4DC-03PA

COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY • COLLEGE OF AGRICULTURE

UNIT 3

4-H Entomology Project

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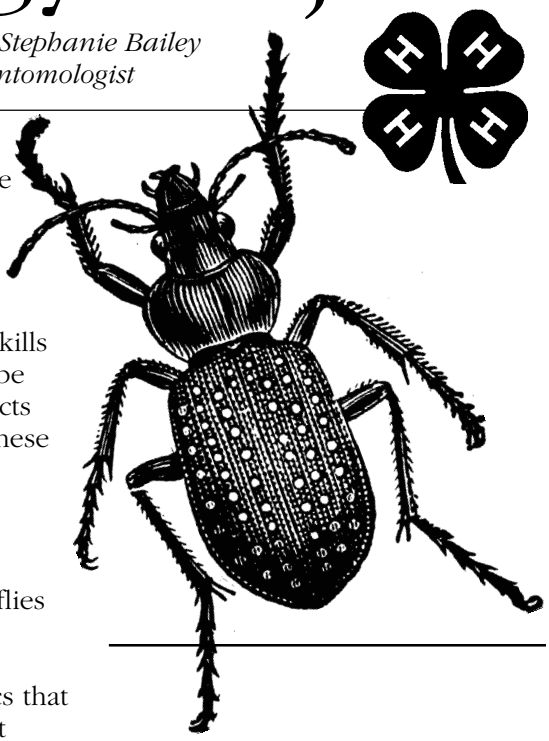


Welcome to Unit III of the 4-H Entomology project. After completing two entomology units, you are now a young entomologist experienced in collecting and identifying insects. You have learned where to find certain kinds of insects and some special techniques for collecting and preparing them for display. You also read about insect metamorphosis, and you may have observed different stages of insects while you were collecting.

In Unit III you will continue learning to identify and recognize more insects and will begin to explore other areas of entomology. The objectives of 4-H Entomology Unit III:

- Learn to recognize or identify more insects.
- Learn two more insect orders in detail.
- Learn to identify some of the more common immature insects.
- Learn more about the biology of some insects.
- Develop your leadership qualities.

Things you will do to meet these objectives:

- Increase and improve your insect display collection to include at least 100 insects representing at least eight orders.
- Do the exercises on the orders Hymenoptera and Diptera.
- Collect, preserve and identify 10 immature insects.
- Keep records of your 4-H Entomology activities.
- Do optional activities (three short-term or one long-term activity).

Getting Started

In order to improve your skills as an entomologist, you will be examining two orders of insects very closely in this project. These orders are Hymenoptera and Diptera.

Hymenoptera

Bees, wasps, ants and sawflies all belong to the order Hymenoptera. They have combinations of characteristics that other insects do not have, but some flies, beetles and other insects mimic Hymenoptera in appearance and are often mistaken for them. In this exercise you will take a closer look at some body characteristics of Hymenoptera that are useful in separating them from other insects.

Hymenoptera are typically winged, but some are wingless. Winged Hymenoptera have two pairs of membranous wings with the **hind wings** smaller than the **front wings**. The wings are not hairy or scaly. In most Hymenoptera the abdomen is pinched or narrowed between the abdomen and thorax, but in some Hymenoptera, such as sawflies, the abdomen and thorax are broadly joined. (See the drawings on page 2.) The condition of having the body narrowed between the abdomen and thorax is called "wasp-waisted." All wingless Hymenoptera are wasp-waisted. Many have a stinger at the end of the abdomen.

All Hymenoptera have mouthparts with chewing jaws, or **mandibles**. Part of the mouthparts, especially among bees, may be adapted into a **proboscis** for sucking nectar. The **compound eyes** are usually large and the **antennae** are long.

Some of the groups of Hymenoptera are often confused with each other. Sawflies differ from the others in *not* being wasp-waisted. Ants differ from other Hymenoptera by having one or two bumps, called **nodes**, on their wasp waists. Ants may be winged or wingless. Leg characteristics are helpful in separating wasps from bees. The five basic leg segments beginning with the segment attached to the body are **coxa**, **trochanter**, **femur**, **tibia** and **tarsus**. The tarsus is divided into subsegments, and in most insects

the subsegments are more or less the same size. In wasps and bees the first subsegment of the tarsus is much larger than the others and is called the **metatarsus**. The metatarsus of bees is very large and flat. In wasps the metatarsus is round in cross-section.

The bodies of both bees and wasps may be very hairy or with only a few hairs. The body hairs of bees are microscopically branched, but wasp hairs are simple. You will not be able to see this difference without a good microscope.

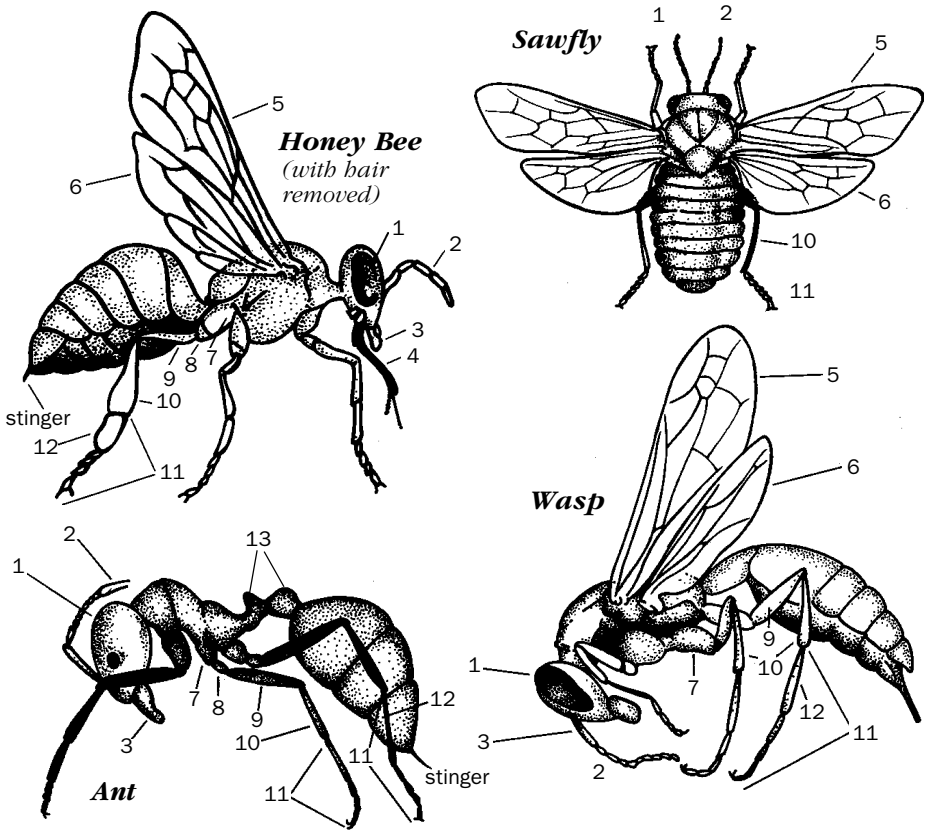
Bees always have wings, but wasps may be winged or wingless.

The drawings on this page have numbered body parts. Similar parts have the same number. Use the boldfaced words to identify those body parts in the spaces provided.

hind wings **front wings**
mandibles **proboscis**
compound eyes **antennae**
nodes **coxa**
trochanter **femur**
tibia **tarsus**
metatarsus

The answers are on p. 10, but do not look at them until you have tried to figure them out for yourself.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____



Diptera

The order Diptera contains the true flies. You may be familiar with some of the common kinds such as the house fly, horse fly, greenbottle fly and mosquito. Notice that in spelling the common names of true flies, "fly" is a separate word. In the names of insects that are not true flies, such as dragonfly, butterfly, dobsonfly and so on, "fly" is not a separate word. There are many kinds of true flies. Some resemble bees or wasps in shape, coloration or hairiness. In this study you will look at characteristics that separate flies from other insect orders.

The outstanding characteristic of true flies is that they usually have only one pair of developed **wings**. The second pair of wings are reduced in size to small structures called **halteres**. The halteres may look like a tiny golf tee projecting from the hind part of the thorax. You may need a hand lens to see it. The halteres on house flies and their near relatives may be hidden by whitish flaps called **calypters**. Calypters are extensions of the developed wings.

The mouthparts of flies are usually formed into a **proboscis** for feeding on liquids. The house fly vomits on solid food to dissolve it and then it sucks up the liquid food. Mosquitoes, stable flies and others have a stiff proboscis for puncturing the skin and sucking blood. Some flies do not feed as adults and their mouthparts are undeveloped. No flies have chewing mouthparts.

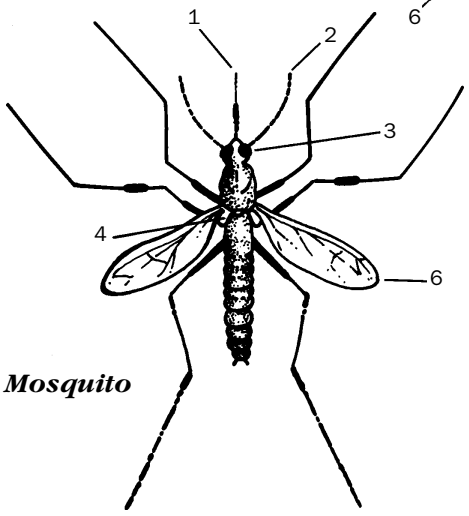
Most flies have short **antennae** with few segments, but mosquitoes, midges and crane flies have long antennae composed of many segments.

The compound **eyes** of flies are large and often occupy most of the head area.

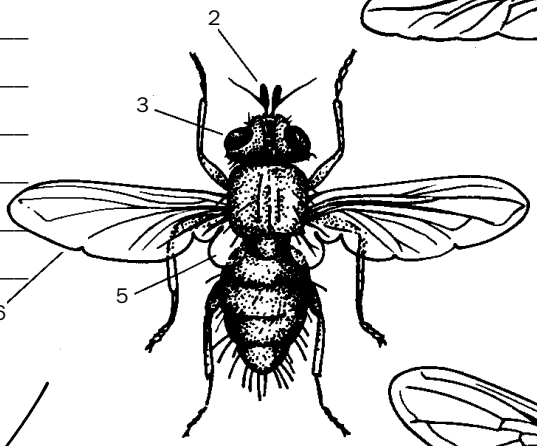
The drawings on this page have numbered body parts. Similar parts have the same number. Use the boldfaced words to identify those body parts in the spaces below.

wings halteres calypters proboscis antennae eyes

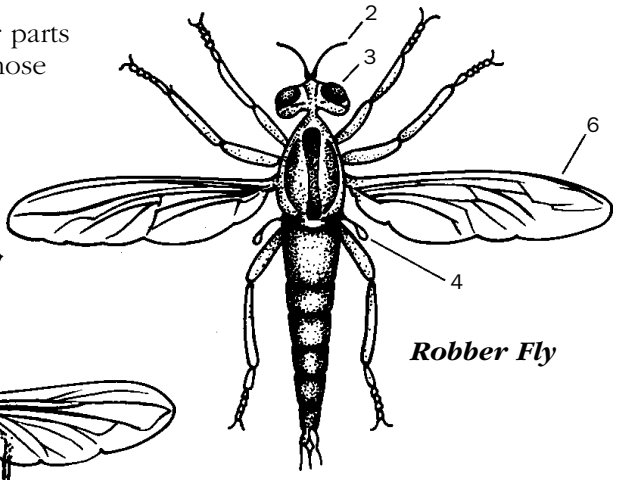
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____



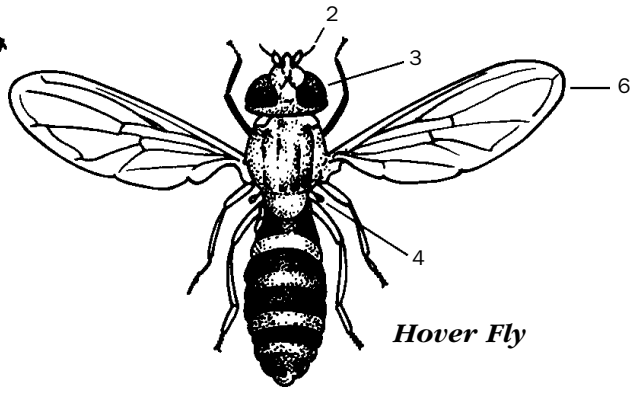
Mosquito



Tachinid Fly



Robber Fly



Hover Fly

The answers are on p. 10, but do not look at them until you have tried to figure them out for yourself.

Collecting Immature Insects

Collecting immature insects will help you learn more about the life cycle of the insects. Immature insects occur in many of the same places as adult insects. Some are easier to find and collect. Others may be hidden in logs, plant stems, soil, pond silt, manure and other messy places. You may need an axe, knife, trowel, sieve or tweezers depending on the habitat (living niche) you are going to search. You will also need a note pad, pencil and a supply of jars with lids numbered with a china pencil or stick-on label.

You will probably find many larvae of the same kind living together in groups or in the same habitat niche. Or you may find a variety of larvae living close together. Collect five or six larvae of each kind. Use a separate jar for each kind, and add to the jar some of the material in which you found the larvae. This will keep them alive and fresh until you get home and can prepare them for preservation. Do not mix different larvae together or overcrowd larvae in the same jar. They may injure each other if they are overcrowded or are of different kinds.

Record information on your note pad that will be useful later when you are making out permanent labels or identifying the larvae. Record the following notes for each jar:

- Jar number
- Date and locality
- Habitat (such as rotten log, pond silt, maple leaf, etc.)
- Distinctive color or markings (Some may change color or fade after they are preserved. Your notes will be a record of what they looked like in life.)
- Peculiarities (such as, in a web nest, had a smell, etc.)

Some insects will stay alive in collecting jars for several days or more. Others may die and begin to rot in a few hours. Be ready to preserve soft-bodied larvae as soon as you get home.

Preserving Immature Insects

Insect nymphs can be placed directly into alcohol for storage, but insect larvae may shrivel up in alcohol unless they are “fixed” first. There are special fixative solutions you can buy from biological supply houses, but you can easily fix insect larvae with a hot water treatment. To fix insect larvae with

hot water, bring a cup of water to a boil in a sauce pan. Remove the pan from the heat and wait a half minute. Then pour the hot water onto the larvae you have waiting in a coffee can. The larvae will be killed instantly, but they should be left in the hot water for several minutes until they are slightly cooked. If the water is too hot when you pour it on the larvae, they may burst open like an overdone wiener. If the water is not hot enough, it may not kill the larvae instantly and they will also be underfixed. After the larvae are fixed, transfer them to 70% alcohol in glass vials with a tight-fitting cap or a stopper.

Prepare an information label to go into each vial of immature insects. Tell the date and the location where the insects were collected. Also tell on what plant, animal or other habitat they were found, who collected them and how they were prepared for storage (**see the example below**). Use high quality rag paper for the label or else it may dissolve in time. Use India ink and a fine crow quill pen or a No. 2 pencil to write out the label. Labels written with ball point pen, hard-leaded pencil or a typewriter will fade and become unreadable. When you find out what kind of larvae you have, you can add an identification label to the vial. Do not attach labels to the outside of the vials. They will eventually rub off or get smudged and unreadable.

Fayette Co., Ky. 14 June 19____ On potato leaves Coll. R. Scheibner	Hot water to 70% alcohol

Identifying Immature Insects

Identifying immature insects in a systematic way with keys is very difficult without a good microscope and special training. However, there are other ways to identify common types. Some larvae are very distinctive in appearance; some are found in special places. They are often illustrated in the same books you use to identify adult insects. Social insects occur in all stages in their colonies; by identifying the adults you know what the larvae are. Some nymphs resemble the adult form so closely that you can associate them with their adults very easily. Rearing immature insects to the adult stage is another way to identify the immature form. The following notes may be helpful for identifying some immature insects.

Insect Nymphs

The following are examples of insect nymphs that closely resemble their adults except that their wings are undeveloped:

- Grasshoppers
- Crickets
- Mantids
- Cockroaches
- Assassin bugs
- Squash bugs (adults are often present with the nymphs)
- Milkweed bugs (adults are often present with the nymphs)
- Boxelder bugs (adults and nymphs often together; nymphs are red)

Caterpillars

Caterpillars are the larvae of moths and butterflies. They are usually worm-like, have a distinct head and short, segmented legs on the front end of the body. The abdomen has fleshy legs with rows or circles of tiny hooks (crochets) on the end of the legs. Caterpillars may be hairy, spiny or naked. Some are hard to identify. Others have distinctive shapes or habits that make identification easy. Some of the kinds that are easier to find and identify:

- **Woollybears**—the common woollybear being very hairy, black with a broad band of brownish-orange around the middle. It is better known than its adult form, the isabella moth. Solid black woollybears are the caterpillars of the great leopard moth. Solid yellow-to-orange woollybears, also called saltmarsh caterpillars, are the caterpillars of the acrea moth.
- **Bagworm**—naked caterpillar inside an individual silk bag covered with bits of plant material. Common on cedar and arborvitae and sometimes on other trees. The adult is rarely seen. Only the adult male has wings.
- **Hornworms**—large, naked caterpillars with a single horn on the end of the body. Common kinds are tobacco hornworm, tomato hornworm and catalpa hornworm. The adults of hornworms are sphinx moths.
- **Cutworms**—naked caterpillars, 1-2 inches long, usually found in soil around the bases of cut-off garden plants. There are many kinds that are hard to separate into species. The adults are called millers, owlet moths or noctuid moths.
- **Cabbage caterpillars**—the most common being the imported cabbageworm. It is green, 1 inch long and with four pairs of fleshy legs. The adult is a white butterfly. The cabbage looper has only two pairs of fleshy legs and is pale green; the adult is one of the owlet moths. The cross-striped cabbage catepillar is small, about 1/2 inch long, dark colored with fine cross stripes. The adult is a pyralid moth related to the European corn borer.
- **Corn caterpillars**—the corn earworm, being the common caterpillar found in corn ears. It has various color phases. The European corn borer is a pale, dingy caterpillar up to 1 inch long and bores into corn stalks.
- **Royal moth caterpillars**—medium to very large caterpillars with one or more pairs of horns on the thorax. They feed on various tree leaves. The caterpillar of the royal walnut moth is called a hickory-horned devil, and it feeds on hickory, walnut, sumac and sweet gum. The imperial moth feeds mostly on oak, maple, sycamore and pine. The rosy maple worm, the orange-striped oakworm and the spiny oakworm

are the medium-sized members of the royal moth group. These caterpillars often feed in groups. The rosy maple moth caterpillar is green, the orange-striped oakworm is really black and yellow striped; the spiny oakworm is solid blackish with pairs of spines all along its body. (Get Entfact 008 *Saturnid Moths* from your county agricultural agent for more information on this group of moths.)

■ **Eastern tent caterpillar**—hairy caterpillars in web nests in crotches of cherry trees in early spring. The adult is a small, brown moth with two narrow, white bands across the front wings.

■ **Fall webworm**—hairy, white caterpillars living together in web nests over the ends of tree limbs in summer. The adult is a pure white tiger moth.

■ **Monarch**—the caterpillar occurs on milkweed in late summer and fall. It is naked but brightly marked with black, white and orange bands.

Beetle Larvae

Beetle larvae vary so much in form and structural details that it is impossible to give a good general description of them. However, some individual types are easily recognized.

■ **White grubs**—brown-headed, large, plump, white-bodied larvae curved into a C-shape. They occur in sod and rotten logs. The adults are scarab beetles such as May beetles, green June beetle, Japanese beetle and chafers.

■ **Wireworms**—brown-to-pale, narrow, hard, straight-bodied larvae resembling a piece of wire. They occur mostly in soil and feed on roots. The adults are click beetles.

■ **Mealworms**—resemble wireworms but occur in barn chaff or similar situations. The adults are darkling beetles.

■ **Roundheaded wood borers**—found under loose tree bark or boring into the wood. They are legless, and the fleshy body is broadened and rounded right behind the head. The adults are long-horned beetles.

■ **Flatheaded wood borers**—somewhat resemble roundheaded borers and are found in similar places. The area behind the head is broadened and flat.

■ **Leaf beetle larvae**—many different kinds, but most are plump and soft-bodied. Common ones are Colorado potato beetle, elm leaf beetle, cereal leaf beetle (on seedling oats and wheat) and asparagus beetle. They are found on host plants whose name they bear.

■ **Mexican bean beetle**—spiny, yellow larvae found on bean leaves. Although they are leaf feeders, they really belong to the ladybird beetle family.

Hymenoptera Larvae

Hymenoptera larvae have two main forms, caterpillar-like and grub-like. The larvae of social Hymenoptera such as bees, ants and some wasps are grub-like. They can be identified by recognizing the nest you collect them from. Sawflies are usually caterpillar-like except they have more than four pairs of fleshy legs and the legs do not have crochets. They often feed in groups on pines, dogwood and other tree leaves. Distinguishing different sawflies is difficult. There are also many other larval forms of Hymenoptera—especially among the parasitic types.

Diptera Larvae

Diptera is also a large group with many forms. Mosquito larvae are familiar enough and are often illustrated in pictures so no description of them will be given here. The house fly larva (maggot) is often pictured too, but you may not be able to separate it from close relatives such as face fly, root maggots, flesh flies and blow flies just by looking at the picture. They are all peg-shaped, white and without a developed head. Many of them occur in the same places. They all can be called muscoid fly larvae to be on the safe side. Cattle grubs are grub-like and are identified as the grubs that occur in the swellings on the backs of cattle. The grubs can be squeezed out of the warble (swelling on the animal's back) in winter. Rat-tail maggots are soft-bodied larvae with a long thin tail at the end of the body. They occur in farm lagoons or other shallow water high in organic matter. The adult is a drone fly that resembles a drone honey bee in appearance. You will probably find many kinds of fly larvae that you can't identify without rearing them.

Observing Metamorphosis

In Unit II you learned that insects develop from egg to adult in stages. They grow and change from stage to stage by molting until the adult stage is reached. The development of an insect from egg to adult is called its life cycle. The way it changes form as it goes through its life cycle is called its **metamorphosis**. Different insects have different types of metamorphosis. You learned that there are four types:

1. no metamorphosis,
2. gradual metamorphosis,
3 incomplete metamorphosis and
4. complete metamorphosis.

Observing insects as they change from one stage to another is a very interesting project. Some insects can be easily observed through their entire life cycle in their natural habitat (living place). Others may be harder to observe for various reasons. Their life cycles may be long (several years sometimes), or they may live in special habitats where they are hard to observe, or they may jump or crawl from place to place so you cannot keep track of them. Some of these problems can be overcome by rearing the insects in cages.

When rearing insects in cages, it is important to know what food each kind will eat. You will also

need to know what other habitat conditions they need such as moist, dry, shady, sunny, places to hide, soil to burrow in, etc. Try to duplicate the insect's natural living conditions as much as possible. These considerations will determine the kind of cages that will be suitable for rearing the insect. Sometimes you can use one kind of cage to rear the insect through part of its life cycle and then transfer the insect to another type of cage to complete its life cycle. See pages 8 and 9 for examples of different types of cages and how they may be used.

Short-term Projects

The following options can be done as short-term studies. Sometimes it is inconvenient to try to rear an insect through its entire life cycle. It may take too long, or there may be other reasons. However, you may still be able to observe them through part of their cycle. Try some of the short-term projects listed below:

■ Collect pupae of moths and butterflies, and keep them in a glass jar or screen cage until they emerge. Be sure the jar is large enough to allow the insect to expand its wings. No food is needed for pupae.

■ Collect larvae and/or pupae of insects you find under loose bark or in rotten wood. Early spring is a good time to collect. Fill coffee cans half full with soft, rotten wood from where you found the immature insects. Put only one kind of immature insect in each can, and cover the can to keep the rotten wood from drying out. If drying does begin to occur while you are waiting for the adult insects to emerge, add a little water from time to time. Preserve one or two of the immature insects from each can so you can match them with the adults when they emerge. (See the section on preserving immature insects.)

■ Collect mosquito egg rafts or mosquito wigglers, and keep them in jars of clear, pond water. Add a pinch of dry yeast powder to each jar to feed wigglers. Cover the jar with a cap or screen to keep adult mosquitoes from escaping when they emerge. Preserve in 70% alcohol an egg raft, a sample of each size of wiggler, a pupa and an adult.

■ Collect aquatic insects of all kinds and keep them together in an aquarium. Some of the insects and their larvae may be predaceous (they feed on other insects), so you may have to keep restocking the aquarium. Pollywogs are food for some of the predaceous insects. Prepare the aquarium by putting about 2 inches of sand in the bottom. Use water from a pond or stream to fill the aquarium. If you use tap water, let it stand for a few days in the aquarium before adding insects. Plant some small aquatic plants or put some algae (green pond scum plants) in the aquarium. Cover the aquarium with a glass or screen top to keep flying aquatic insects from escaping. When larvae molt, save their cast skins in alcohol.

■ Find small plants infested with aphid colonies, and transplant them into a rearing set-up as shown in Rearing Cages (Figs. B, D, and L). Observe the colony to see if you can discover where small aphids come from. Do the large aphids lay eggs?

■ Repeat the activity above, but add a green lacewing or a ladybird beetle or their larva to the cage. If the aphid colony is entirely eaten, transfer the lacewing or ladybird to another aphid colony set-up.

■ Collect plant galls and keep them in covered glass jars until adult insects emerge. Not all galls will produce insects for you. Some galls are produced by mites, or the gall may be old and the insects have already emerged. If you find many galls of the same kind, open some of them up to see if anything is living inside.

■ Using any of the rearing cages shown in Figs. A, G, J, or K, observe a leaf-feeding caterpillar to see how it feeds and molts. Give the caterpillar fresh food daily if it is not being reared on a living plant. Supply it with leaves from the kind of plant it was collected on. Woollybear caterpillars will feed on a wide variety of plant leaves.

■ Using rearing cages such as are shown in Figs. J or K, rear Mexican bean beetles, Colorado potato beetles, squash bugs, hornworms or cabbageworms, etc., in their natural habitat. Preserve the different growth stages in 70% alcohol.

■ Collect rat-tail maggots and watery sludge from farm lagoons and rear the maggots in glass jars. Screen the top of the jar to keep the adult insects from escaping. What does the adult insect look like?

■ In the fall, collect full-grown Monarch butterfly caterpillars from milkweed, and put them in a large glass jar (Fig. A) or emergence cage (Fig. L). If they are not fully grown (1-1/2 inches long), keep them supplied with fresh milkweed leaves until they are. In a short time after they are fully grown, they will form a chrysalis (pupa) and then emerge as adult butterflies.

Long-term Projects

Long-term projects include insects with long life cycles or insects that can be maintained continuously through many life cycles in rearing cages. You are not limited to the options suggested below.

■ **Stored Product Insects—** Certain beetles and moths infest cereal products in our homes or grain bins. If you find infested packages of flour or meal in your home, transfer the material to large glass jars for observation. Keep the jars tightly covered with a solid cap or tightly woven cloth. Do not use screen or gauze because the insects can crawl through it. Some insects may even chew through tightly woven cloth so keep a check on that. Smearing a very thin

layer of vaseline around the inside lip of the jar will keep insects from crawling up to the cloth cover.

Infested grain from grain bins can be handled the same way as home stored products, but it is more apt to have more than one kind of insect infesting it. You may try separating the insects into pure cultures of each kind so you can more easily associate the larvae and pupae with the adult. Or you may keep the cultures mixed to see how the different species compete with each other.

When you are not observing the insects, keep the rearing jars in a warm, dark place.

■ **Rearing Giant Silk Moths**—Giant silk moths include the Cecropia, Polyphemus, Io, Luna, Royal Walnut Moth and Imperial Moth. They are all large moths and are reared in a similar way except that the larvae of each kind feeds on different leaves. The Royal Walnut Moth and the Imperial Moth differ from the others in their life cycle in that they pupate in earthen cells in the ground instead of cocoons above ground. (Get Entfact 008 *Saturnid Moths* from your county agricultural agent for more information on these moths.)

You can start rearing these moths from any point in their life cycle. You may start with an adult female moth that emerged from a cocoon you collected. You can tie her to a piece of screen and hang the screen outdoors overnight to attract a male which will mate with her. After she is mated, her abdomen will get large and full of eggs. Then remove her from the screen and put her in a large paper bag to lay eggs. (If you don't get eggs in this way, you buy eggs from biological supply houses.) Eggs will be attached to the sides of the paper bag. Cut the paper bag into pieces holding about 10 eggs and place them in hatching containers. A coffee can with a plastic cover or a plastic sandwich box is fine. When the eggs begin to darken in color due to the larvae developing inside the eggs, place food plant leaves in the container. Entfact 008 will tell you suitable leaves for each type of moth. Supply the caterpillars with fresh leaves every day if necessary. When the caterpillars grow to about an inch long, transfer them to larger containers to prevent overcrowding. You may want to transfer them to cages such as those shown in Figs. A-L.

When caterpillars are fully grown, they will be 4-5 inches or more long. They will then begin to shrink like an accordion in preparation to changing to pupae. If the caterpillars are a type that burrows in soil to pupate, you will have to transfer them to containers of soil. If they are cocoon spinners, do not disturb them while they are spinning their cocoon. (Cocoons are also obtainable from biological supply houses.) After they have spun their cocoons, wait a week or more to allow time for them to transform to pupae. The cocoons can then be transferred to the refrigerator or to a cage in the garage or breezeway. The cocoons need to be kept cool so they will emerge in the spring. The cage will keep predators from attacking the cocoons. In spring transfer the cocoons from the refrigerator or small overwintering cages to emergence cages that are large enough to provide plenty of room for the moths to expand their wings. Do not disturb the moths until their wings have fully expanded and hardened. In large cages, the moths will mate and the females lay eggs and you can rear them through another cycle if you want.

■ **Rearing Crickets**—There are many kinds of crickets, but the house crickets and the larger sized field crickets are a good choice for rearing. You can sell surplus crickets from your rearing operation to fishbait stores. Field crickets normally live outdoors, and you can find them under rocks or boards. House crickets live in buildings and are straw-colored. If you can't find these crickets, you can buy them from fishbait stores or biological supply houses. When collecting crickets, make sure you get both sexes. Females are the ones with a long, thin egg-laying tube at the end of the body.

Crickets need more rearing space than most other insects. Have your rearing set-up ready to go before you get your crickets. You will need a large container such as a garbage can, pickle crock, metal-lined box, large lard can or wash tub. The container should be about 2 feet deep and the bottom about 15 x 15 inches. Containers this size will support about 200 crickets. Place a 4-6 inch layer of clean, slightly damp sand in the bottom of the container for the crickets to lay eggs into. Sawdust may be mixed with the sand to hold moisture better. Excelsior or sawdust scattered lightly over the sand surface will provide hiding places and protection for young crickets. A piece of cardboard rolled into a 1-2 inch diameter cylinder can be used as a hiding place for large crickets. Provide a continuous water supply with a chick waterer. The saucer of the waterer should be filled with cotton to prevent young crickets from drowning. Place the rearing set-up in a place where a temperature of 80 to 90°F can be maintained. Cricket rearing will slow down or stop when the temperatures get too low. You can suspend a light bulb in or above the container to provide extra heat when you need it. You can experiment with regulating the temperature by using different wattage bulbs or by raising or lowering the bulb. Apply a thin layer of vaseline about 6 inches wide around the inside lip of the container to keep crickets from crawling out. If the container is not deep enough to prevent crickets from jumping out, cover the container with screen.

Use about a dozen crickets of each sex to start your rearing operation. In a shallow dish, provide food such as powdered

dry dog food or chicken laying mash. About three weeks after eggs have been laid in the sand, very tiny nymphs will appear. Newly hatched nymphs need soft food such as apple slices, banana or pieces of lettuce laid over the dry food in the dish. Feed only small amounts of food at a time, and replace food often enough to prevent spoilage.

It takes four to five weeks at 90°F for newly hatched nymphs to develop to the adult stage. At 80°F the development time is about nine weeks.

Rearing Cages

Rearing cages can be made in a variety of ways to suit your purposes. Some are easier to look into; others are easier to get insects in and out of; some are easier or cheaper to make; some are better adapted for rearing certain kinds of insects. The cages illustrated in Figures A-L are only a few of the many examples you could use. They are described below:

A. Basic glass jar cage to which can be added food, water, hiding places or other basic requirements for the insects. Any large wide-mouth jar is suitable.
B. Basic jar set-up for rearing insects on a live plant.
C. Basic jar set-up for rearing blow flies or similar flies.
D. Plastic cylinder cage to serve the same purpose as cage B. You can cut the top and bottom off clear plastic soft-drink bottles to form the cylinder. The flower pot provides soil drainage for the growing plant.
E. Terraria are better shaped to set up combination habitats such as for aquatic larvae that move onto land to pupate or emerge as adults.
F. A battery jar used in place of a basic glass jar and set up for rearing cockroaches. The bottle with the wick provides water for the insects.
G. Rolled screen cage set-up used for rearing insects on a growing plant.
H. Modified rolled screen cage to enclose part of a large growing plant. Also called a sleeve cage because it fits on a limb like a sleeve.
I. Rolled screen cage set up for rearing insects on fresh twigs.
J. Rolled cage for enclosing small plants in their natural habitat. The stake anchors the cage to the ground.
K. Barrel hoop cage. Barrel hoops or heavy wire are used to suspend a cheese cloth cover over a plant growing in the garden.
L. Rearing cage for large moths. Any conveniently sized cardboard-packing box can be used to make this cage. Cut a square hole in one side of the box. Cover the hole with screen to serve as a window to look in and also to provide ventilation. A round hole cut in the end of the box and provided with a cloth sleeve serves as a door through which food can be provided without letting insects escape. The screen and sleeve are held in place with masking tape.

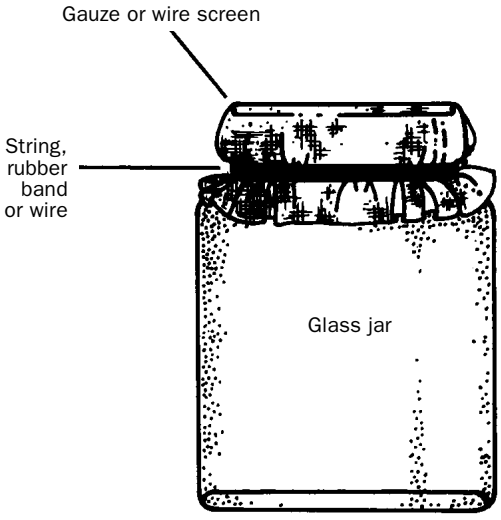


Figure A

Figure B

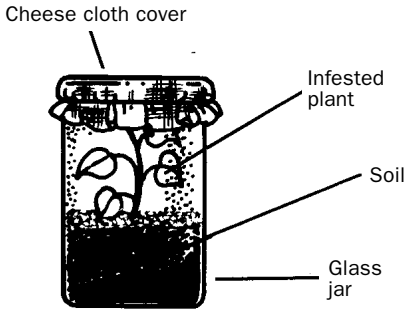
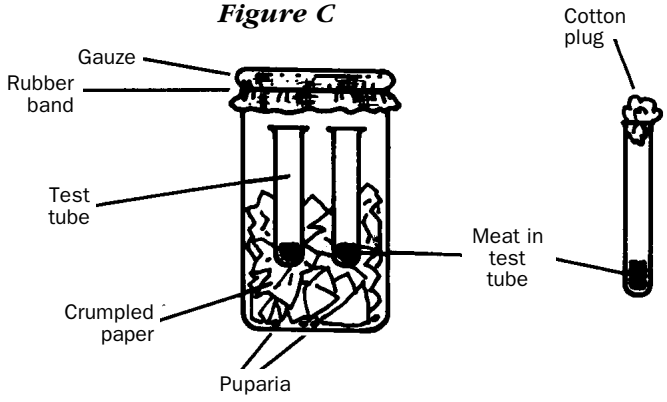


Figure C



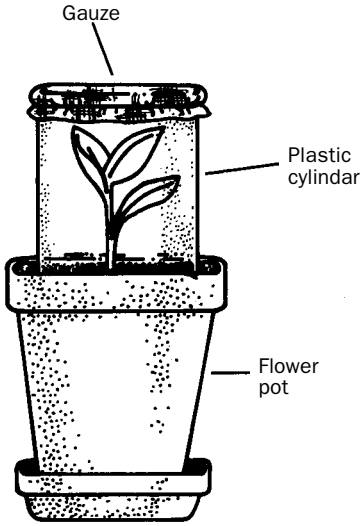


Figure D

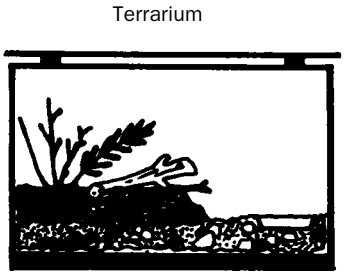


Figure E

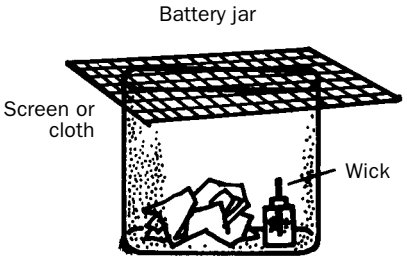


Figure F

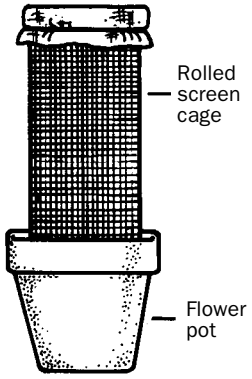


Figure G

Figure H

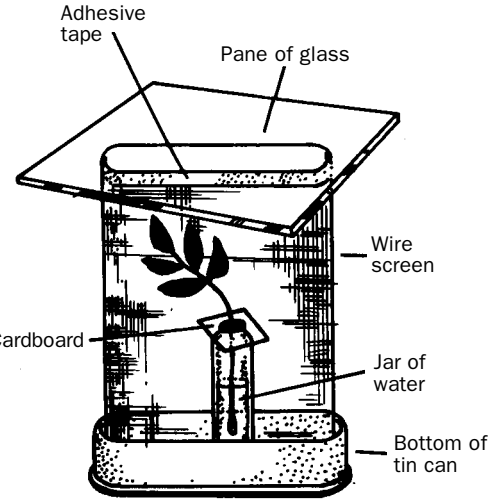


Figure I

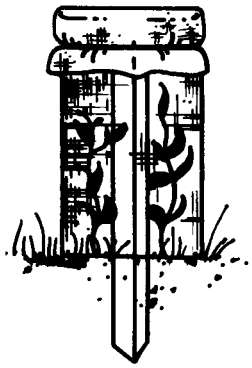


Figure J

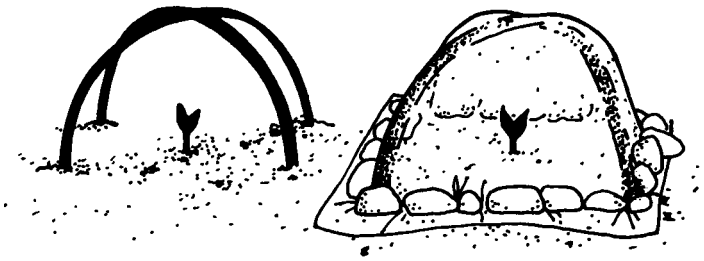


Figure K

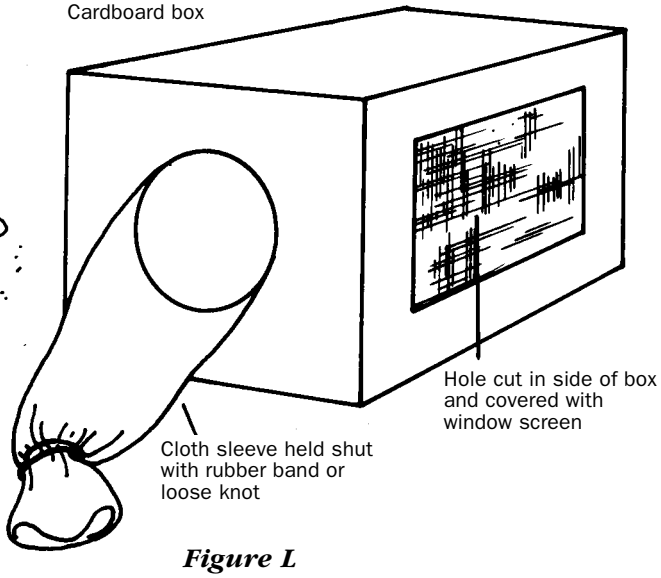


Figure L

Suggested Resources

The following publications may be of interest to you as you work on your 4-H project. They may be ordered from your county agricultural agent at your County Extension Office.

ENT-3: Controlling Millipedes and Sawbugs
ENT-4: Making Use of a Cattle Backrubber
ENT-6: Termites
ENT-7: Controlling Sod Webworms
ENT-8: Controlling Bagworms
ENT-9: Insect Pests of Coniferous Trees and Shrubs
ENT-10: Controlling White Grubs
ENT-20: Grain Sorghum Insects
ENT-25: Kentucky Soybean Insect Guide
ENT-29: Control of Household Insects
ENT-30: Dangerous Spiders & Their Control
ENT-32: Insect Pests of Shade Trees & Woody Ornamentals
ENT-34: Livestock Insects
ENT-36: Fly Control Around Dairy Barns
ENT-37: Insect Pests of Dairy Cattle
ENT-38: Fleas
ENT-39: Beef Cattle Pests
ENT-40: Tobacco Insect Pests
ENT-41: Beginning Beekeeping for Kentuckians
Entfact 002: Raising Mealworms or Fishing Worms
Entfact 003: Stinging Caterpillars
Entfact 007: Rearing Crickets
Entfact 008: Saturnid Moths
Entfact 302: Sweet Corn Pest
Entfact 304: Potato Pests
Entfact 401: Cankerworms
Entfact 404: Maple Galls
Entfact 408: Oak Galls
Entfact 409: Japanese Beetle
Entfact 607: Management of Head Lice
Entfact 611: Carpenter Bees
Entfact 619: Structure-infesting Ants

Records

The recognition you get for your work in 4-H depends on what you do. To help keep track of your project-related activities, record them as you do them. Then when you are ready to complete your project record, you will have the information you need.

Part of your entomology record includes project-related activities you participated in during the year. There is a place to record these activities on your project record. Examples of activities you might want to record are given below.

4-H Club meeting participation:
- Number of club meetings attended
- Committees served on (clean-up, membership drive, fund raising, etc.)
- Committee reports given
- Demonstrations or talks given
- Exhibits displayed
- Offices held (president, treasurer, secretary, committee chairperson, etc.)

Other activities not at club meeting:
- Helped another club member with his or her project
- Exhibited project in competition at local, county or state fair
- Exhibited project at school, store, civic club, etc.
- Gave a demonstration at school or at an adult organization
- Went on a group field trip
- Enrolled in an adult entomology club or society (Lepidopterists' Club, for example)
- Took photographs of entomology activities

Awards and recognition for entomology participation include:
- Ribbons received at fairs
- Pins, trophies or certificates of accomplishment received
- Newspaper articles in which you are mentioned (save the clippings)
- Radio or television appearances

Answers to Hymenoptera Exercises
1. Compound eyes; **2.** Antennae; **3.** Mandibles; **4.** Proboscis; **5.** Front wings; **6.** Hind wings; **7.** Coxa; **8.** Trochanter; **9.** Femur; **10.** Tibia; **11.** Tarsus; **12.** Metatarsus; **13.** Nodes

Answers to Diptera Exercise
1. Proboscis; **2.** Antenna; **3.** Eyes; **4.** Halteres; **5.** Calypter; **6.** Wing

4-H Unit III Entomology Project Record

Name of Member_____ Year_____

Parent or Guardian_____

Mailing Address_____

County_____ Name of Club_____ Grade in School_____

Name of School_____ Birth Date_____

Years in this Project_____ Years in 4-H_____

1. I participated in the following entomology activities. (If the activity relates to club participation, record "club" in the "where" column. Otherwise, record the place where the activity occurred.)

Date **Kind of Activity (Title)** **Where**

_____

_____

_____

_____

2. I helped _____ other 4-H'ers with their entomology projects. I helped them by:

_____

_____

_____

_____

3. I participated in the following community service activities through my 4-H club:

_____

_____

_____

_____

4. I read the following articles, pamphlets or books to prepare for my demonstrations or to help me to learn more about entomology (list titles, authors and, if available, dates):

_____

_____

_____

_____

5. I used the following equipment in completing my project this year (list each item, whether you bought or made the item, how much it cost):

_____

_____

_____

_____

6. I received the following awards and recognition (list activity, date of activity, where it took place and award or recognition received):

_____

_____

_____

_____

7. I completed the following Optional Activities for Unit III:

_____

_____

_____

_____

8. In your own words, write a summary of your entomology project. Tell what you did, what you learned from the project and how you could have improved your project. Write your story on a separate sheet of paper, and attach it to this record sheet.

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