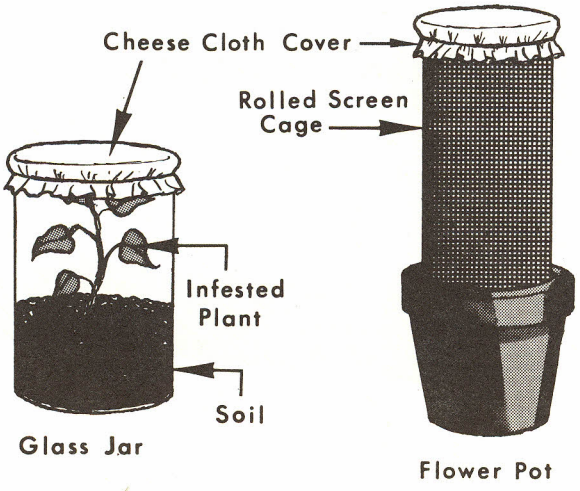
PLACING INSECTS IN BOXES

Place only pinned and labeled specimens in the box. Orders should be displayed in neat rows with order label below and in the center of the row. Order labels should be about 2 inches long and 1/2" wide. Neatness in pinning and displaying insects is important at county and state fairs.



REARING INSECTS

Many insects are easy to rear if you provide the right kind of food and surroundings. Simple rearing cages made of screen wire, or large glass jars with cheese cloth or screen wire tops can be used.



Most caterpillars can be reared into adult butterflies or moths by collecting the eggs or young caterpillars and furnishing them with fresh food from the plants they were found on. This can be done in large pickle jars or in cages made of screen wire rolled into a cylinder with the ends closed with wooden disks or cardboard. It is wise to place an inch or two of soil in the bottom of the cage as many caterpillars pupate in soil.

Potato beetles can be reared on a potted potato plant in a screen cage placed over the plant, or in a cage placed over a plant in the garden. The larvae pupate in the soil.

House flies can be reared in glass jars with a small dish or jar cap filled with damp bran and a little sugar in the bottom of the jar. Keep the bran moist but not soaking wet. Eggs, larvae, and pupae can be observed. Watch for adult flies to emerge.

Roaches can be reared in fruit jars in which bran, dog food or other food products have been placed. Observe the egg capsules which are generally on the abdomens of the adult roaches until they are almost ready to hatch. Rearing roaches will require several weeks.

Plant lice (aphids) are easy to rear on the host plant which has been potted and covered with a glass jar or placed in a glass jar. Young aphids are generally born alive. Watch for birth of aphids and observe growth.

Lady beetles can be reared from eggs or small larvae caged with a colony of aphids on a host plant. Lady beetles consume large numbers of aphids, so be sure the food supply is plentiful.

Many other kinds of insects can be reared in simple cages. Use your own imagination.

BENEFICIAL AND HARMFUL INSECTS

Most kinds of insects are not harmful to man. However, the injurious species can cause serious losses. Some insects carry diseases which affect our health and may even result in death. Insects carry malaria, yellow fever, bubonic plague, sleeping sickness, typhus fever, and many other diseases of man

and of domestic and wild animals. A very few of the kinds of insects in Nebraska cause losses estimated at $100,000,000 annually in Nebraska alone.

Beneficial insects help by keeping harmful insects under control, pollinating plants, furnishing food for wildlife and fish, decomposing dead plants and animals, and furnishing food. They contribute to our welfare in many ways which cannot be evaluated.

Some of the harmful insects common in Nebraska which are readily collected are:

1. Corn rootworms
2. Grasshoppers
3. Cutworms
4. Wireworms
5. Chinch bugs
6. European corn borers
7. Armyworms
8. Corn earworms
9. Ants
10. Leafhoppers
11. Alfalfa weevils
12. Clover leaf weevils
13. Bean leaf beetles
14. Flea beetles
15. Webworms
16. Horn flies
17. House flies
18. Stable flies
19. Face flies
20. Cattle lice
21. Cattle grubs (larvae)
22. Poultry lice
23. Sheep keds
24. Longhorned borers
25. Metallic wood borers
26. Bagworms
27. Scale insects
28. Leaf beetles
29. Bark beetles
30. May beetles
31. Cockroaches
32. Carpet beetles
33. Fleas
34. Crickets
35. Silverfish
36. Termites
37. Grain weevils
38. Flour beetles
39. Indian meal moths
40. Mosquitoes

Some of the beneficial insects common in Nebraska are:

1. Mayflies (fish food)
2. Honey bees (honey and wax) (pollinator)
3. Dragon flies (eat mosquitoes)
4. Damsel flies (eat mosquitoes)
5. Preying mantids (predator)
6. Stone flies (fish food)
7. Assassin bugs (predator)
8. Some stink bugs (predators)
9. Lacewings (predators)
10. Ant lions (predators)
11. Ground beetles (predators)
12. Solitary bees (pollinators)
13. Leaf cutter bees (pollinators)
14. Lady beetles (predators)
15. Tiger beetles (predators)
16. Fireflies (predators)
17. Bumble bees (pollinators)
18. Robber flies (predators)
19. Rove beetles (predators)
20. Flower flies (predators)
21. Tachinid flies (predators)
22. Ichneumon wasps (parasites)
23. Chalcid wasps (parasites)
24. Braconid wasps (parasites)
25. Wasp egg parasites (parasites)
26. Scavenger beetles (scavengers)
27. Blow flies (scavengers)
28. Dobson flies (fish food)
29. Leaf beetles (on weeds)
30. Weevils (on weeds)
31. Aphids (on weeds)
32. Termites (when they decompose fallen trees)
33. Grasshoppers (as fish and bird food)
34. Blister beetles (as destroyers of grasshopper eggs)
35. Bee flies (eat grasshopper eggs)
36. Springtails (decompose dead vegetation)
37. Thistle butterfly (eats thistles)
38. Fruit flies (scientific studies)
39. Butterflies and moths (aesthetic)
40. All insects (subject matter for poems and prose, songs, ornaments, and collecting)

PREVENTING MUSEUM PESTS

Small beetles (dermestids) called museum pests, destroy unprotected collections by eating the dried insects. To prevent damage by these pests a small container of para-dichlorobenzene (PDB) moth crystals, or moth balls, should be kept in the box at all times.

Moth balls can be prepared by heating a common pin red hot, then forcing the head of the pin into the moth ball. Pin the balls into the bottom of the box. This will prevent the moth balls from rolling about and breaking specimens. Large boxes should have three or four balls pinned in them.

IDENTIFICATION OF INSECTS

Insects, like all other animals, are identified by body characteristics from the animal kindgom to species. An example of identification of the common housefly as compared to man is:

	Man	Housefly
Kingdom	Animal	Animal
Phylum	Chordata	Arthropoda
Class	Mammalia	Hexapoda
Order	Primates	Diptera
Family	Hominidae	Muscidae
Genus	Homo	Musca
Species	sapiens	domestica

The scientific name of mankind is Homo sapiens, the scientific name of the housefly is Musca domestica.

There is only one species of mankind living today. There are nearly 1,000,000 species of insects named, and probably at least twice that many that have never been named.

Identification of insects to family, genus, and species is very difficult--too difficult for 4-H members to attempt. In all 4-H Entomology projects, order names are all that are required for insect identification. Members who wish to attempt more specific identification of common insects are encouraged to do so, but this is not required.

INSECT ORDERS

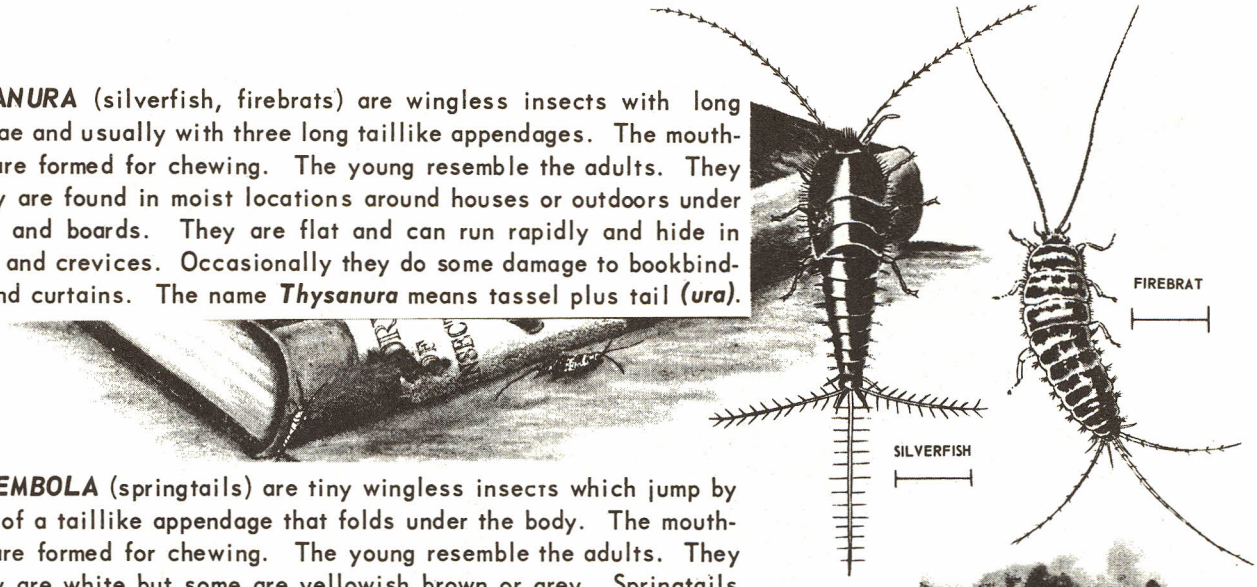
Insects are placed in certain orders because of similar body (generally wing) characteristics. The orders of insects are:

Coleoptera.....beetles
Lepidoptera .....butterflies and moths
Hymenoptera .....bees, wasps and ants
Diptera .....flies
Orthoptera .....grasshoppers, crickets, preying mantids, walking sticks and cockroaches
Hemiptera .....true bugs
Homoptera .....scales, cicadas and aphids
Odonata .....dragon and damsel flies
Mallophaga .....chewing lice
Tricoptera .....caddis flies
Neuroptera.....aphid lions, ant lions, dobson flies
Siphonaptera .....fleas
Corrodentia .....book lice
Ephemeroptera.....May flies
Dermaptera.....Earwigs
Thysanoptera.....Thrips
Anoplura.....sucking lice
Mecoptera .....Scorpion flies
Collembola .....springtails
Thysanura.....silverfish and firebrats
Isoptera .....termites

The following drawings will help you identify your insects to orders:

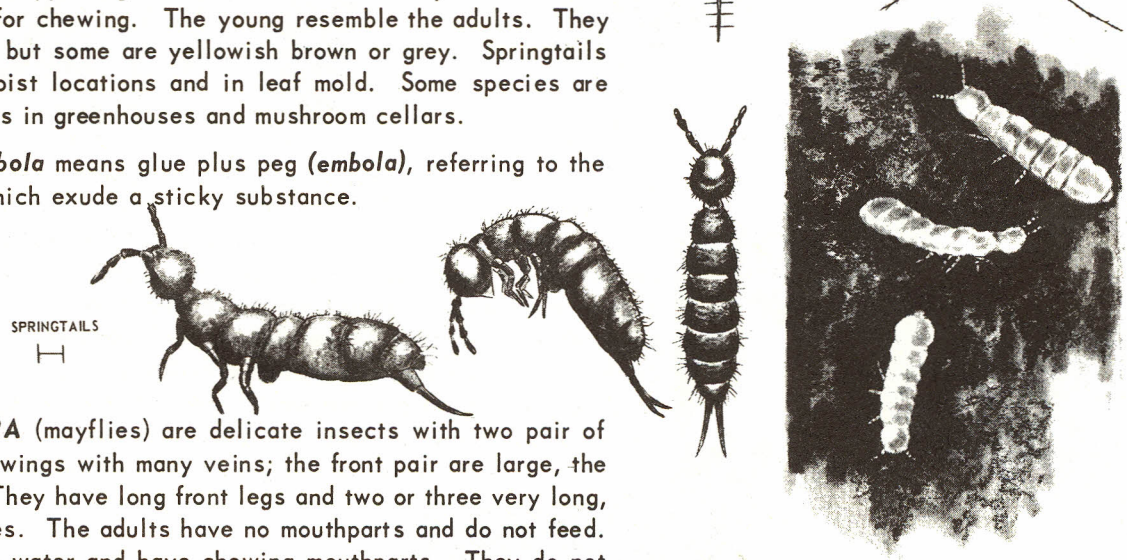
IDENTIFICATION OF INSECTS BY ORDER

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)***.

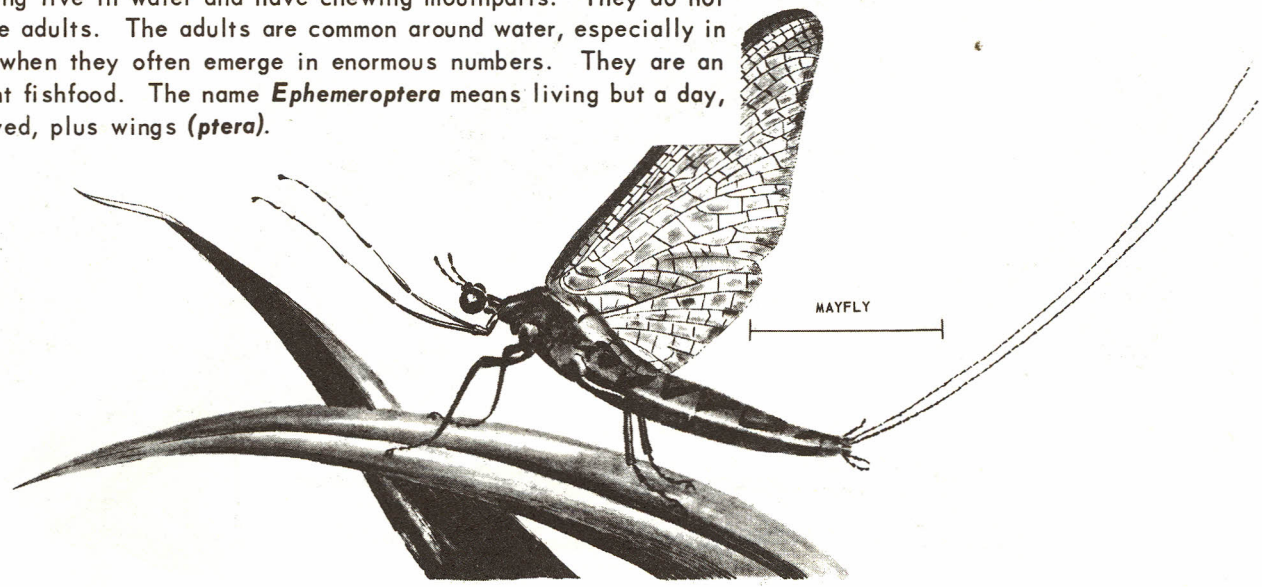


COLLEMBOLA (springtails) are tiny wingless insects which jump by means of a taillike appendage that folds under the body. The mouthparts are formed for chewing. The young resemble the adults. They usually are white but some are yellowish brown or grey. Springtails are common in moist locations and in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

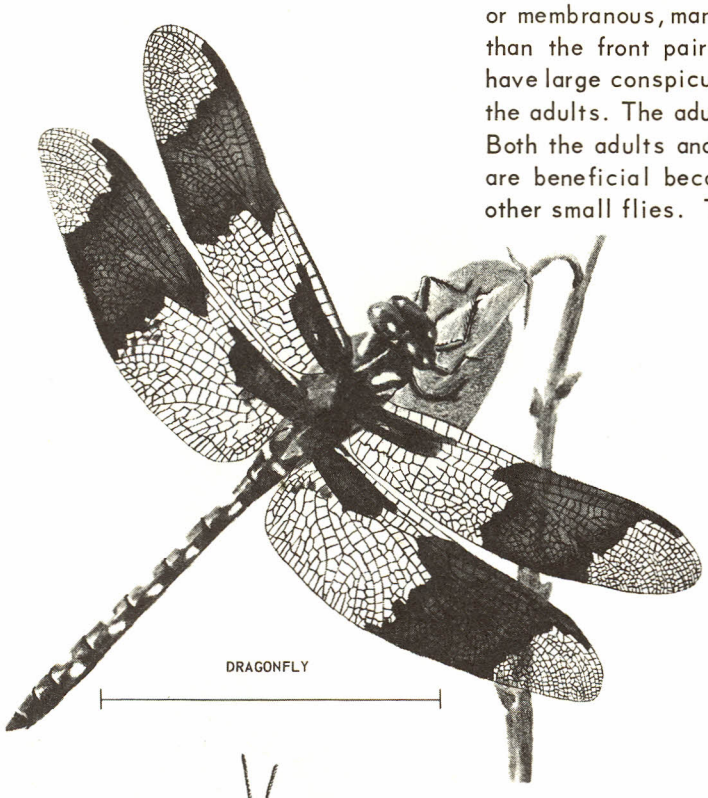
The name ***Collembola*** means glue plus peg ***(embola)***, referring to the ventricle tubes which exude a sticky substance.

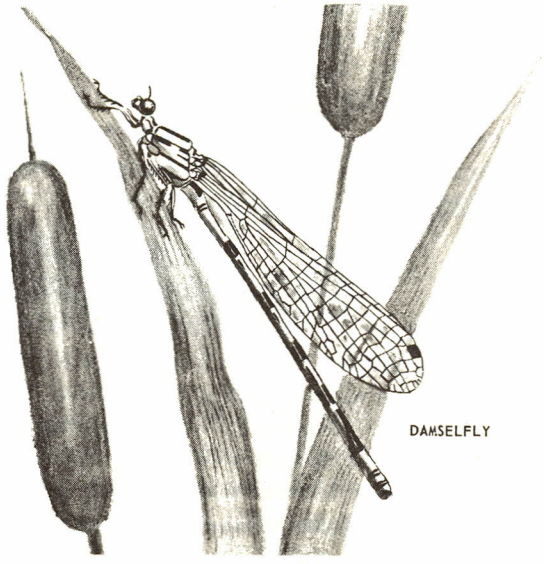


EPHEMEROPTERA (mayflies) are delicate insects with two pair of triangular-shaped wings with many veins; the front pair are large, the hind pair small. They have long front legs and two or three very long, taillike appendages. The adults have no mouthparts and do not feed. The young live in water and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

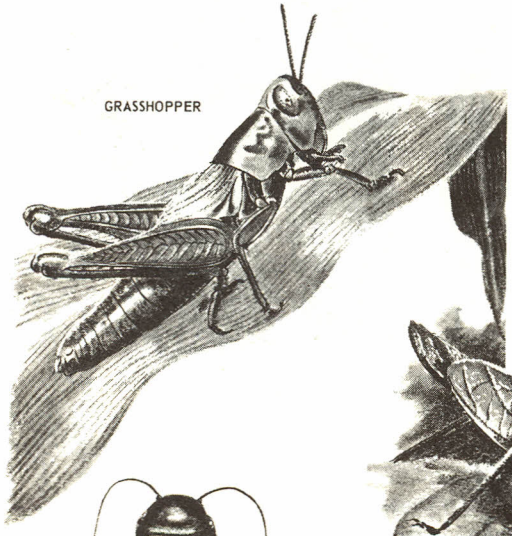


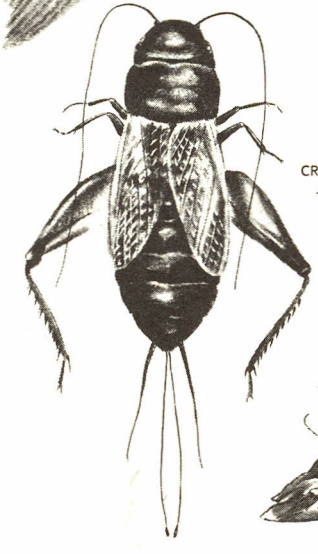
ODONATA (dragonflies, damselflies) are large insects with two pair or membranous, many-veined wings, the hind pair as large as or larger than the front pair. The mouthparts are formed for chewing. They have large conspicuous eyes. The young live in water and are not like the adults. The adults are common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

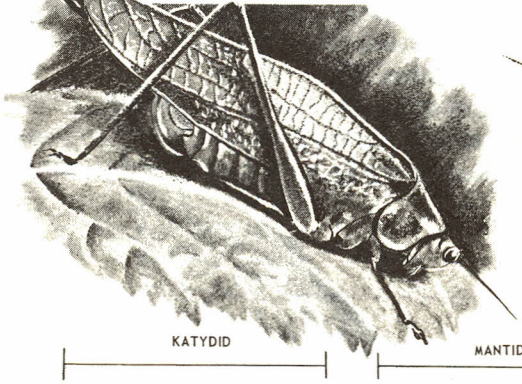


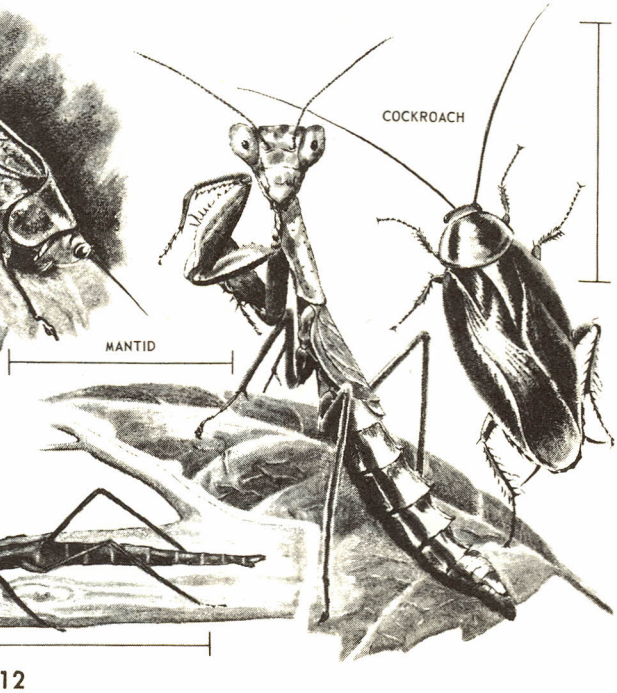


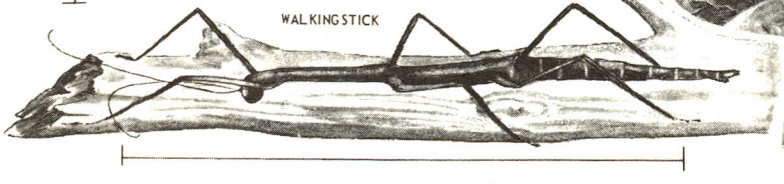
ORTHOPTERA (grasshoppers, crickets, katydids, roaches, mantids, walkingsticks) generally have two pair of wings which have many veins. The front pair usually is slender and the hind pair broad and fanlike. The mouthparts are formed for chewing. The nymphs resemble the adults. Several groups in this order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











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

Only two wings. Flies. **DIPTERA**

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

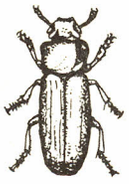
First pair wings overlap at tip--sucking beak. True Bugs. **HEMIPTERA**

Sucking beak.

Wings not overlapping at tip.

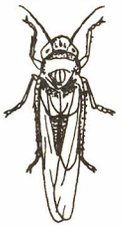
Wings not covered with scales or hairs.

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



Wings not forming hard shells over body.

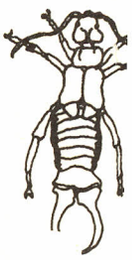
Wings held over body like a roof. Sucking mouthparts. Beak appears to come from the rear of the head or close to front legs. Aphids, Leaf-hoppers, Cicadas, Scales, Mealy bugs. **HOMOPTERA**



Wings not body like a

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

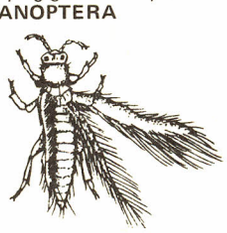
Forewings short, no tip of abdomen--pi forceps at tip of ab Earwigs. **DERMAP**



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

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

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



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

ADULT INSECT SPECIMENS
WINGED

HOW TO USE THIS KEY

This key is designed to help identify only adult insects so make certain you have an adult insect. Special keys are required to identify immature insects.

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

Wings not held over body like a roof.

+

Mouthparts not on end of beak.

+

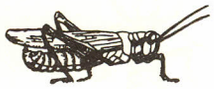
Front wings thick and leathery; hindwings membraneous.

Both pairs of wings thin–often transparent.

+

gs short, not reaching domen–pincer-like t tip of abdomen. **DERMAPTERA**

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



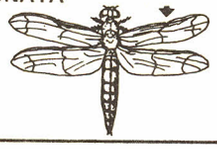
Wings with few veins and crossveins. Ants, Bees, Wasps. **HYMENOPTERA**

Wings with many veins and crossveins.

+

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

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



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

No long thin projections on tip of abdomen. Lace -- wings. Antlions. **NEUROPTERA**

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

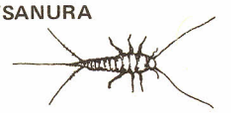
ADULT INSEC
WING

No wings presen

Chewing mouthparts.

Body not covered with powder-like scales.

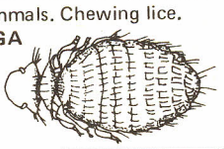
Body covered with powder-like scales. Usually have a pair of long hair-like projections on tip of body. Silverfish, Fireg
THYSANURA



Firebrats

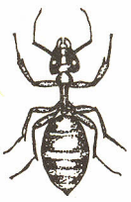
Not flat but round insect. Size varies from small to large.

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

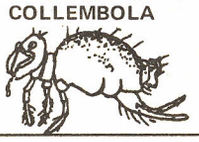


Abdomen wide at base.

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

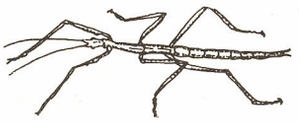


Small insect about 1/8" long, with a springing mechanism at tip of abdomen. Springtails.
COLLEMBOLA

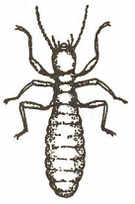


Larger than 1/8", no springing mechanism.

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



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



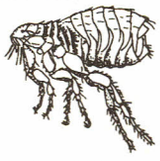
T SPECIMENS
LESS

t in adult state

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

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

SIPHONAPTERA



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

Mouthparts have a long beak.

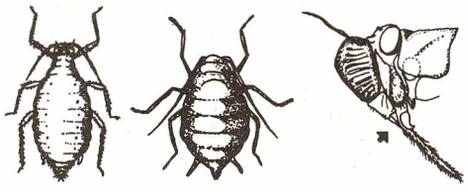
Mouthparts not jointed May be fleshy or beak may appear absent

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

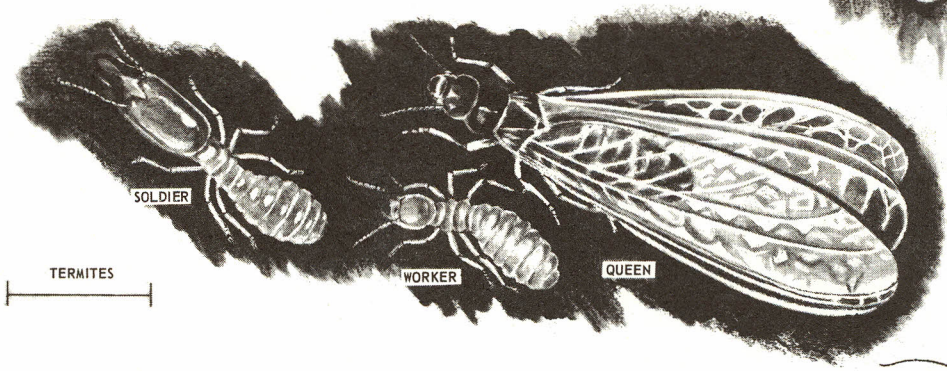
Antennae hidden in pits of head--- not seen from above. Body looks like a tick. Flies. **DIPTERA**

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

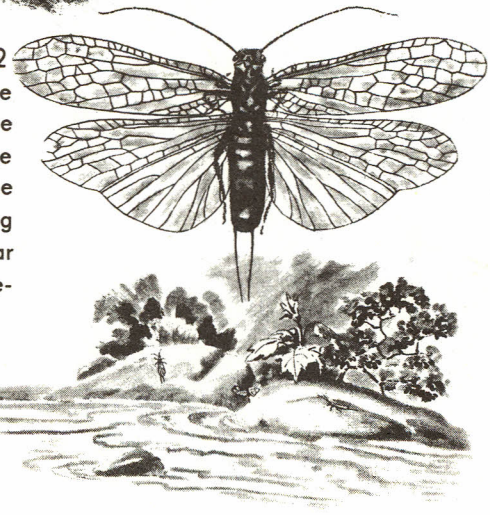
Beak appears to come from the rear of head or close to front of legs. Aphids, Leafhoppers, Cicadas, Scales, Mealy bugs. **HOMOPTERA**

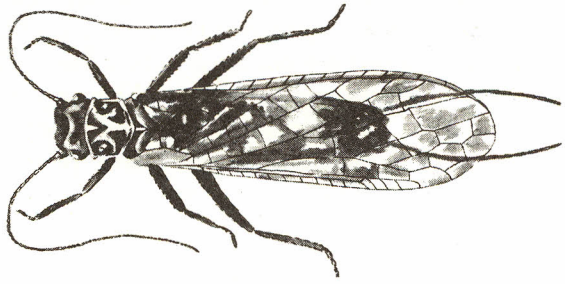


ISOPTERA (termites) are small, soft-bodied yellowish or whitish insects that live in colonies in wood. Colonies consist of three classes —workers, soldiers, and swarmers. The workers and soldiers are wingless and never leave the colony. The swarmers are reproductive forms having dark bodies and four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

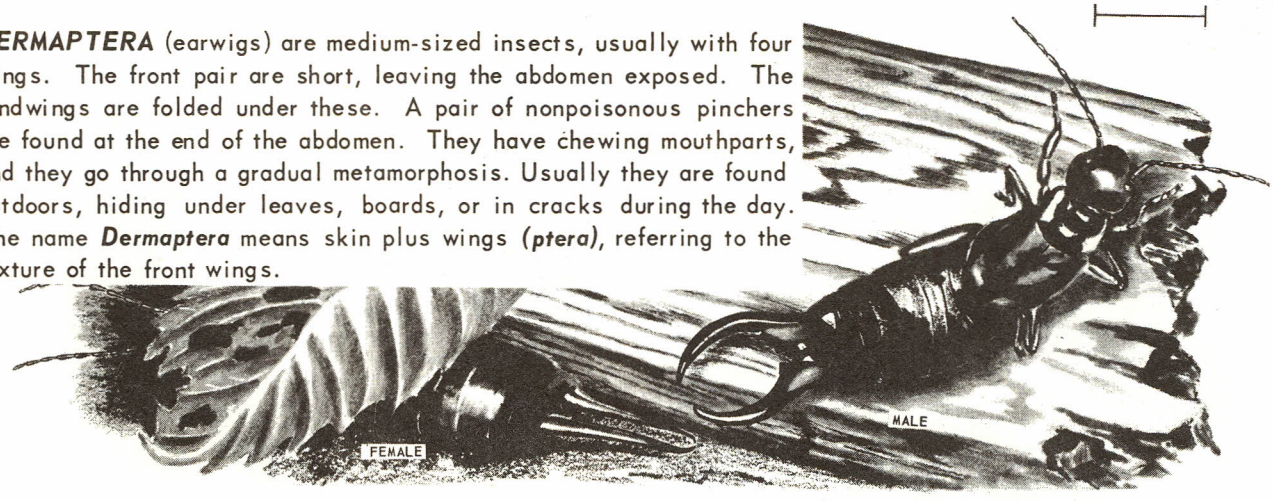


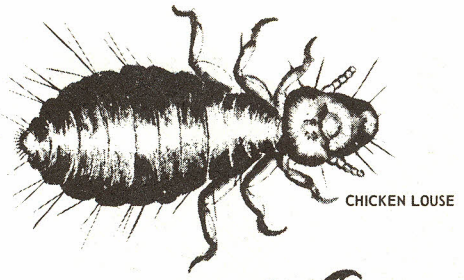


STONEFLIES

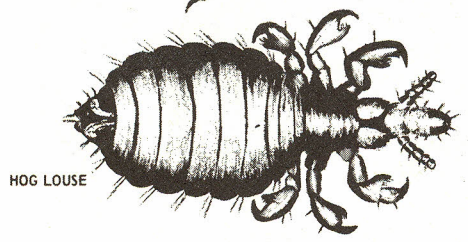
EARWIG

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.

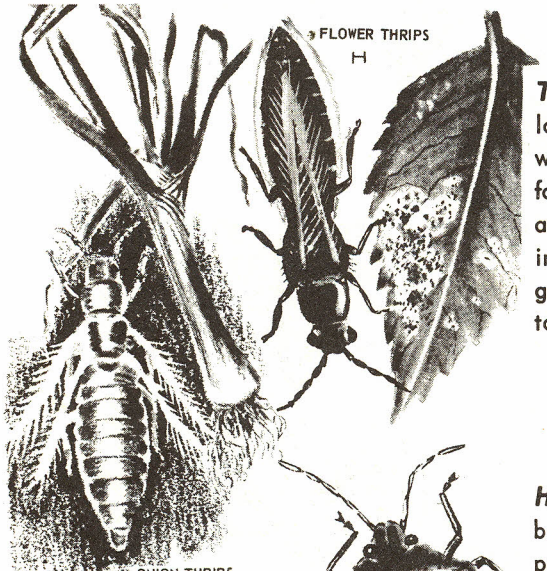




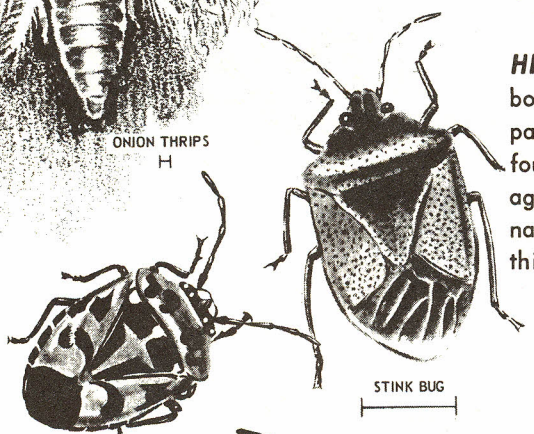
MALLOPHAGA (biting lice or bird lice) are small, flat, wingless, parasitic insects with mouthparts formed for chewing. The legs and antennae are short. The immature stages resemble the adults. They feed upon feathers, hair, wool, and skin scales. They are frequently important pests of domestic fowls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



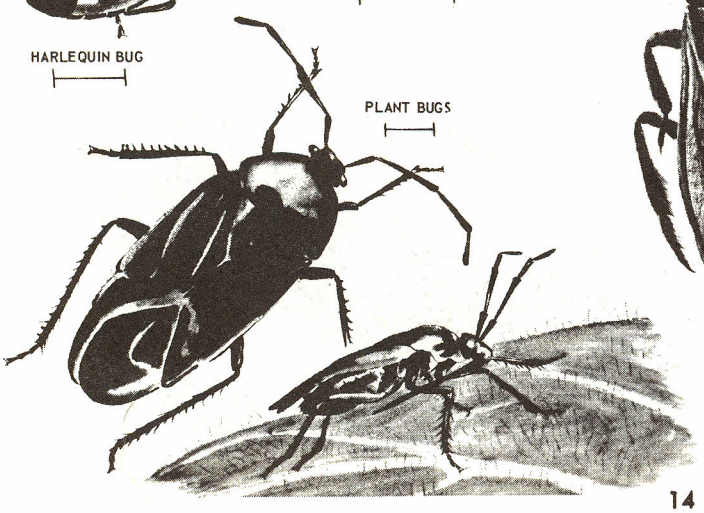
ANOPLURA (true lice or sucking lice) are small, flat, wingless, parasitic insects with mouthparts formed for piercing and sucking. The legs and antennae are short. The immature stages resemble the adults. These insects are found on man and domestic animals, but not on fowls. They feed by sucking blood.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

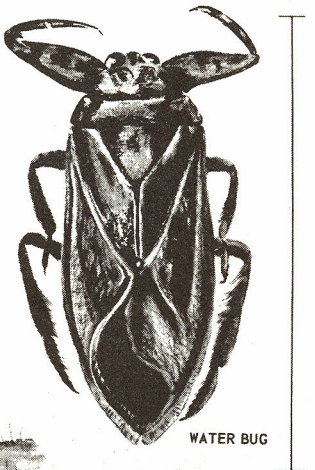


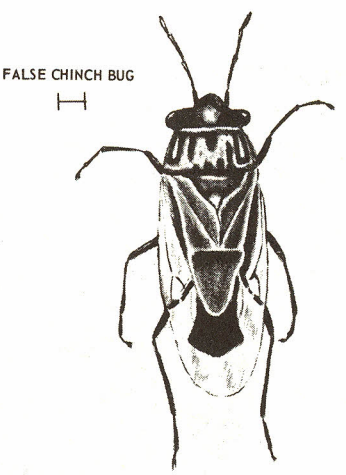
THYSANOPTERA (thrips) are mostly very small insects about ⅛ inch long, usually with two pair of slender wings with few veins but fringed with long hairs. The legs and antennae are short. The mouthparts are formed for piercing and sucking, and the immature stages resemble the adults. Some of these insects 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.



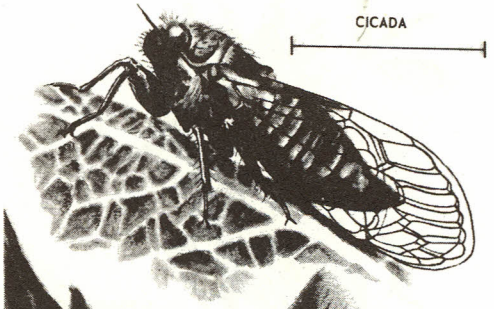
HEMIPTERA (true bugs) usually have four wings folded flat over the body. The front pair are thickened with membranous tips. The mouthparts are for sucking and are prolonged into a beak. The insects are found in water, on plants and animals, and cause considerable damage by their feeding. They go through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



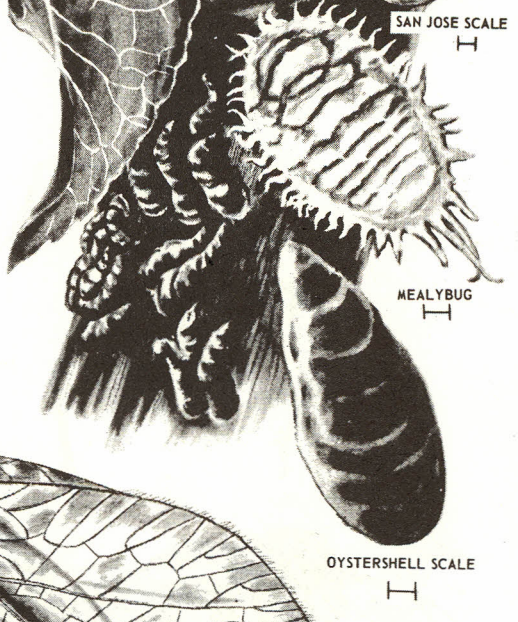


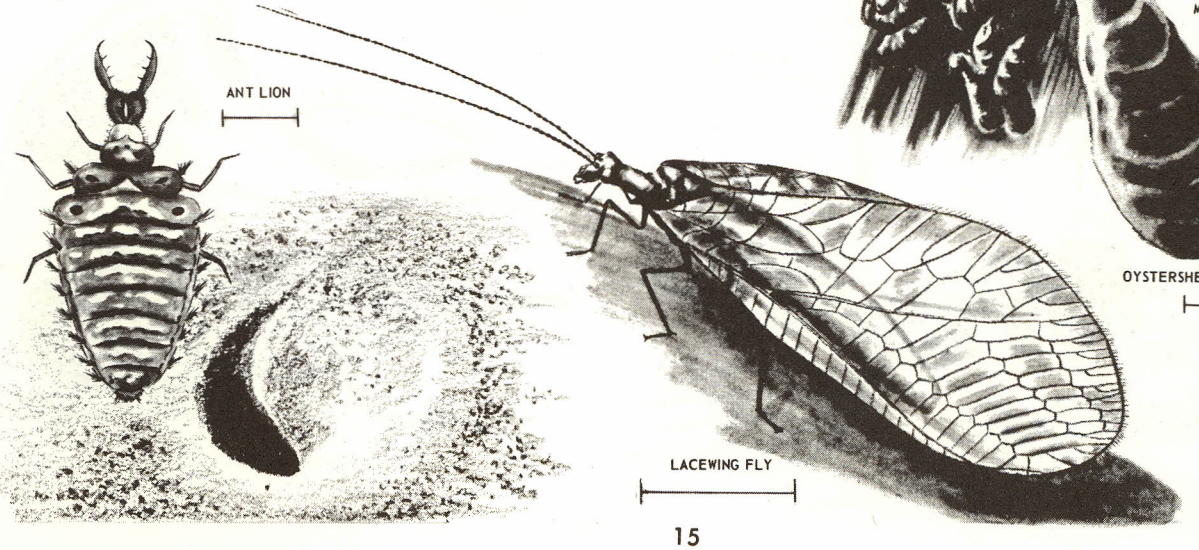


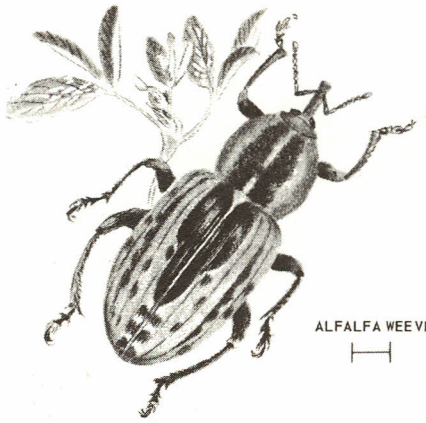
HOMOPTERA (aphids, leafhoppers, cicadas, whiteflies, mealybugs, and scale insects) may or may not have wings. All have sucking mouthparts. Wings, when present, are four in number and are held rooflike over the body, and usually are membranous. Cicadas and leafhoppers all have wings. Aphids may be winged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

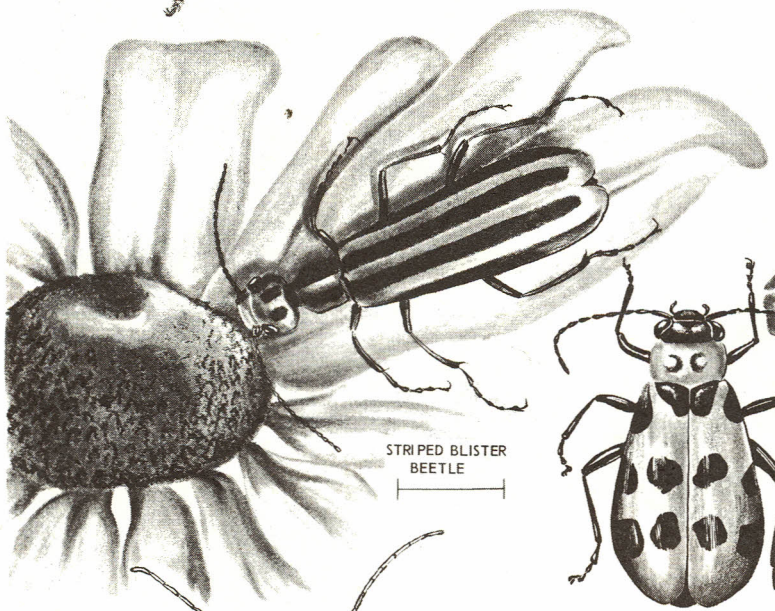




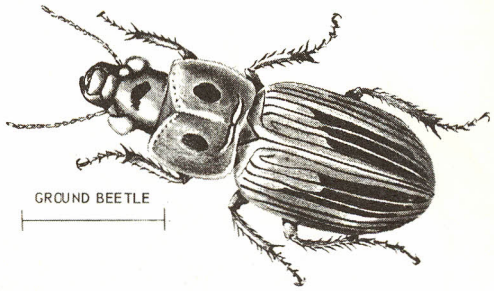


ALFALFA WEEVIL

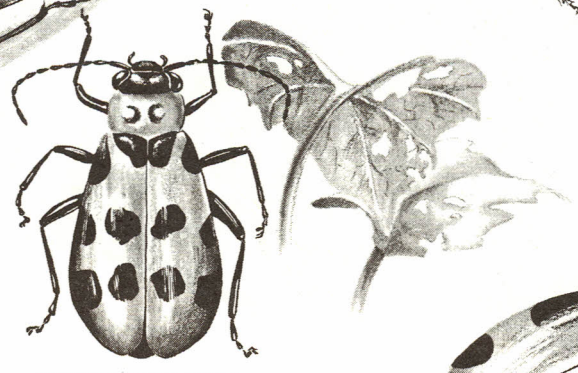
COLEOPTERA (beetles and weevils) usually are winged, with two pair of wings. The front pair are thick, forming a hard shell and meeting in a straight line down the middle of the back. The hindwings are membranous and are folded under the front wings when at rest. The mouthparts are formed for chewing.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



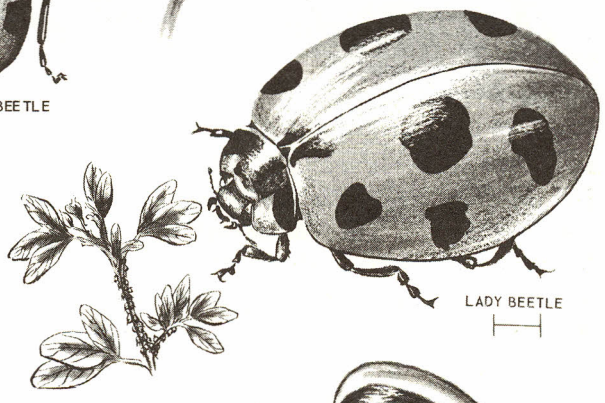
STRIPED BLISTER BEETLE



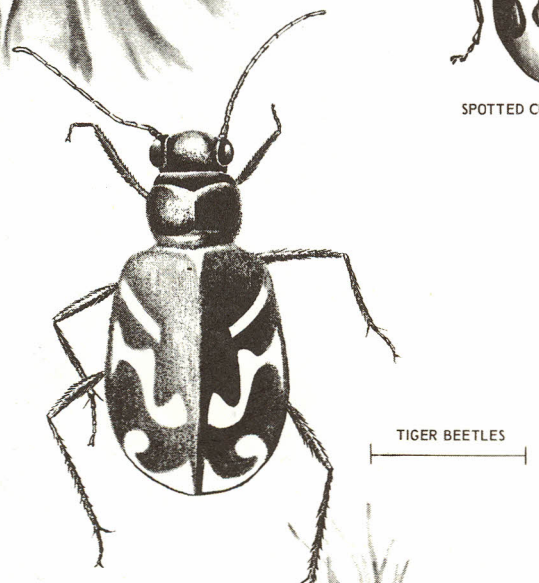
GROUND BEETLE



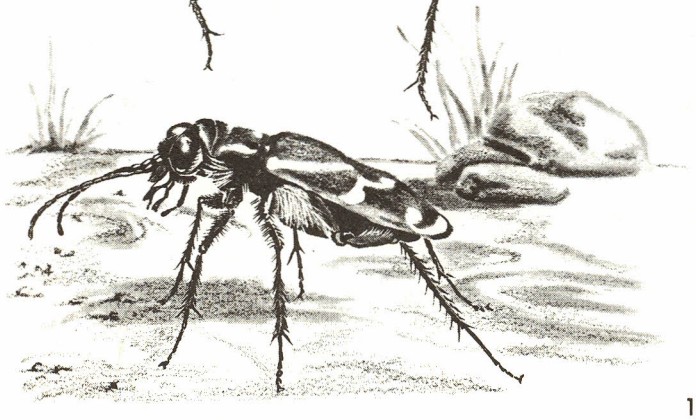
SPOTTED CUCUMBER BEETLE

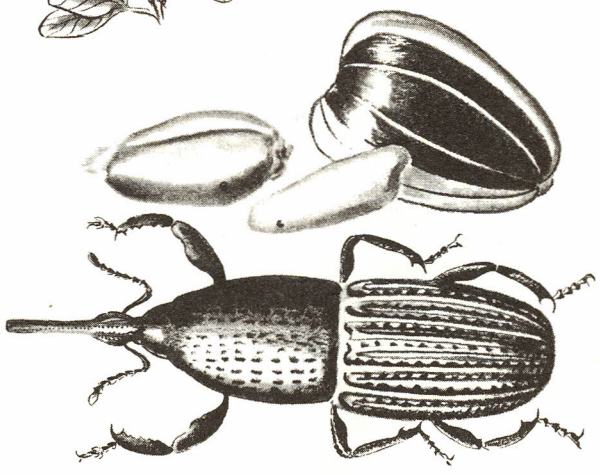


LADY BEETLE



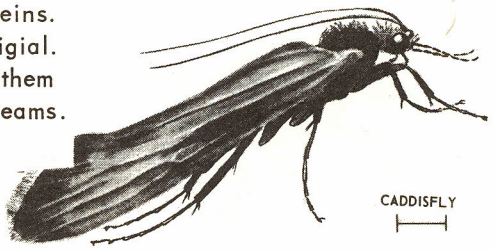
TIGER BEETLES





GRANARY WEEVIL

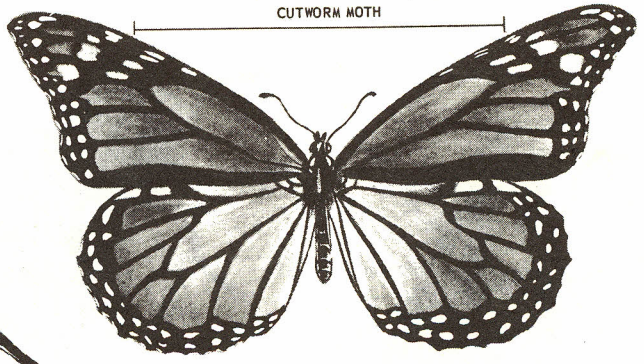
TRICHOPTERA (caddisflies) are soft-bodies insects with two pair of wings clothed with silky hairs and having a medium number of veins. The antennae are long. The mouthparts of the adults are vestigial. The immature stages are wormlike and live in water. Most of them build cases about their bodies. The adults are common around streams. The name ***Trichoptera*** means hair plus wings ***(ptera).***



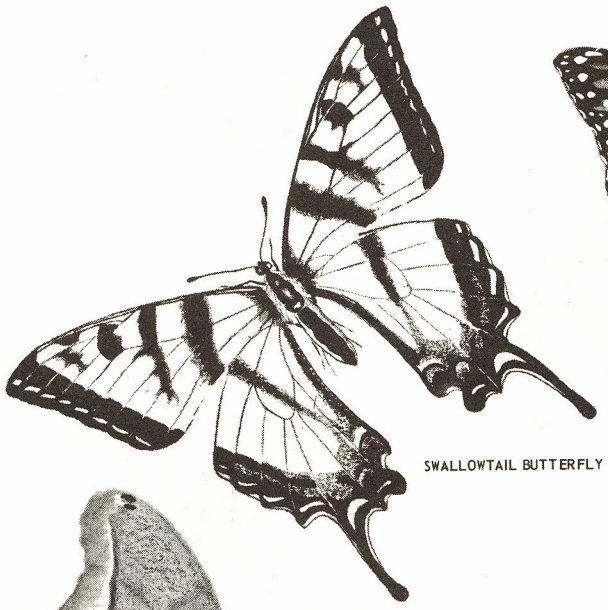
CADDISFLY

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).***

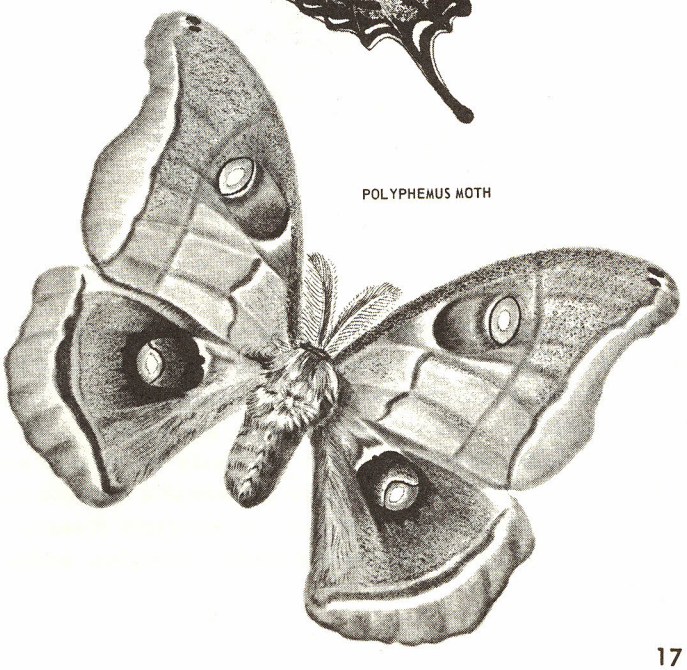
CUTWORM MOTH



MONARCH BUTTERFLY



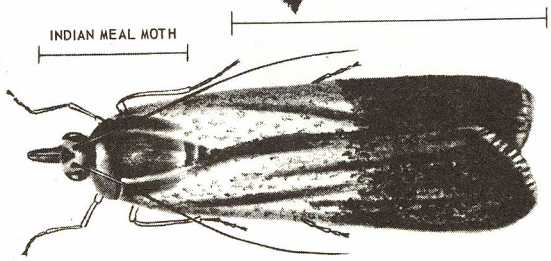
SWALLOWTAIL BUTTERFLY

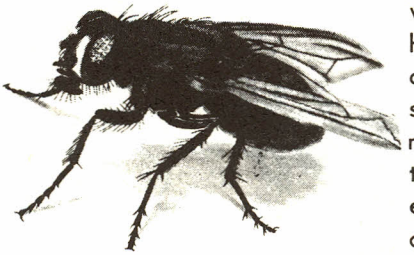


POLYPHEMUS MOTH

CLEARWING MOTH

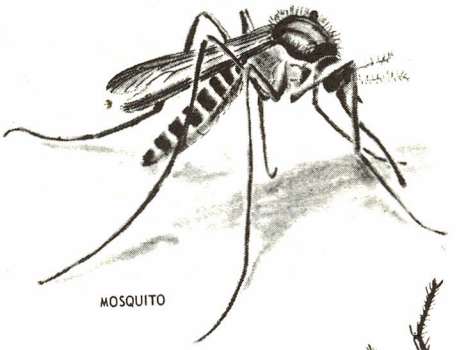
INDIAN MEAL MOTH



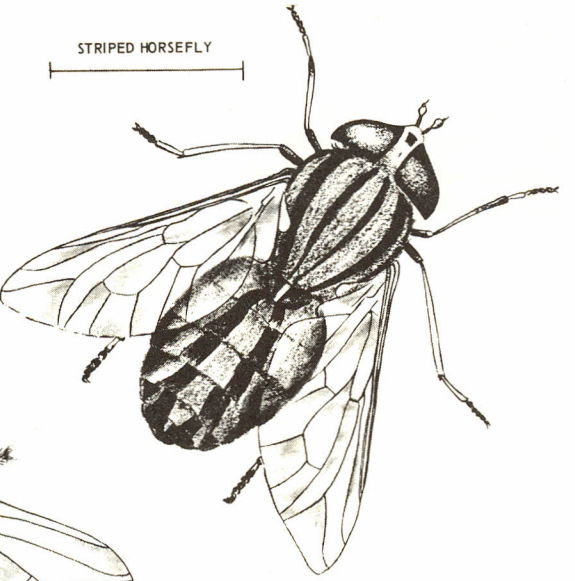


HOUSEFLY

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.

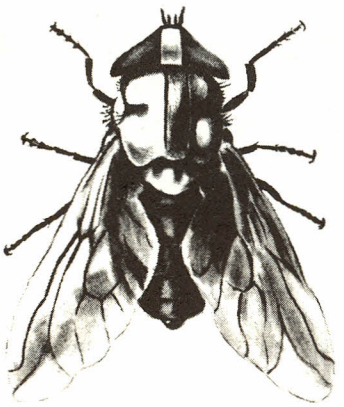


MOSQUITO

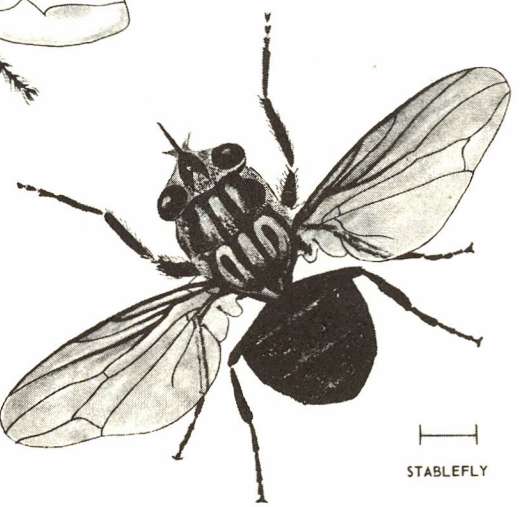


STRIPED HORSEFLY

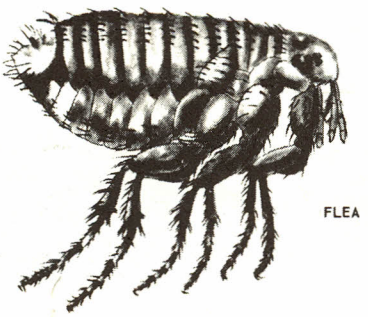
FLESHFLY



WESTERN HORSEFLY



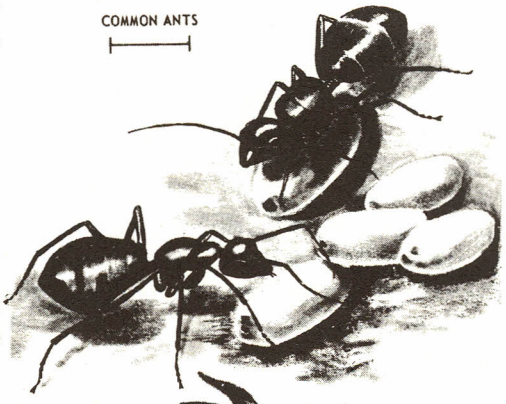
STABLEFLY



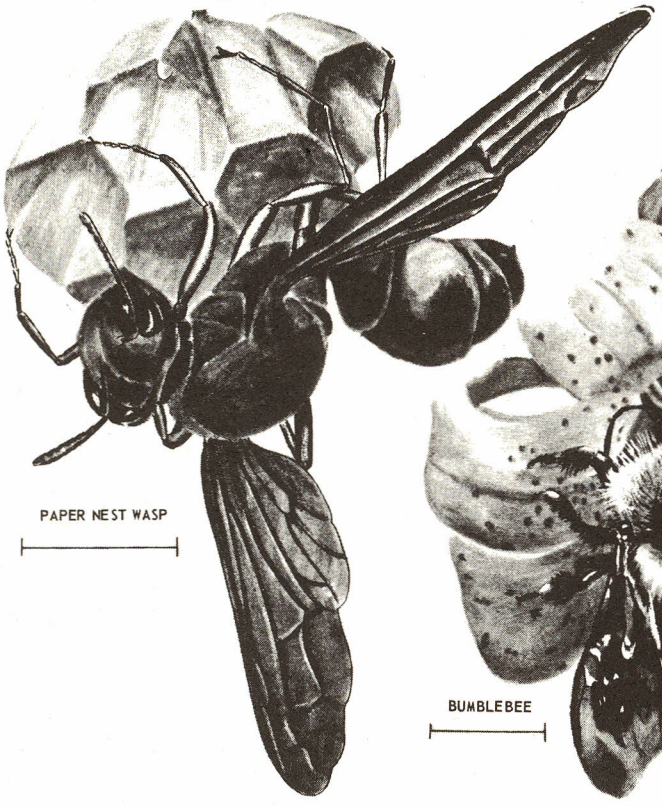
FLEA

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.

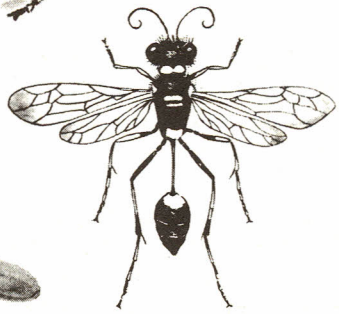


COMMON ANTS



PAPER NEST WASP

BUMBLEBEE



MUD DAUBER WASPS

PIGEON TREMEX

HONEYBEE

INSECT CONTROL

Americans are the best fed and best clothed people in the world because we use scientific methods to produce and protect our food and fiber crops. If we did not control insect pests many foods would be difficult to grow or not fit to eat. Insect borne diseases of man would increase rapidly. Much illness would be present, and the death rate would increase.

Insect control is generally accomplished by:

1. Cultural methods of growing crops.
2. Biological control measures.
3. Mechanical control.
4. Chemical control.

Cultural controls used in Nebraska are delayed planting of wheat to prevent Hessian fly injury and rotation of crops to reduce corn rootworm damage.

Biological control is the use of beneficial insects or insect diseases to keep down the numbers of harmful insects. We should protect beneficial insects as much as possible. The future will bring greater uses of biological control methods such as use of insect diseases and sterilants.

Mechanical control is the use of screens to prevent flies from entering buildings, swatters to kill insects, and barriers to keep termites out of our homes.

Chemical control is done by applying an insecticide to the crop or animals when harmful insects are present, or the use of poisoned baits.

Some insecticides are used to control insects by contacting the insects' body or entering its breathing system. Others are used to kill insects when the insects eat the chemical in baits or on plants.

Some of the many kinds of insecticides used are pyrethrum, rotenone, methoxychlor, chlordane, lindane, malathion, diazinon, parathion, and Sevin.

To observe how insects are controlled by chemicals, you can spray aphids with 2 teaspoons of 57% malathion concentrate in 1 gallon of water. Malathion kills aphids upon contact. How long does it require to kill aphids?

To demonstrate how stomach poisons work, spray a plant with 3 level tablespoons of methoxychlor or Sevin 50% wettable powder to 1 gallon of water. Place the plant or a portion of it in your rearing cage with a few grasshopper nymphs. Observe how long it requires to kill grasshoppers after they begin feeding on the plant.

Memorize the ABC's of insecticide use.

A. Always keep insecticides in the original containers. Always read the label before using. Always use the right amounts on the right crops for the right insect.

B. Be certain insecticides are stored in a safe place away from food and feed supplies, preferably in a locked storage area. Be certain that you know what each insecticide is and what it is to be used against.

C. Containers must be disposed of safely. Many accidents can occur if containers are used for other things. When an insecticide package, can, or jar is empty, dispose of it by burning paper containers, breaking glass containers, and crushing metal containers, then burying them at least 24 inches deep in a safe place. CAUTION -- never crush or burn aerosol cans. Dangerous explosions could result. Bury the entire can.

OPTIONAL PROJECTS

Advanced 4-H entomology members may continue this project by selecting one or more optional projects. Select one of your own choice or from the following suggested activities:

1. Insect control. Obtain control recommendations from your county agent or College of Agriculture.

   A. List insecticides that kill by contact.

B. List insecticides that kill by stomach poison action.

C. Use one of the contact insecticides on aphids, scales, or other sucking insect. Observe and report actions of the insects and time required to kill.

D. Use one of the stomach poisons on a chewing insect. Observe and report the actions of the insects and time required to kill.

E. Learn the different types of chemicals used as insecticides and hazards they may present in use.

2. Insects and health. Obtain references from your school library or other libraries. Prepare a brief report on the insects that carry the following diseases.

A. Bubonic plague

B. Malaria

C. Yellow fever

D. Typhoid fever

E. Sleeping sickness

F. Typhus fever

3. Insects and wildlife. Study from reference books and observe the importance of insects to wild life.

A. What insects are important as fish food?

B. What birds are important as insect feeders?

C. List a group of mammals and the kinds of insects they eat.

D. Observe adult birds feeding young in the nest. What kind of insects are fed to the young? How many times are young fed in an hour? Careful! Do not disturb the birds. Watch through binoculars if possible.

4. Insect homes. Insects use many unique methods of rearing young in "nests." Make a collection of insect homes. Some for a start are:

A. Bees' combs

B. Mud daubers' nests

C. Paper wasps' nests

D. Solitary bees' nests

E. Potter wasps' nests

5. Insects and weather. How does temperature affect insects? Collect a few housefly maggots and place them in jars with some of the food with which they were found.

A. Place one jar in a warm place but not in sunlight. How many days before adults emerge?

B. Place one jar in a cool place such as the basement. How many days before adults emerge?

C. Place one jar in a refrigerator. How many days before adults emerge?

From this experiment what did you discover about the effects of temperature on insects.

6. Beekeeping. Obtain a swarm of bees in nature or purchase a package from a dealer. Place swarm in a hive and observe how they develop combs, collect pollen, rear brood, and store nectar.

A. Keep a record of costs

B. Keep a record of honey produced

C. Keep a record of profit or loss

D. Obtain a record form from the extension entomologist, Nebraska College of Agriculture and Home Economics. Your county agent can order one for you.

A publication "Beginning with Bees in Nebraska" is available from your extension entomologist or county agent. This will help you start the beekeeping activity.

7. Insect survival. Most insects have various methods of escaping their enemies or protecting themselves. Most bees and wasps can sting. Other insects are rapid runners or fliers. One of the most interesting studies of insect survival is how they mimic other insects or use camouflage to blend with backgrounds.

Make a collection illustrating ways insects survive.

A. Display protection of an insect by stinging or biting.

B. Display insects that mimic other insects.

C. Display insects that blend with backgrounds so they are difficult to see.

DEMONSTRATIONS

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

1. What is an insect?

2. Controlling insects that damage clothing.

3. Controlling cattle grubs.

4. Controlling cattle lice.

5. How to make collecting equipment.

6. How to mount, pin, and display insect collections.

7. How insects grow.

8. How insects destroy food and fibers.

9. Insects and health.

10. Our friends, the insects.

You can prepare these and many other demonstrations from materials in this manual, references in libraries, and information that you can obtain from your county agent and the College of Agriculture and Home Economics.

SUGGESTED REFERENCES

School or public libraries may have books that will help you with entomology projects. Your county agent has many circulars and other references on insects. The following books are especially helpful:

"Insects" (A Golden Nature Guide) by Herbert S. Zim and Clarence Cottam

"Butterflies and Moths" (A Golden Nature Guide)by Robert Mitchell and Herbert Zim.

"Insects in Kansas" Revised Edition by Dell E. Gates and Leroy L. Peters, Available from Kansas State University Distribution Center for $2.50

"The Insect Guide" by Ralph B. Swain Doubleday & Company, Garden City, New York

"USDA Yearbook of Agriculture, 1952"

"World of Insects" by Paul Pesson.George G. Harrap and Co. Ltd., Toronto, Canada

"Insects" Peter Farb and the Editors of Life, 1962. Time Incorporated, New York.

"Insect Pests" George S. Fickter and Herbert S. Zim. A Golden Nature Guide. Golden Press

ENTOMOLOGY

Entomology is the scientific study of insects—their habits, biology and control.

Entomology is a subdivision of the larger field of biology, which is the study of all forms of life, both plant and animal.

Insects deserve special attention because they are the largest and perhaps most important group of animals as far as man is concerned. Insects attack food crops and livestock, causing almost four billion dollars annual loss in the United States. Another 400 million dollars is spent each year to control insects. In addition, insects spread diseases of man and his animals and plants.

Many insects, however, are beneficial. More than 50 types of crops depend on insects for pollination. Honeybees in the U. S. produce almost 40 million dollars worth of honey and beeswax each year. Many insects attack harmful insects that attack crops and livestock and often keep these insects from becoming destructive. Some insects are even being used to control weeds.

Entomologists will always be needed to study insects. Insect problems seem to increase each year and the old insect problems appear to be constantly changing. The old image of the entomologist wearing a pith helmet and chasing butterflies across the landscape with an oversized bug net has changed. Today's entomologist may be seen in the laboratory, working with complex mechanical and chemical apparatus and using the latest computerized techniques to analyze his results. However, there is much field work to be done as well.

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

Some entomologists teach courses in entomology to train students to enter specific careers. Students majoring in Agronomy, Agricultural Engineering, Ag. Economics, Plant Pathology or Zoology would all benefit from a course in entomology, as would many others. Almost everyone, especially someone who wants to farm, should know something about insects, because at some time, this knowledge will come in handy. A farmer, for instance, can save himself hundreds or even thousands of dollars over the years by knowing his insect problems. Teachers of entomology are employed by small colleges and large universities.

The extension entomologist does just what the name implies—he extends information about insects from the university to the general public. The information is developed by research entomologists, and is modified or adapted by the extension entomologist, who then releases it to county extension agents, farmers, stockmen, or anyone who requests it. He does this by preparing bulletins and leaflets, through public meetings, through magazines and newspapers, radio and television.

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

If you would like more information about entomology as a career, write the Department of Entomology, University of Nebraska, Lincoln, Nebraska 68503, or the Entomological Society of America, 4603 Calvert Road, College Park, Maryland 20740.