How to Collect and Preserve Insects

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illustrated by
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INTRODUCTION

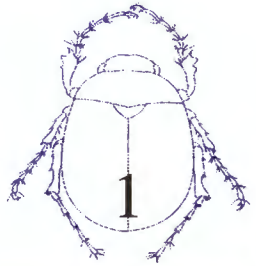
With rather simple equipment, the amateur as well as the trained entomologist can make a rewarding and valuable collection of insects. First-time collectors usually make a general collection that includes specimens taken from numerous habitats. This provides a good introduction to the diversity of insects. Later, the amateur or professional entomologist will frequently specialize in one or two groups of species. Butterflies and beetles are often chosen because they are large, showy, and easy to find.

Making an insect collection may have educational, recreational, and scientific value. Collecting insects is one of the best ways for individuals to learn about the diversity and abundance of insects. In addition, many people enjoy the collecting and derive satisfaction from later organizing and displaying the specimens, some of which may be quite striking. On a practical level, collections of beneficial insects and of household and garden pests can be used by farmers, homeowners, and pest control operators to help them recognize these insects. The scientific value of collecting insects is exemplified by the large research collections maintained by some museums, universities, and government organizations, such as the Illinois Natural History Survey. These collections, which may contain millions of specimens, are permanent records of the world's insects, the most abundant form of animal life on Earth.

This publication serves as a basic "how-to" guide for collecting and preserving insects and introduces the world of entomology, the scientific study of insects. In a broader sense, this publication may help students and others to learn to enjoy insects for their peculiarities, their similarities, and, most of all, for their amazing diversity.

PROTECT ENDANGERED SPECIES

Although the vast majority of insects encountered by collectors are very common, some species are threatened or endangered with extinction, often because of destruction of their natural habitats. Collectors must act responsibly to avoid endangered species. For a list of endangered species in your area, contact the nearest office of the United States Fish and Wildlife Service.

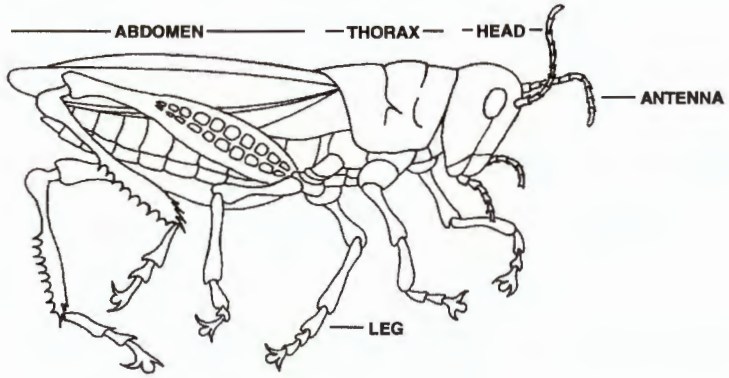


WHAT ARE INSECTS?

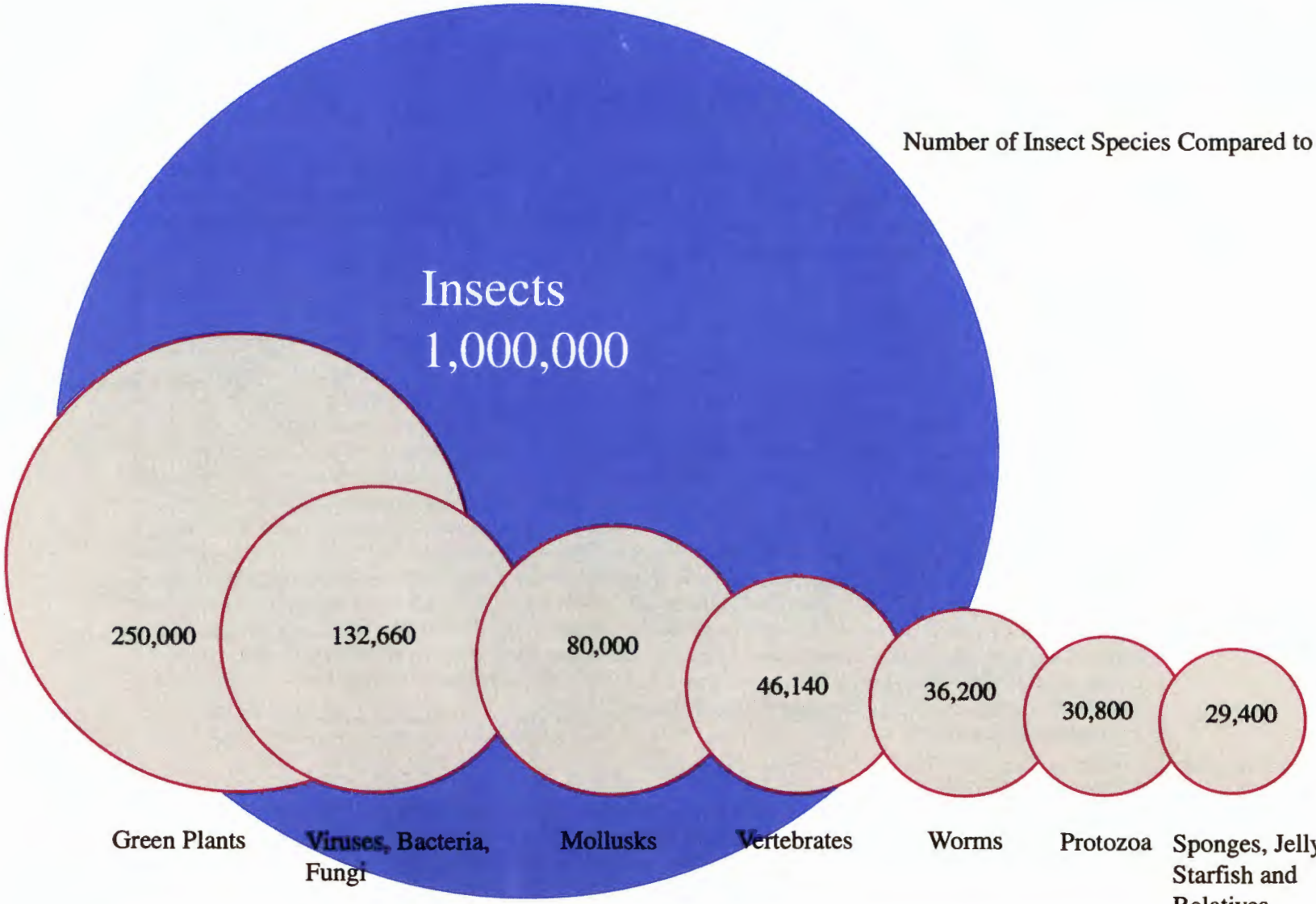
Insects are a remarkable group of organisms consisting of more than 1 million known species, more than all other animal species combined. More than 80,000 insect species have been described in North America alone. Insects inhabit a wide range of environments and exhibit phenomenal diversity in form and role. They exist as parasites, herbivores (plant-eaters), predators of other insects or related arthropods, and scavengers and detritivores (organisms that feed on dead and decaying plants and animals). Most insect species provide direct or indirect benefits to humans.

The Class Insecta is the largest in the Phylum Arthropoda, the animals characterized by a segmented body, paired jointed legs, and a hardened external skeleton (exoskeleton). Adult insects can be recognized by the fusion of segments to form three distinct body regions: head, thorax, and abdomen. For most adult insects, the head has a pair of antennae; the thorax has three pairs of legs and two pairs of wings.

Insect Body Regions



Number of Insect Species Compared to All Others



Section I - Collecting Insects

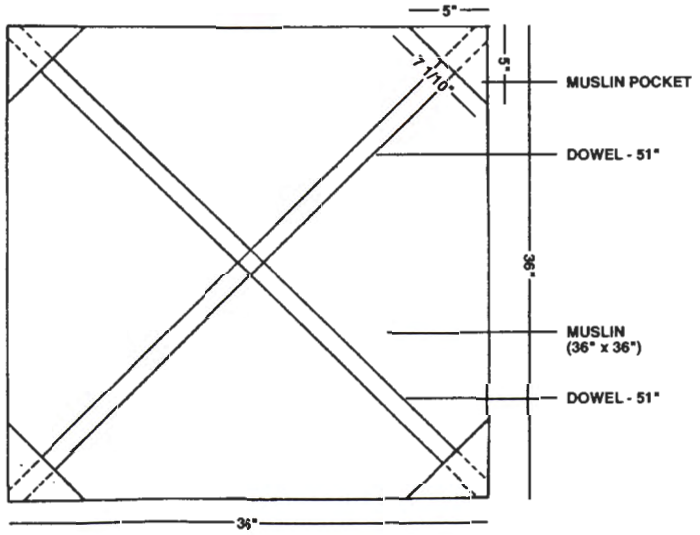
COLLECTING EQUIPMENT

Collecting insects requires only a small amount of equipment. A net and killing jar are essential, and many insects can be found by using this equipment alone. A greater variety of insects can be collected, however, if a few more items are used. The following is a list of equipment that many collectors carry with them in the field. Most of the smaller items can be stored in a collecting bag or vest.

• Absorbent tissue:
for use in killing jars, aspirators, and storage boxes. Facial tissue (such as Kleenex) works well.

• Aspirator:
a suction device for collecting small insects and mites. Several designs are available. The safest to use is the blow type, which prevents the user from inhaling small particles, fungal spores, insect eggs, and hazardous or unpleasant fumes. Aspirators can be purchased from BioQuip Products. (See list of entomological supply companies on page 73). To catch an insect with an aspirator, put the blowing end in your mouth, grasp the vial in your hand, position the collecting tube as close to the insect as possible, and blow suddenly and hard. The suction created draws the insect into the holding vial. Insects should be removed from the aspirator frequently and put in a killing jar to prevent them from damaging each other.

Beating Sheet



• Beating sheet or ground cloth:
for catching insects shaken from trees and other plants. A hand-held beating sheet is made by attaching a yard-square piece of muslin cloth to a crisscrossed frame made of dowels, which are fitted into four corner pockets. Rather than constructing a beating sheet, the collector may use a light-colored umbrella, a white tray, or a light-colored piece of cloth spread on the ground under the plant.

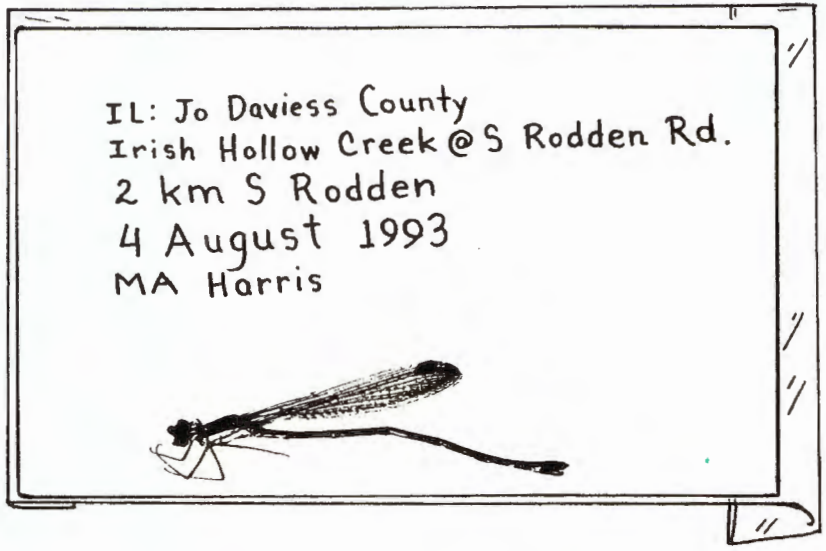
• Boxes (small):
for storing insects after they have been removed from killing jars. The box should be layered with Kleenex or other absorbent tissue.

• Camel's-hair brushes:
for picking up tiny insects and mites.

• Forceps or tweezers with slender tips:
for picking up small insects.

• Glassine envelopes (stamp collecting envelopes) or folded glassine sheets (wax paper is a good substitute):
for storing butterflies, dragonflies, and other delicate specimens. These transparent mylar or glassine envelopes are designed to hold delicate insects, such as damselflies or dragonflies, for permanent storage. Each envelope is designed to hold a single specimen plus a 3 x 5-inch notecard. The locality, date, and collecting information are recorded on the notecard. Mylar or glassine envelopes can be purchased through entomological supply companies (see listing at end of book) or your local photography store. Record locality information on notecard, insert notecard into the envelope, place (do not glue) the dried specimen into the envelope, and fold over the end of the envelope.

Glassine Envelope With Specimen



• Hand lens:
for examining tiny insects. This is especially handy if it is worn on a cord around the neck.

• Identification guides:
for doing preliminary field identifications and obtaining information about specimens. See *A Field Guide to the Insects of America North of Mexico* by D.J. Borror and R.E. White, Houghton Mifflin, Boston.

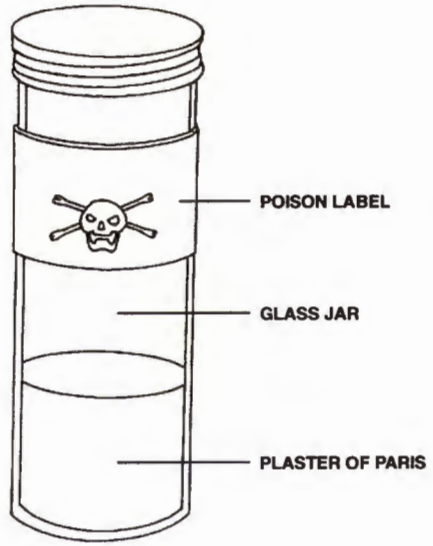
• Notebook and pencil:
for taking notes and recording data. A permanent marker is useful for writing data on plastic bags.

• Plastic bags:
for storing plant material, insects for rearing, or soil and litter samples.

• Vials:
small bottles containing ethanol for collecting and killing specimens.

• Knife:
a strong knife, such as a jackknife, for opening galls, seed pods, twigs, and other plant material.

Killing Jar



• Killing jar:
several jars of various sizes will be needed for capturing and killing specimens. A killing jar can be made from a wide-mouth glass jar with a metal screw-on lid. Peanut butter jars (18 oz.) and olive jars (8 oz.) are good choices. For several reasons, ethyl acetate is the recommended insect killing agent for most collectors. Its fumes are less toxic to humans than other substances, and insects placed in a jar with ethyl acetate are knocked out quickly and remain limp as long as they are kept in the jar. Ethyl acetate can be ordered from biological supply houses, and jars can be recharged easily by adding more ethyl acetate. Some collectors dislike ethyl acetate because it kills the insects too slowly, and insects that appear dead sometimes revive when they are removed from the jar. Beginners who cannot obtain ethyl acetate can substitute nail polish remover.

Materials needed for killing jar
ethyl acetate
eye dropper
plaster of Paris
tissue (facial tissue, paper towel, other absorbent paper)
wide-mouth glass jar with screw lid

Construction of killing jar
1. Make sure the jar is clean and dry.

2. Pour about 1 inch of wet plaster of Paris into the jar. Plaster of Paris is used to absorb ethyl acetate.

3. Allow time to set.

4. Add ethyl acetate to the jar with an eye dropper until the plaster of Paris appears saturated. No pools of ethyl acetate should remain on the surface.

5. Place several crumpled pieces of tissue paper into the jar to keep the insect from getting damaged and to absorb moisture.

6. Label the jar with the word "poison."

7. For safety, wrap the bottom of the jar with masking tape or other suitable tape to absorb shocks and prevent the jar from breaking.

Use and care
1. When transferring insects from a collecting device to the killing jar or collecting them directly into the jar, keep the jar closed whenever possible.

2. Keep small, delicate insects in a jar by themselves. Insects such as large beetles are apt to mutilate small flies and other delicate specimens if kept in the same jar.

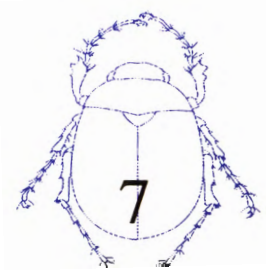
3. Keep a special jar for moths and butterflies. When these die, they shed large quantities of scales that stick to other insects.

4. Keep the inside of the jar dry. Wipe out wet jars with paper or cloth. To reduce condensation, keep the jar out of the sun and change the absorbent paper frequently. Do not crowd the jar with large juicy insects such as grasshoppers.

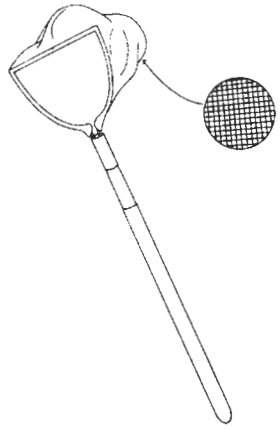
5. Empty the insects from the jar before they become entangled in a ball at the bottom. This will prevent damage to the smaller specimens and reduce discoloration caused by moisture buildup.

6. Recharge jars before each field trip by adding ethyl acetate with an eye dropper.

7. Keep jars away from young children and pets.



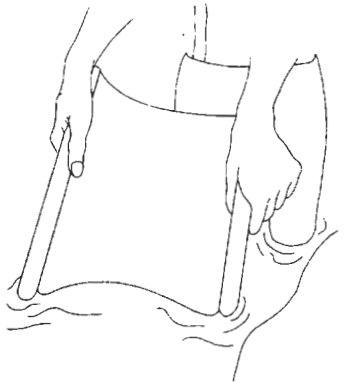
Aquatic Nets



• Nets:
a light aerial net for capturing butterflies and other flying insects and a strong sweeping net for dragging through vegetation. An aerial or butterfly net should be made with a lightweight bag and handle so that it can be swung easily. A sweep net, which is pulled through brush and vegetation, must be stronger and more durable. Instructions are given below for making a standard sweep net. The size and shape can be changed according to the needs of the collector, the kind of collecting to be done, and the materials available. An aerial net can be made by following the same instructions but substituting white polyester netting for the muslin. Aquatic and screen barrier nets (diagrams on right) can also be used for collecting insects. They are used in and around streams, ponds, lakes, and rivers.

Netting
In general, when capturing an insect in flight, you should swing the net rapidly to capture the insect, and apply extra force at the end of the swing to bring the insect to the tip of the bag. Twist the handle in a way that causes the bottom of the bag to flip over the rim and trap the insect. To keep the insect in the tip, squeeze or twist the bag tightly to close it above the insect.

If an insect is on a plant or the ground, you can approach from behind and swing the net with a downward stroke. After the insect is trapped beneath the net, hold up the tip of the bag and the insect will likely crawl or fly up into it. While gently holding the captured insect in the fold of the bag, place the open killing jar or vial in the net and around the specimen. Tap the net so the insect enters the jar and slide the top of the jar along the side of the net to the bag opening. Immediately place the lid on the killing jar or vial after removing it from the net. Small insects can be collected from the net with an aspirator.



Collecting from grasses, shrubs, flowers, and trees with a sturdy sweep net is an easy way to obtain large numbers of insects. Sweep the net sideways rather than up and down to be most effective. The contents of the bag should be removed after every few sweeps. This practice will prevent damage that occurs when the insects are jostled about with debris in the net. Take care not to damage the plants being swept.

CONSTRUCTING A NET

Materials needed

Fine wire or hose clamp - to secure net to handle
Handle - a large wooden dowel or discarded broom handle 30 to 40 inches long
Muslin - 1.5 yards of material, 36 inches wide
Sturdy wire - 4.5-foot-long piece of wire (gauge no. 6 to no. 8) that can be bent into a rigid circle about 15 inches in diameter

Construction

Net - Cut four muslin pieces with the dimensions shown in diagram A at right. Sew the pieces together along the curved edges. Fold a band as shown in diagram B and sew around the hoop.

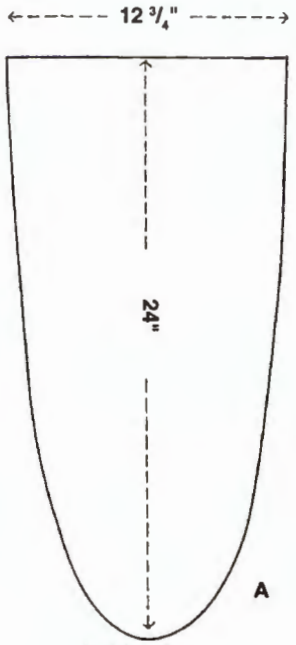
Hoop - Shape the hoop as indicated at lower right, making one stem 1/2 inch longer than the other.

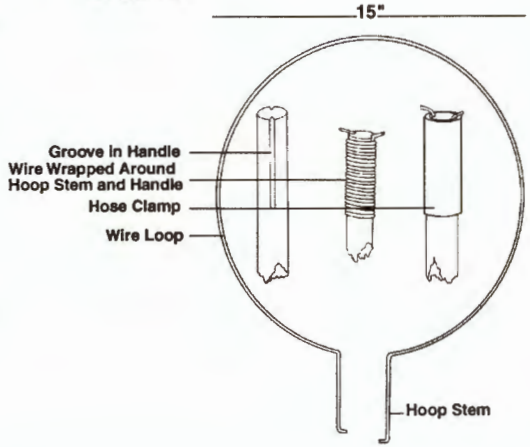
Handle - On opposite sides of the handle, gouge or chisel vertical grooves for the wire stems.

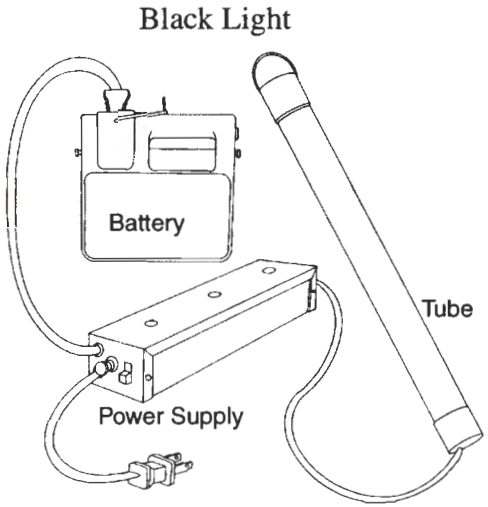
Assembly - Thread hoop into the handle grooves and fasten securely with hose clamp or with fine wires wrapped around the handle.

Use and care

Insects can be captured with a net by dragging it through vegetation or by swinging it in the air. Because nets are easily ripped, they should be kept away from barbed wire, briars, and thorny trees. Also, they should be kept dry. Moisture rots the fabric, making it tear more easily. Many insects caught in a wet net are unfit for collection.







COLLECTING TECHNIQUES

Collecting aquatic adult insects at night
For best results, collect on warm and cloudy or moonless nights. Drive a vehicle to a spot overlooking a stream or lake and turn on the high-beam headlights. Pour enough alcohol into a shallow pan, such as a pie pan, to cover the bottom with 1/8 to 1/4 inch of fluid. Place the pan beneath the headlights. If aquatic insects are flying, they will come to the light and eventually drop into the fluid. Transfer these specimens to a jar of 70% ethanol (ethyl alcohol). A black light can be substituted for the headlights.

Collecting aquatic adult insects during the day
During the day, aquatic insects frequently rest on or under bridges and window ledges, and they show a preference for dense trees and shaded habitats. They are especially numerous in spots where heavily-leaved branches hang low over the water and form humid, protected areas during the heat of the day. These are especially good places to sweep with an aquatic net. Aquatic insects may also be picked off stones in such places, especially early in the season.

Collecting aquatic larvae
Practically every stream or lake harbors aquatic insect larvae that may be taken by various methods, some simple and others requiring specialized and complicated equipment.

1. Look under logs and stones. Search out crevices because some insects hide and require a careful search.

2. Tear apart bunches of leaves, roots, and other debris that may have piled up in front of a rock or log or that may have accumulated at the end of a root or branch dangling in the water.

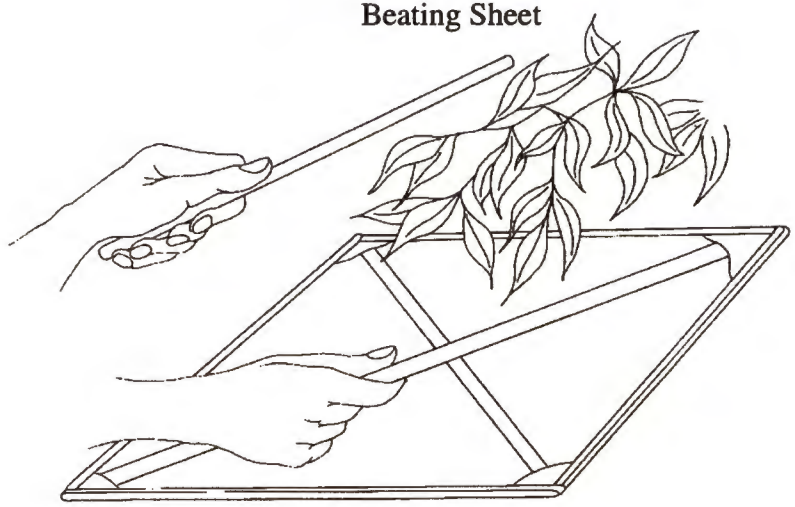
3. Collect bunches of aquatic plants and search through them carefully.

4. Sift mud, sand, or gravel taken from the bottom of the lake or stream.

Beating

Insects that feed or rest on trees, bushes, and other plants are often difficult to spot amid the foliage and can be collected by "beating" the plant. In trees, do this by holding a beating sheet, umbrella, or pan beneath the tree while striking the branches with a stick or net handle (see below). For plants that are low to the ground, the sheet is set next to the plant. Gently place the foliage over the sheet with your arm, then hit the plants several times with your free hand. The insects that drop onto the sheet should be collected quickly before they fly or crawl away. The easiest way to do this is to use an aspirator, but picking them up by hand or using forceps also works. Beating is especially good for collecting beetles, true bugs, and caterpillars that drop from the plant when disturbed. Those that play dead, like many weevils, are very easy to collect from a beating sheet. Insects that fly when disturbed, however, are best collected with a sweep net. For instructions on constructing a beating sheet, see page 4.

Beating Sheet



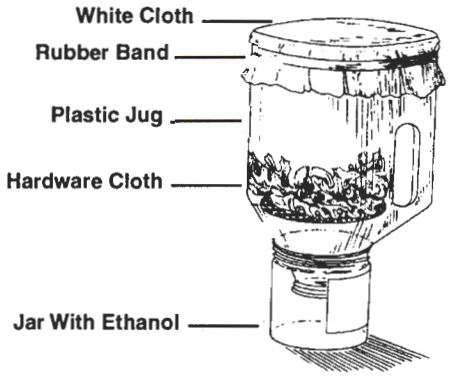
Sifting, separating, and extracting

Many interesting, rare, and diverse kinds of insects live in rotten logs, leaf mold, and other forest ground cover. In late fall and winter, numerous insects seek shelter in these spots to overwinter. Searching by hand for them is time-consuming, and small insects may go unnoticed. Several pieces of equipment are available for removing insects from debris or soil.

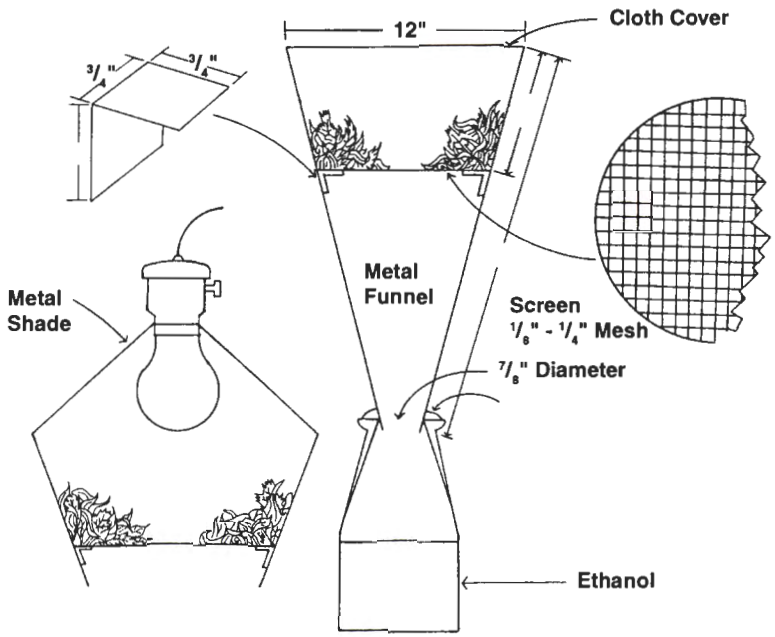
• Berlese funnel

The most efficient way to remove minute insects from soil and ground cover is to use a Berlese (pronounced Bur-lazy) funnel. This piece of equipment consists of a funnel with a screen placed about a third of the way down the length. Heat, usually in the form of a light bulb, is applied either around the upper portion or over the top of the funnel. A container of 70% ethanol is placed at the small bottom opening. Leaves, debris, or other materials are placed on the screen. The heat from the bulb drives the animals downward out of the debris and into the container of ethanol.

Homemade Berlese Funnel



Berlese Funnel



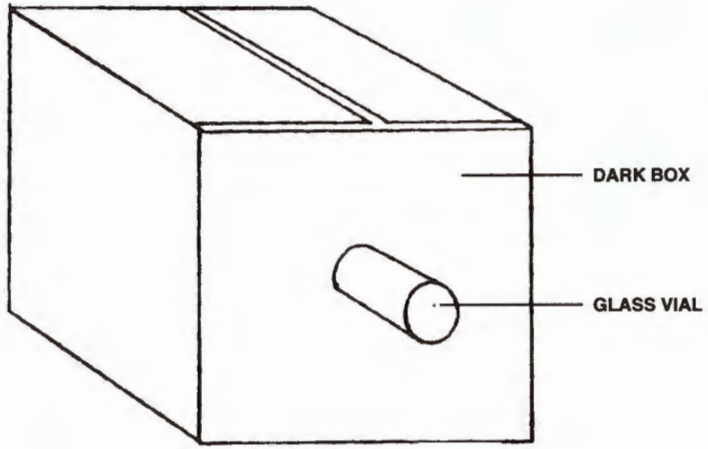
• Flotation

This technique is used to collect eggs, pupae, and insects in other inactive stages of development that live in the soil or among the roots of plants. Soil and root samples are broken up in a container of water and stirred gently. Many insects will float to the surface where they can be removed with a sieve or filter paper.

• Separator box

Another simple device used for removing insects from debris is an opaque (doesn't allow light in) box with a tight-fitting lid to which is attached a glass jar or similar collecting chamber (see below). When a sample is placed in the dark box, those insects that are attracted to light will crawl or fly into the jar. Because the separator box is often used to remove insects from debris that accumulates in a sweep net, it is also called a sweeping separator.

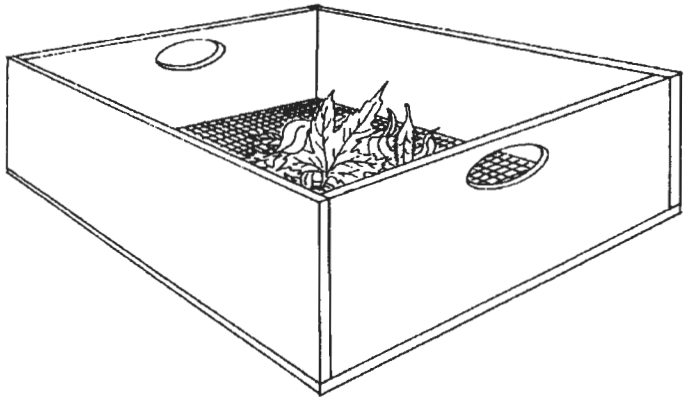
Separator Box



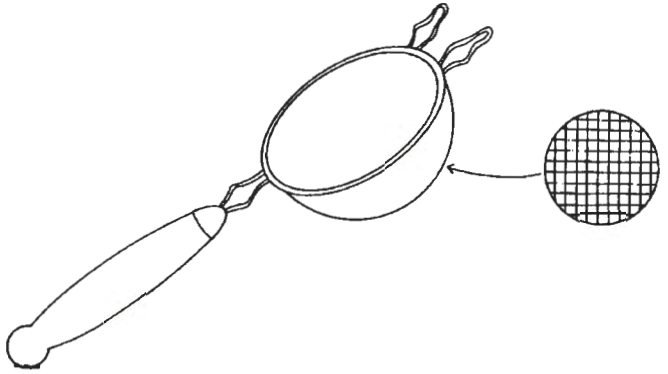
• Sifter

Sifting is a good method for removing large, active insects from a sample. A 12-inch by 12-inch sieve about 4-6 inches deep with an 8 to 12 mesh screen bottom works well. Debris is placed in the sifter, which is then shaken over a white surface (you may also use your beating sheet). The insects that drop out can be picked up by hand, with an aspirator, or with a camel's-hair brush. Insects that play dead when they fall can be spotted when they "revive." A variety of sifters with different sizes of screening can be used. A kitchen sifter can be used to extract smaller insects.

Wire Screen Sieve



Kitchen Sifter

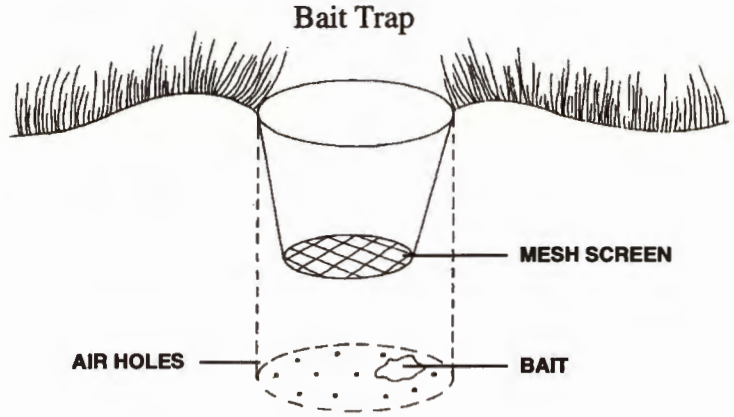


Trapping

Collectors use a variety of traps and trapping techniques to capture insects and other arthropods. These range from simple and inexpensive to elaborate and costly. Some are designed to collect certain insects that are rarely collected without a trap. Others are useful for general collecting. The traps and techniques described here are just a small sample of those available to the collector. A collector can invent new traps or modify old designs for unique purposes.

• Bait traps

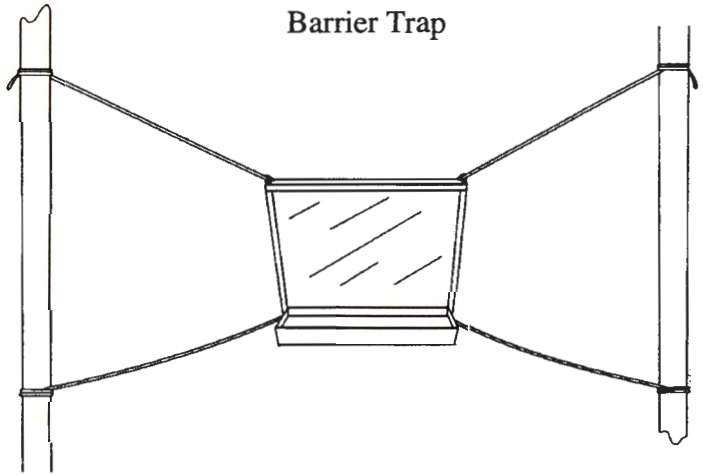
The addition of bait to many traps will attract large numbers of certain types of insects. Baited pitfall traps are common collecting devices. The bait is placed in the bottom of the collecting can and covered with a screen, or it is suspended into or over the trap. Dead animals, rotting foods, and dry cereals are good baits for various crawling insects. One type of pitfall trap, the cereal dish trap, is particularly effective for collecting insects attracted to dung. This trap is made from a cereal bowl filled with 70% ethanol and sunk into the ground. The bait is suspended in a small cup over the trap, supported by a wire coat hanger.



• Barrier traps

When insects hit a barrier in their flight path, they tend to fly upward or drop. Barrier traps placed in flyways rely on such behaviors to capture flying insects. One simple barrier trap is the windowpane trap, which consists of a piece of clear glass or plastic with a shallow trough filled with 70% ethanol attached at the bottom. When the trap is hung across a path, in a flyway, or at the edge of the woods, flying insects crash into it. Those that drop after hitting the glass fall into the trough and are killed.

Barrier Trap



• Emergence traps

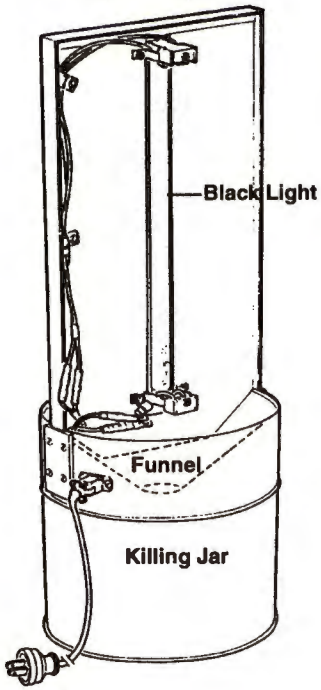
Immature insects live in a wide range of habitats, including plant stems and roots, galls, rotting logs, decaying vegetation, soil, and water. When these insects emerge as adults, they can often be captured in an emergence cage. The cage can be as simple as a net sleeve over a tree branch or a screened box placed over a patch of soil.

• Light traps

Light traps provide a good method for collecting large numbers of night-flying insects or for collecting insects from several locations at once. They are also a valuable tool for individuals who cannot be out at night to collect.

The simplest light trap consists of an ultraviolet light (often called a black light) and a collecting pan with alcohol covering the bottom. The pan is placed below the light, and insects flying toward the light eventually drop into the alcohol. When set up near a stream or lake, this trap is very effective for collecting the winged adults of many aquatic insects. Commercial light traps of various designs are also available. Most of these consist of a light source, a series of baffles, a funnel, and a killing jar. The jar usually contains alcohol as the killing agent.

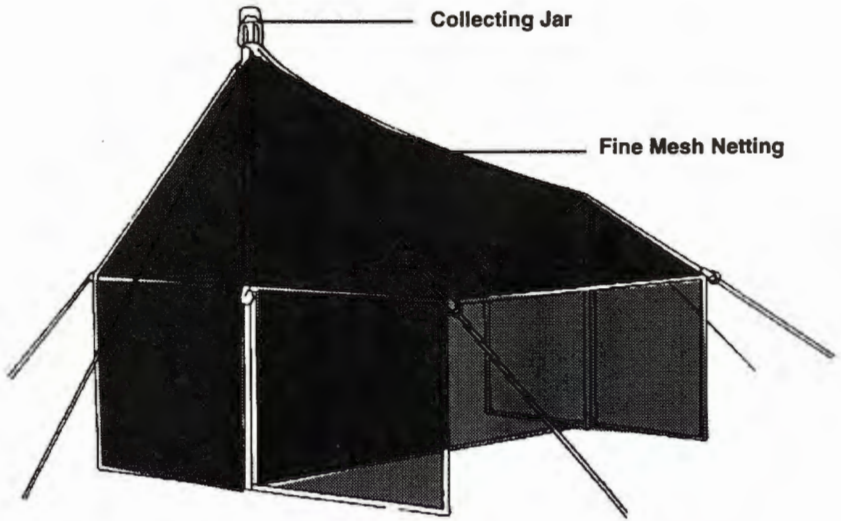
Light Trap



• Malaise traps

Another, more elaborate trap is the malaise trap, which captures flying insects that move upward when they strike a barrier. This trap is a tentlike structure made of netting with a collecting chamber at the top. Insects entering the trap eventually fly or crawl upward while attempting to escape. Instead of escaping, they become trapped in a killing jar or a container of ethanol. Malaise traps can be purchased from commercial suppliers or constructed at home. A dark fabric is recommended for the base. Malaise traps placed across paths or alongside streams, woods, or sheltered clearings frequently yield good catches. Also, when selecting a site, it is best to keep in mind that most insects fly upward.

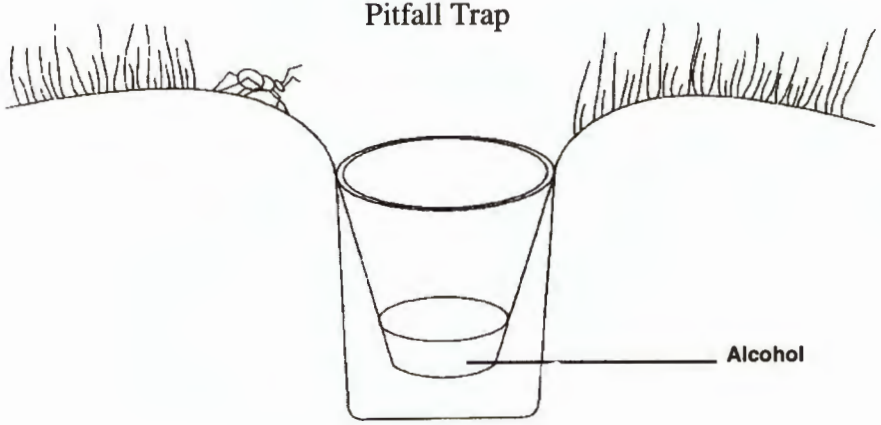
Malaise Trap



• Pitfall traps

Insects that crawl about on the ground can be captured in a pitfall trap. The simplest trap can be constructed easily by placing a can or plastic container in the ground. Add enough killing agent (such as alcohol) to cover the bottom of the container. To keep rainwater out of these traps, a board can be propped up over the opening. Further modifications can change a simple pitfall trap into a bait trap as shown on page 15.

Pitfall Trap



Searching

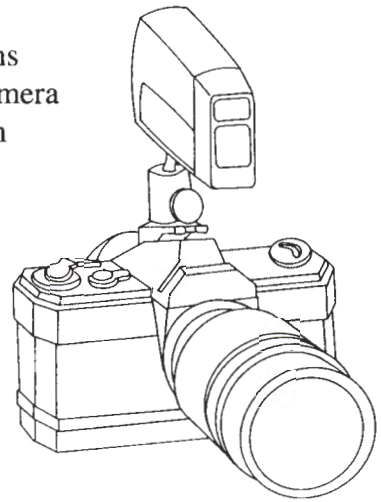
Searching for individual insect species is a good way to collect specimens and learn about specific insects at the same time. The collector can find out exactly where each insect lives, what it eats, and how it behaves. When you locate an insect, you can capture it in a number of ways. You can pick it up by hand, with forceps, or with a moistened camel's-hair brush. You can collect it with an aspirator, a net, or a killing jar. You can also cut the foliage upon which it rests and place this in a plastic bag. For some insects this might be the only technique that works.

Using your hands is often the easiest way to collect an insect. For most insects, if you use proper techniques, you need have no fear of injury. Insects bite by moving their jaws sideways and pinching or piercing with their mouth parts. Only a few biting insects are large or strong enough to actually break the skin. To prevent an insect from biting, you should grasp it firmly by the sides of the body. Beware that some true bugs and flies can inflict painful bites, and some caterpillars have stinging hairs. You should also learn to recognize and avoid stinging insects. The stinger is located at the tip of the abdomen. (Only female wasps, bees, and some ants have a sting.)

Photography

Don't overlook one of the most obvious methods of "capturing" an insect — photography. The simplest use of photography in entomology is to document the habitat in which collections are made. Such photographs, either black and white or color, can be made with relatively simple cameras. Photos add greatly to the information about a collecting site and can be included in a field notebook, usually with descriptive captions. Because of the small size and relatively quick movements of insects, close-up insect photography requires special equipment and procedures that are beyond the scope of this publication.

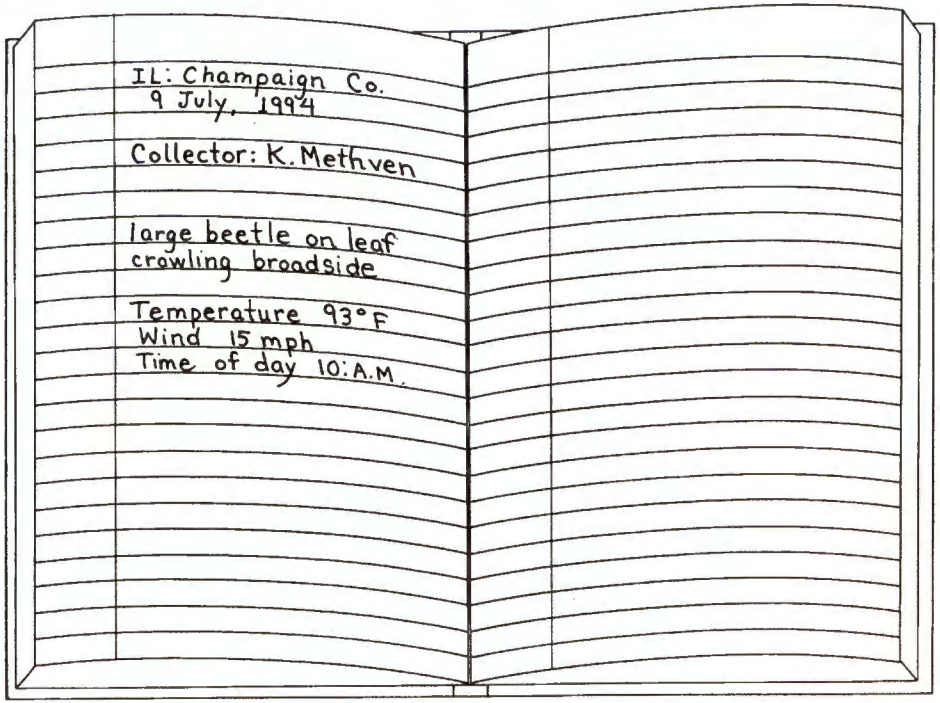
Single Lens
Reflex Camera
With Flash



TAKING FIELD NOTES

Stopping to take notes after chasing and capturing a spectacular butterfly or a particularly desirable beetle requires a certain amount of discipline. With practice, though, note-taking becomes as much a part of collecting as placing a butterfly in folded glassine sheets or putting a beetle in the killing jar. Making field observations is only a small step beyond recording the collecting information that all specimens must have—the date and location of collection and the name of the collector. For field note-taking, a sturdy, bound notebook that fits in a jacket or pants pocket is best. Avoid loose-leaf pages because these have a tendency to get lost or torn. Always use a pencil to take notes because the writing will not smear if it gets wet. As notebooks become filled with information, they may be rewritten, typed, entered into a computer, or left as they are, and they become part of the collection. The information in the notebook on collecting date and locality should correspond to each insect's label to allow for ready reference later on.

Field Notebook



The type of information that should be included in a notebook will vary greatly with the situation. Observations can include the weather for the day (sunny, rainy, cloudy), the type of habitat in which you are collecting (old field, open oak woods, farm pond), what the insect was doing when collected (feeding on milkweed, burrowing in the soil, flying from flower to flower), the time of day (early morning, evening, night, etc.), and the types of capturing techniques used, such as netting, pitfall trapping, etc. (For more information, see *The Wildlife Observer's Guidebook* by C.E. Roth, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.)

Section II - Preserving Insects

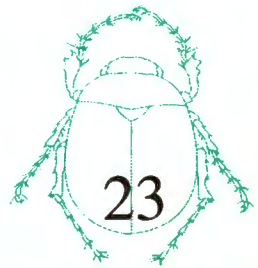
HOW TO HANDLE UNMOUNTED SPECIMENS

Keeping specimens fresh
For specimens that will be stored on pins, it is best to mount them as soon as possible after collecting and killing. It is easier to mount and position the insect without fear of breaking the legs, antennae, or wings while it is still fresh and pliable. If it is not possible to pin the insects in the field, fresh specimens can be placed in an airtight container lined with absorbent tissue. They can be kept in the refrigerator for about one week, longer in the freezer, without becoming moldy. Remove the specimen and place it on a new piece of absorbent paper to remove the excess moisture. Insects can also be kept in an ethyl acetate jar and will remain flexible as long as the ethyl acetate does not evaporate.

"Relaxing" specimens
If specimens become dry and difficult to pin, they must be "relaxed." To make a relaxing jar, place 2 inches of sand at the bottom of a wide-mouth jar. Add a small amount of phenol (carbolic acid) to a cup of water and then saturate the sand with this mixture. Place a piece of cardboard, cork, or wood over the saturated sand. Put the specimens on the cardboard, cork, or wood, and cap the jar with an airtight lid. The insect should be soft, pliable, and ready for pinning and spreading in about 48 hours. This time varies with the size and type of insect, and specimens can spoil if they are left in a relaxing jar too long. Keep the relaxer in a cool room. Too much heat and moisture in the relaxer causes mold to form on the insects.

Restoring shriveled specimens
Soft-bodied insects, such as caterpillars, shrivel up if they are allowed to dry out. One method used to restore these insects is to soak the specimens in one part household detergent to three parts warm water for no longer than 15 minutes. If they still are not soft, place them in a relaxing chamber for two hours. After this treatment, they should be rinsed with ethanol and placed in 70% ethanol for permanent storage.

Cleaning specimens
Specimens often are covered with soil particles, moth scales, tiny insects, seeds, and lint. Most of this debris can be removed with a camel's-hair brush dipped in ethyl acetate (nail polish remover). Insects that are covered with mud, dung, or similar material can be cleaned by putting them in alcohol or a mixture of water and detergent.



HOW TO MOUNT SPECIMENS

Specimens may be mounted and stored in several ways. Three basic ways to permanently store insects for your collection are described below: (1) dry and pin the specimens, (2) keep in 70% ethanol [ethyl alcohol, not rubbing or isopropyl alcohol, should be used for preserving in liquid], or (3) mount the specimens in balsam on a microscope slide. Pinning and mounting on microscope slides are described in detail on the following pages.

Pinning insects

Insect pins, different from ordinary straight pins, are needed to properly mount insect specimens. Stainless steel insect pins are 38 mm long and range in thickness from extremely fine (sizes 000-1) to heavy duty (5-7). Pin sizes 2 and 3 are used most commonly.

Most hard-bodied insects, such as beetles, flies, wasps, moths, and butterflies, are preserved on pins. These medium to large hard-shelled insects should be pinned vertically through the body as described below and shown on the next page.

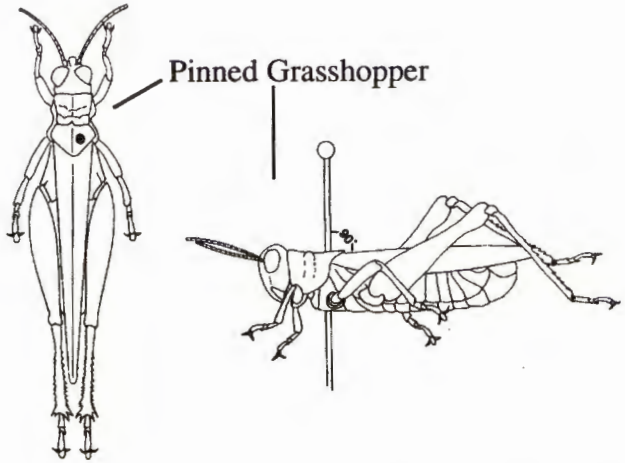
• Bees, wasps, and flies
Pin through the thorax between the bases of the front wings slightly to the right of the middle of the body.

• Stink bugs
Pin just to the right of the midline of the scutellum (the large triangle between the bases of the front wings).

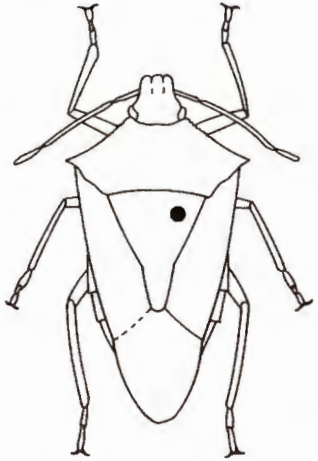
• Grasshoppers
Pin through the back part of the prothorax (the saddle behind the head) just to the right of the midline.

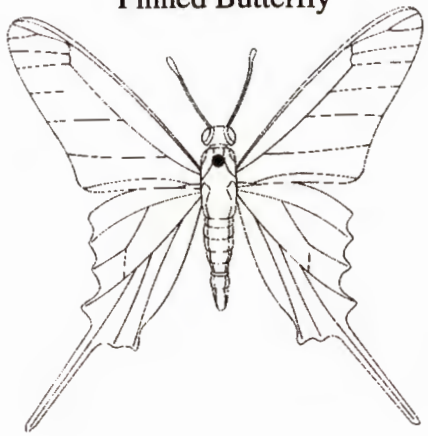
• Beetles
Pin near the front margin of the right wing cover near the midline of the body.

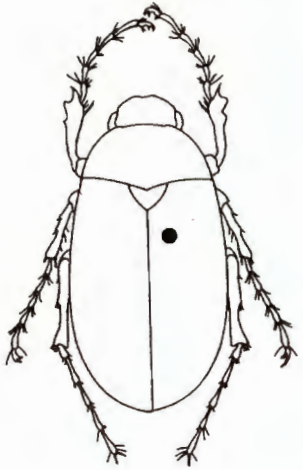
• Moths, butterflies
Pin through the center of the thorax between the bases of the front wings.


Pinned Grasshopper


Pinned Fly


Pinned Stink Bug


Pinned Butterfly


Pinned Beetle

Pinning block

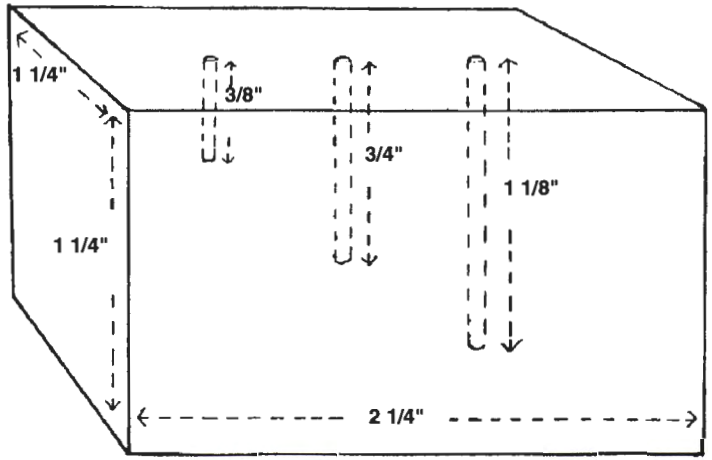
To make all the specimens a uniform height in your collection, a pinning block should be used. A pinning block is a small piece of wood, metal, or plexiglass that has three small holes, which are slightly larger than the pin diameter, drilled into the top of the block. The depths of these holes are 3/8, 3/4, and 1 1/8 inches. To use the block, pin the insect and insert the pin into the deepest hole. This pushes most specimens about three-fourths of the way up the pin while leaving room at the top of the pin for handling. This method, however, may position some thick-bodied insects too close to the head of the pin. For these, the pin should be inserted head first (upside down) into the shortest hole and the specimen should be pushed onto the pin. This leaves enough space at the top of the pin for handling. The hole of intermediate depth (3/4") is used for positioning labels and is described later.

Pinning insects with elongated abdomens

The abdomen of wasps, lacewings, and several other insects will sag when the specimen is killed and pinned.

To prevent the unwanted drooping you can (1) stick the pinned insect on the vertical surface of a block so that the body, by its own weight, dries in a normal position; (2) pin the insect on a horizontal surface and run stiff paper on the pin beneath the body, supporting it in a natural position until the insect dries; or (3) brace the abdomen by crossing two pins beneath it and inserting them into the block.

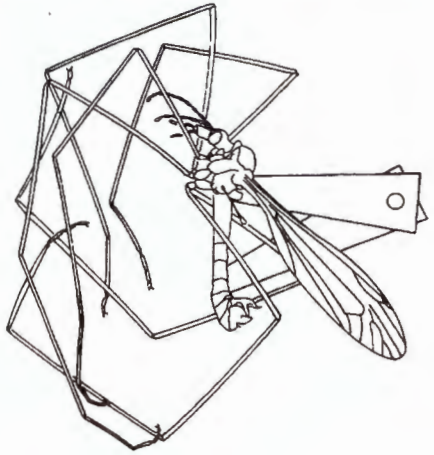
Pinning Block



The long legs of the crane flies make them difficult to handle. They are best pinned on double point mounts. The legs should be directed away from the pin to avoid breakage during handling.

Tiny moths and some flies are often mounted on minute, headless pins called minutens rather than on points. These are inserted into small blocks of soft, pithy material that are attached to standard insect pins. For this purpose, cork, balsa wood, or silicon rubber can be used. In general, tiny moths are prepared by pushing the minuten through the body and into the block.

Crane Fly on Double Point Mounts



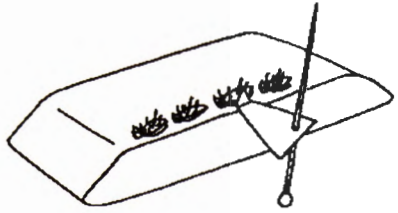
Pointing and pinning small insects

Very small insects cannot be pinned through their bodies with regular pins. Attempts to do so will shatter their bodies and appendages. Instead, they should be mounted on paper points.

Points are small triangles of stiff paper about the thickness of a notecard. They are punched or cut from good quality paper, such as rag-content, heavy ledger paper, or two-ply bristol board. If points are cut with scissors, they should be no larger than 3/8 inch long and 1/8 inch wide.

To prepare a point for attaching an insect, insert a no. 2 pin through the wide end of the point. Using a pinning block, push the point 1 1/8 inches up the pin. Adhere the insect to the point. Clear nail polish works well. White glue, which dries fast and forms a "skin," can be used if mounting is done quickly. Insect Repair Adhesive, a cellulose-based liquid sold by BioQuip Products (see address on page 73) is an excellent adhesive.

Using Rubber Eraser to Mount Specimens on Points



To mount specimens on points, follow the steps below. If possible, use a dissecting microscope to make sure specimens are mounted correctly.

1. Place a row of specimens along the edge of a raised surface. A 3/4 inch-high rubber eraser provides a good surface. Position specimens on their backs with heads directed to your left or on their sides with heads directed to your right. This will allow the point to be easily attached to the right side of the thorax of each specimen near the middle right leg. Using forceps, bend the tip of the paper point (1/16 inch or less) downward to fit the angle of the insect's side where the point will be attached.

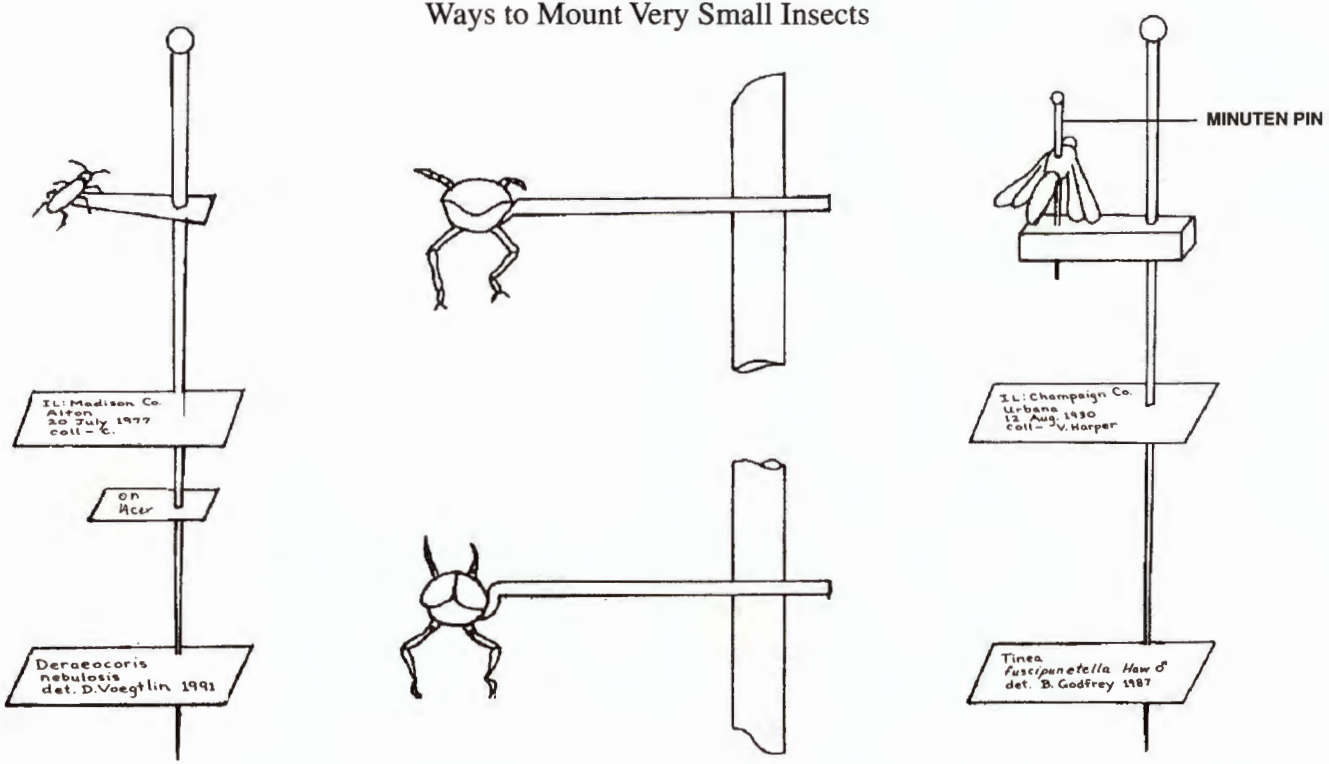
2. Hold the pin and touch the folded tip of the point to the glue, or smear a very small amount of the glue onto the tip with an insect pin or other fine instrument.

3. Press the glued tip against the specimen. If the specimen is positioned on its back, hold the pin upside down and support the left side of the insect with your finger as you press the point against the specimen. Hold the pin upright, and align the specimen gently with the forceps or your finger.

When the pin is held in the right hand and the point directed to the left, the insect should be mounted with its top surface horizontal and its head forward. Legs, wings, and antennae should be in view, and at least half the body should be free of glue and the point. Contact should be with the body, not just with a leg or a wing.

For leafhoppers the point tip should be kept straight. Glue is smeared on the upper surface of the tip, which is pressed against the underside of the body just to the right of the midline.

Ways to Mount Very Small Insects



Spreading insect wings

The wings of moths and butterflies should be spread before they are put into a collection. Some collectors also spread the wings of dragonflies and one pair of wings on grasshoppers. This technique requires the use of a spreading board. To spread insects of various sizes, the collector will need boards with center grooves ranging in width from 3/16 to 5/8 inch and side boards ranging from 1 1/2 to 3 1/2 inches. The following directions are for constructing and using a spreading board for medium-sized insects.

How to construct and use a spreading board

Materials

- two hardwood end pieces - 4 x 3/4 x 1/2 inches
- two softwood top pieces - (first-grade pine is satisfactory), 1 7/8 x 12 x 1/2 inches, with the top surface planed at an angle, so that the thickness at one edge is 1/2 inch and at the other 3/8 inch
- one flat polyethylene or plastizote foam piece, 1 x 11 x 3/8 inches (may be purchased from vendors on page 73)
- nails
- white glue

Construction

1. Nail the top pieces onto the ends so that the slanting surfaces of the tops face upward and the narrower edges are parallel and 1/4 inch apart.

2. Glue one strip of foam beneath the top pieces, covering the 1/4-inch opening between and fitting snugly at each end.

Use

1. Relax the specimen if necessary and pin it as described in the previous section. Insert the insect body in the groove so that the wing bases are level with the inside edges of the top pieces.

2. Cut two narrow strips of paper. Lay a narrow strip of paper across the wings on each side about 1/2 inch from the groove and secure each strip to the board with pins. This will hold the wings flat against the board. Working one side at a time, remove the lower pin and hold the bottom of the strip between the thumb and index finger of the left hand to control the pressure on the wings as they are moved with the right hand. To position the wings, hold a pin at the

base of the front wing beneath a large vein, and pull the wing up until the hind margin is perpendicular to the body. This often brings the hind wings into place as well. Pin the paper strip in place just below the hind wing. If the insect body rotates as the wings are moved, place a stout pin next to the body at the base of the hind wing. If the wings are difficult to hold in position, you may want to pin the wings temporarily in place by inserting a fine pin (size 0 or 00) near the front margin at the base of each wing.

3. Repeat step 2 for the other pair of wings.

4. When the wings have been adjusted to your satisfaction, lay a wide strip of parchment paper, folded along the inside edge, over each pair of wings and pin it close to but not through the wings. This strip should cover the edges of the wings, which tend to curl as the wings dry. Folding the inside edge of each strip prevents the scales from being rubbed off by the strip.

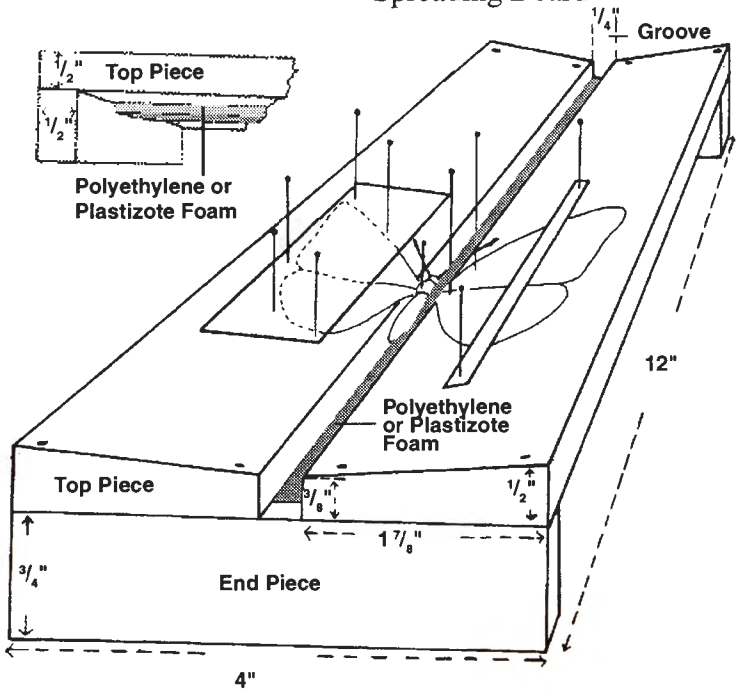
5. Remove the narrow paper strips and any pins placed through the wings or next to the body. Position the antennae so they are parallel to the upper margins of the front wings, and support the abdomen with pins or a small block if it sags.

6. Pin the data label next to the specimen.

7. Repeat steps 1 through 6 for specimens of similar size.

8. Allow the specimens to dry completely. For small specimens, this will take only a few days, but large moths can take as long as three weeks. If specimens are removed too early, the wings will likely droop and their position may shift.

Spreading Board



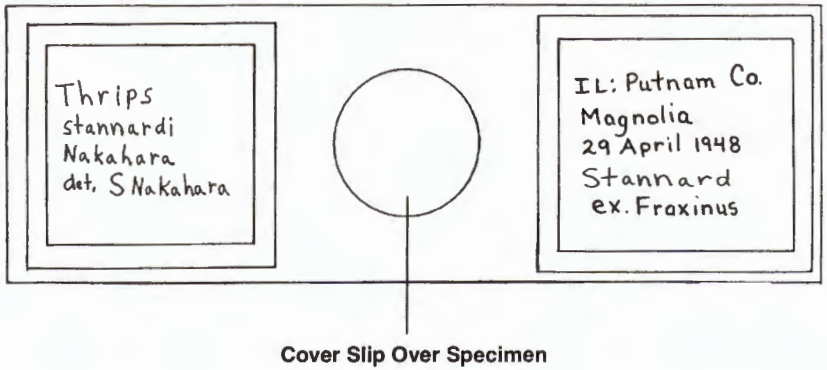
9. Remove specimens with care, attach labels, and store in a pestproof box (see pages 34-37).

Microscope slide preservation

Lice, fleas, aphids, and springtails must be mounted on microscope slides for permanent storage. Insect parts, such as wings, mouth parts, and genitalia (reproductive organs), may be mounted on glass slides to allow identification of some species. In these instances, magnification with a compound microscope is required to examine the fine structures used in identification. Numerous techniques are used for preparing and mounting specimens. No approach is simple, and all procedures involve chemicals that are expensive, may be difficult to obtain, or are hazardous if not handled properly. Detailed instructions can be obtained from technical references or specialists.

In general, before mounting, the specimen is cleaned, cleared (made more transparent), macerated (squashed so that internal organs and muscles can be removed), dehydrated, bleached, or stained for greatest visibility, and washed at certain stages to stop the action of various chemicals. The slide mount is made by dropping a small amount of mounting medium, such as balsam, on the slide, placing the specimen on the medium and carefully arranging its wings, legs, antennae, etc., and gently positioning the cover glass over the specimen. Finally, the mounting medium is allowed to dry, and labels are glued to the slide.

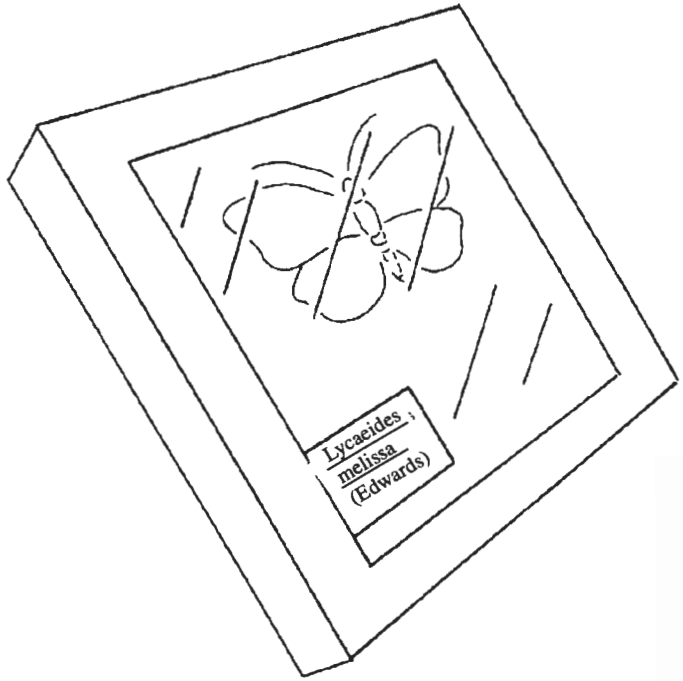
Microscope Slide With Labels



PRESERVING INSECTS FOR DISPLAY

Several additional methods of preservation are useful when preparing insects for display. These techniques are not suitable for preparing specimens for identification because important characters (such as hairs) may break too easily or may not be visible. Caterpillars can be freeze-dried to obtain lifelike specimens with good color that can be attached to pins. Butterflies and moths can be spread in Riker mounts. Riker mounts are display frames in which insects are held in place between glass and a polyester backing for hanging on the wall. Keep in mind, however, that specimens exposed to light will fade. Specimens can also be embedded in plastic for handling in classrooms.

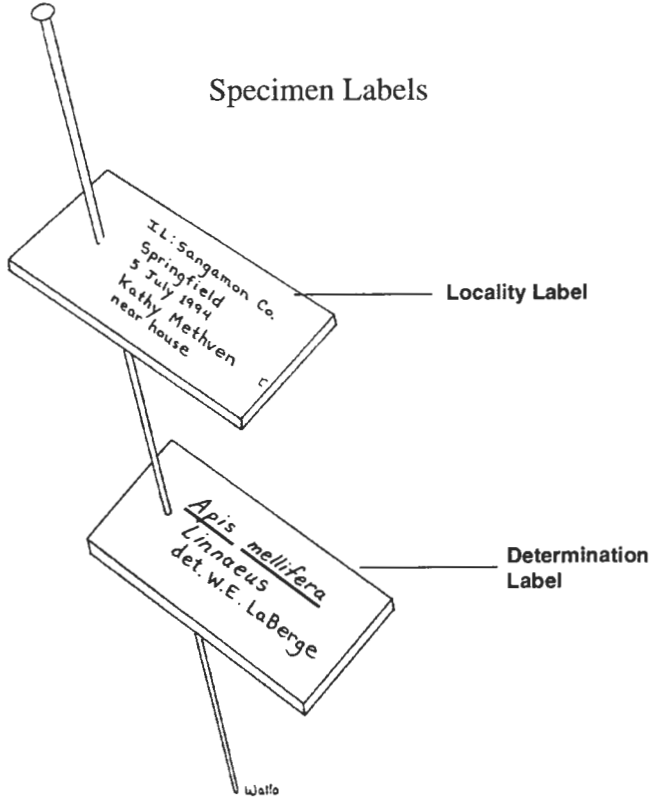
Riker Mount



HOW TO LABEL SPECIMENS

The information recorded at the time of collection must be associated with the specimens in a systematic way. Without this record, the specimens will have little scientific value. The safest method is to label each specimen with complete data. This will make sure that the information is easy to locate. If the species of an insect has been determined, an identification label is also placed with the specimen.

The required information for the data label is the locality and date of capture, but greater scientific value will be attached to the specimen if the name of the collector, the host on which the insect was found (note if it was actually feeding or merely resting), the behaviors observed, the nature of the habitat, and the collecting method are also included. The data are listed in the following sequence: state (two-letter abbreviation), county, other locality data (town or distance and direction from the nearest town, specific park, forest, river, etc.), date (day, month, year), collector, additional data (host, habitat, behavior, trapping method, etc.). Sample labels are shown at right.



Notice that the day is always listed first in the date. The month is spelled out or abbreviated. The year is never abbreviated because collections may contain specimens from more than one century. Periods can be deleted and "Coll. by" can be omitted. Genus and species names are underlined or printed in *italics*.

Labeling specimens

Identification labels include the full scientific name of the insect, the name of the person who made the determination, and the year in which the identification was made. Format varies slightly with the length of the name. Sample labels for identifying a honeybee and the bean leaf beetle are given below.

Apis mellifera Linnaeus det. W. E. LaBerge	Cerotoma trifurcata (Forster) det. J.K. Bouseman

Labels must last as long as the specimen, so the paper used must be of good quality. The best paper is 100% rag and acid-free. These characteristics prevent the paper from becoming brittle and discolored. Labels for pinned specimens should be made of stiff paper, having a weight of about 36 pounds. For specimens in ethanol, the paper should be stiff enough to stand up in the vial. Labels can be printed by hand with an alcohol-proof labeling pen. These pens may be obtained at your local art supply store. Computer-generated labels printed on a laser printer are suitable for pinned and slide specimens but not specimens stored in ethanol.

For pinned specimens, the labels should be as small as possible and uniform in size. Computer-generated labels are usually 1/2 to 5/8 inch long, 3/16 to 1/4 inch wide, and have no more than five lines. It is better to use two small labels than a single large one. Large labels take up too much space in the insect drawer and are more easily bumped, often knocking off the specimen. Labels should be placed about halfway up the pin, but not too near the specimen, and they should project from the pin in the same direction as the specimen. When using a pinning block, the locality label is positioned with the 3/4-inch hole. A second data label is positioned about 3/16 inch below the first. The determination label can be slightly larger than the data labels and is placed about 3/8 inch up the pin (shortest hole on the pinning block).

Labels for specimens stored in fluid are placed in the vials with the specimens. They are designed to stand up in the vial, so they should be slightly shorter than the vial. The paper does not need to be as stiff as that used for pinned specimens.

Microscope slides are labeled with square labels. Because slide-mounted insects are usually viewed with a compound microscope, which inverts the image, labels should be positioned so they are readable when the head of the insect is pointed downward. Two labels are placed on each slide. Collection data are printed on the right, and the determination is recorded on the left (see page 32).

HOUSING A COLLECTION

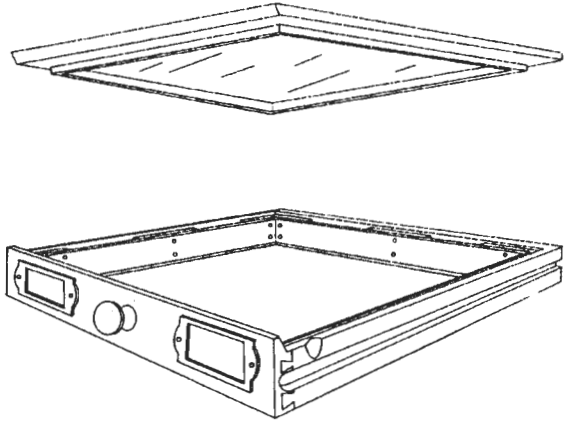
Any collector who plans to keep his or her collection permanently will need to store and care for it properly. Selecting good storage methods can protect specimens from pests, exposure to light, excessive moisture, dehydration, dust, and rough handling.

Various physical characteristics (called characters) are used to identify an insect's family, genus, and species. It is always necessary to see the structure of antennae, wings (if present), legs, and mouth parts. Frequently, minute details of these structures must be examined. Hair or scales covering the body or wings, and the texture of these parts, are important. Thus, specimens should be kept in good condition. The collection also needs to be organized in a manner that will allow it to be useful to the collector and other users (see page 39).

Pinned specimens

After specimens have been pinned and labeled, they should be housed in tight-fitting boxes or drawers to keep out dust and pests, stored away from direct sunlight to prevent fading, and kept in a dry place to guard against mold. Storage boxes should be of uniform size and have soft pinning bottoms, preferably of polyethylene foam. Pins can be easily pushed into the foam and are held securely in place. Also, holes do not remain after pins are removed. Hardbottom boxes and drawers can be filled with unit trays that have polyethylene foam pinning bottoms. These are available in several sizes.

Glass-top Insect Drawer



Several excellent, but expensive, types of boxes for housing insect specimens may be purchased from commercial supply companies. Specimens in major collections are usually stored in standard, wooden, glass-topped insect drawers. Drawers used at the Illinois Natural History Survey are the U.S. National Museum type (18 x 18 x 2 7/8 inches outside diameter). Other types are based on those used at the California Academy of Sciences (19 x 17 x 2 1/2 inches) and Cornell University (19 x 16 1/2 x 3 inches). The drawers are usually housed in wooden or metal airtight cabinets.

Because commercial storage units are nearly dustproof and pest proof, they are usually much better than homemade boxes. Homemade boxes, however, are quite practical for the beginning collector because they are inexpensive or easy to construct. Cigar boxes, 2 inches deep or more, make ideal insect boxes if a layer of polyethylene foam is glued to the bottom. Other wooden or cardboard boxes may be used for specimen storage, but such boxes do not protect specimens against pests, and great care must be exercised in keeping the boxes fumigated. If the collector wishes to construct a wooden, glass-topped insect drawer, the design should follow that of a standard drawer.

Certain insects, such as stored grain beetles and carpet beetles (dermestids), eat dried insects, and unless care is taken, they may destroy an entire collection. To guard against them, various chemical repellents, such as napthalene, can be placed in the boxes containing specimens.

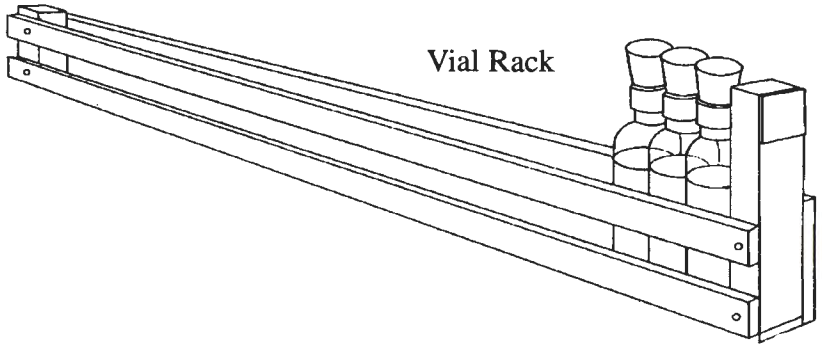
Because the fumigants used in insect collections are toxic to humans, and because most of them are highly flammable, we recommend freezing instead. Placing the entire collection in a freezer will kill pests that are attacking the dried insects. Freezing is the safest and probably one of the most effective methods for getting rid of unwanted pests in your collection.

Place your entire drawer or box of insects in an airtight plastic bag. Leave the bag in the freezer for 4-5 days to make sure all pests have been killed. After freezing, check your collection frequently for signs of further infestation. Repeat the freezing procedure if necessary.

Wet specimens

Specimens preserved in 70% ethanol are usually stored in small vials (1/4 oz.) sealed with neoprene stoppers. If corks or plastic caps are used, evaporation occurs too rapidly. Vials are generally stored in racks that can be easily moved about. Fluid levels should be checked periodically to make sure the specimens do not become dry.

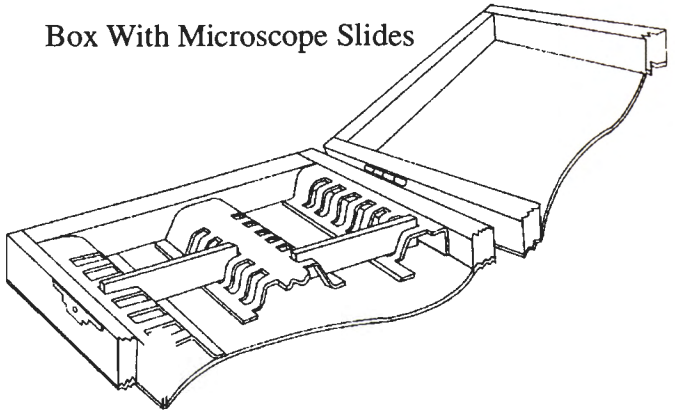
Vial Rack



Slide-mounted specimens

Microscope slides are usually stored in wooden or plastic boxes that can be purchased from biological suppliers. Slots in the boxes hold the slides upright and separate the slides from each other. Other storage cases have trays on which slides are stored flat. If slides are to be placed on edge in a storage box, be sure that the balsam or other mounting material has dried completely (this can take several days) so the coverslip does not shift when the slide is placed in the box.

Box With Microscope Slides



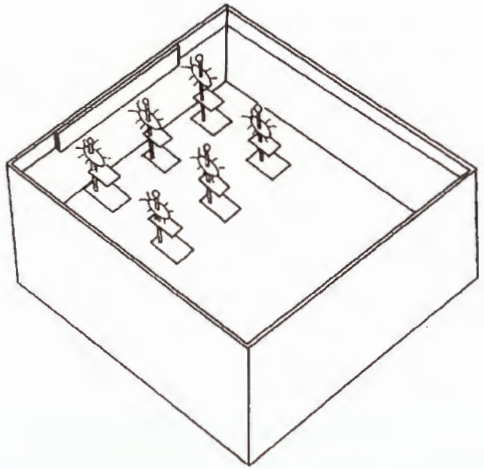
Arrangement of collection

For a small collection—one fitting into one to a few boxes—specimens can be arranged and labeled by order and family. Scientific names should be used, but common names may be added. For special collections, insects can be arranged by host, season, behavior, habitat, etc. Whatever the choice, the arrangement should be neat and consistent, and all labels should be legible and easily seen.

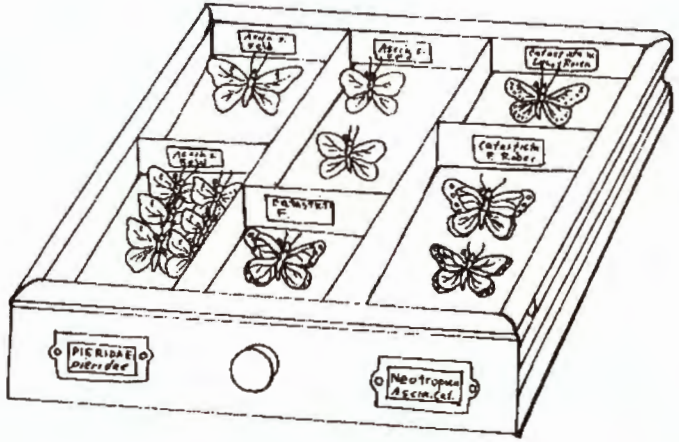
Large research collections with thousands of insect drawers are usually arranged by order, family, genus, and species. The contents of each drawer (order, family, and sometimes genera) are shown on the outside of the drawer. Specimens are placed in unit trays with polyethylene or plastizote foam bottoms. One species is housed per tray, and the individual specimens and trays are labeled with the species name. The unit tray system prevents excessive handling of specimens. Trays, not individual insects, are moved about as collections expand and are rearranged. This helps prevent breakage of specimens. In addition, trays can be placed directly under a dissecting microscope for examination of specimens.

The arrangement of specimens preserved in ethanol or on slides is similar. Vials and slides are placed in racks or boxes that are stored in cabinets or on open shelves. All storage units and individual specimens are labeled clearly.

Unit Tray With Specimens



Drawer With Unit Trays



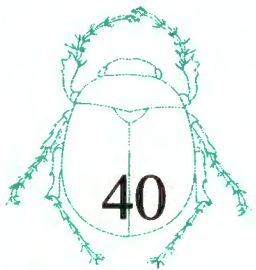
SHIPPING SPECIMENS

Collectors may want to send specimens to specialists or entomological museums for identification. The terms under which specialists will undertake this work varies, but experts will often study well-preserved and labeled collections in return for duplicate specimens that they may keep. The identification of many insects is so difficult and laborious, however, that rapid service cannot be expected by collectors who send in material.

Use special preparation and care to guard against breakage if specimens are to be shipped to a specialist for identification. For pinned specimens, all pins need to be pushed securely into the pinning bottom, and extra pins of the same height should be placed in each corner. A thin piece of cardboard cut to fit snugly inside the box and a layer of bubblewrap or other padding material should be placed above the pins to cover the specimens. The box should be wrapped in paper and packed in a larger box. Surround the smaller box with plastic peanuts. No rattling of the smaller box should be heard when the larger box is gently shaken.

When specimens preserved in fluids are shipped, the contents and the vials must be protected. Vials should be completely filled with ethanol, eliminating air bubbles as much as possible. Vials should be individually wrapped and secured tightly together in bundles. These can be placed in plastic bags to prevent dehydration of specimens in the event that vials are broken or become unstoppered. Finally, the vials should be packed in a large box surrounded by at least a 2-inch layer of packing styrofoam.

Slides can be shipped in boxes as long as padding around each slide is provided to prevent bouncing. Wrapping with plastic bubble sheets is often adequate. Surround the bubblewrapped slide(s) with a layer of styrofoam peanuts in a large box.



Section III - Identifying Insects

CLASSIFYING AND NAMING ORGANISMS

Anyone who begins a collection of specimens, whether insects, plants, or even rocks, must somehow identify and organize those specimens to make the collection attractive. But identifying and classifying are necessary for reasons much more important than just appearance. As collectors, naturalists, or other biologists communicate with each other and share their knowledge and observations, a common system of naming and grouping organisms is necessary to avoid confusion.

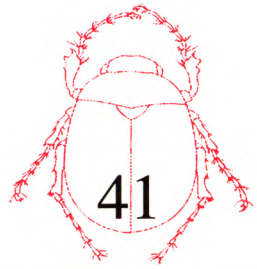
Perhaps the first step in understanding the naming and grouping of organisms is to understand the meaning of the word species. A species is a group of organisms of one kind. Humans, honeybees, and monarch butterflies are each a single different species. That each is composed of members of "one kind" means that the members of a species can mate and produce fertile offspring. Although a species may be known by a common name, more formal and accurate naming employs the binomial (two-name) system set forth by Linnaeus in 1758. In this system, each species is given genus and species names usually derived from Latin or Greek. The scientific name for humans is *Homo sapiens*, the honeybee is *Apis mellifera*, and the monarch butterfly is *Danaus plexippus*. (Genus and species names are always italicized or underlined.)

Genus and species names may sometimes seem unnecessarily complicated, but the use of scientific names is worthwhile for several reasons. First, scientific names are used worldwide. For example, the words red flour beetle may be meaningless to a German-speaking biologist, but the scientific name *Tribolium castaneum* is constant among languages. Scientific names are also universal in another way. People in different regions of the United States may use the name water bug, croton bug, or oriental cockroach to refer to the same insect species. A common name that is well-recognized in one region may carry a very different meaning in a different part of the country. The scientific name *Blatta orientalis* accurately labels this insect, wherever it is found.

Honeybee - *Apis mellifera*

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Hymenoptera
Family: Apidae
* Genus: *Apis*
* Species: *mellifera*

Once organisms are named, grouping or classifying them can help to provide an understanding of how they are related. The established method for classifying organisms employs a hierarchical system, with larger or more general groups (taxa, singular taxon) of organisms subdivided into successively smaller groups. Examining the classification of the honeybee provides an illustration of this system.

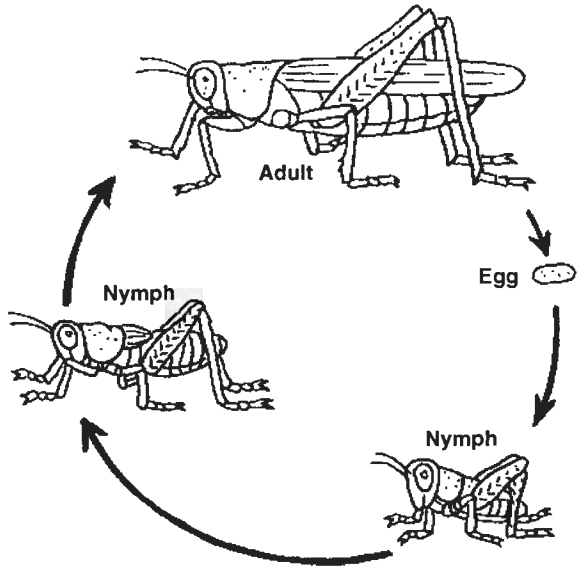


METAMORPHOSIS

Insects, like all other arthropods and certain other animals, exhibit distinct stages of growth. Between the stages, insects go through a process called molting, during which they shed the old cuticle (the exoskeleton), which is subsequently replaced with a new, larger covering. In many insects, growth and development involves marked changes in body form as well as size. The change in body form is called metamorphosis.

Various types of metamorphosis are seen in various insect groups. In some primitive, wingless insects, young stages look very much like adults, and the change in appearance during maturation is primarily just an increase in size. For example, the springtails and firebrats exhibit little change in form as they mature. Although terminology varies, this developmental pattern is usually termed ametamorphosis.

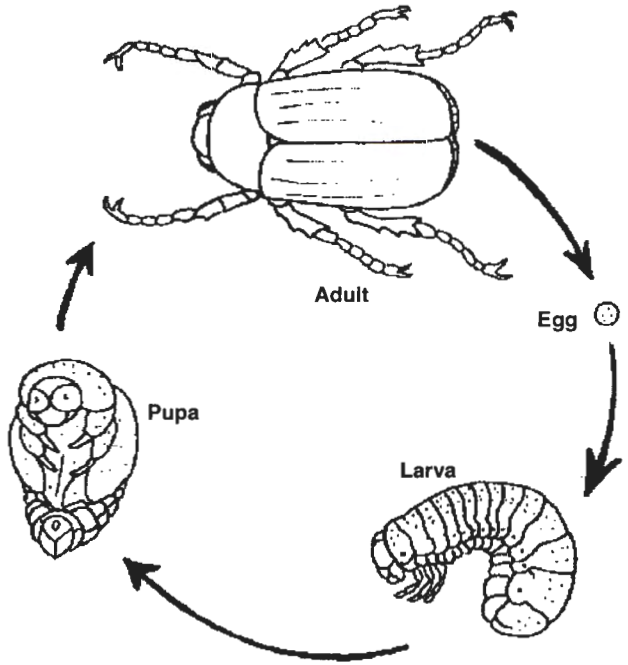
Gradual Metamorphosis



Gradual metamorphosis (also termed incomplete metamorphosis by some) — as exemplified by the growth and development of grasshoppers, dragonflies, cockroaches, true bugs, aphids, and many other insects — involves more noticeable changes in form as immature insects develop through successive growth stages. Visible changes may involve only the appearance and enlargement of wing pads that will form the true wings when the insect molts to the adult stage, as is the case for grasshoppers and many true bugs. In other groups, such as the damselflies, mayflies, and stoneflies, aquatic immatures do not look much like the adult stage, and their maturation involves not only the development of wings but also the loss of external gills and a substantial change in body form. Immature stages of insects that undergo gradual metamorphosis are called nymphs or, if they are aquatic, naiads.

Beetles, butterflies, moths, flies, bees, wasps, and certain other insects undergo what is commonly termed complete metamorphosis. As they hatch from the egg, the immature stages of these insects (grubs, caterpillars, maggots, etc.) are called larvae (singular = larva). Larvae usually do not resemble adults, and their body form changes little until they pupate. During pupation, when the insect is immobile, extreme changes in form occur; caterpillars transform into moths or butterflies, and maggots become flies.

Complete Metamorphosis



SUMMARY OF INSECT ORDERS

A summary of the insect orders is presented in the following text to assist in locating, collecting, and taking care of specimens. The orders are listed in what is called a phylogenetic sequence, or simply, from the most primitive to the most advanced orders. Primitive insects have a very generalized form, often without wings (exceptions to this are the mayflies and dragonflies/damselflies). We show only the adult forms of the insect orders in the following descriptions. (See the section on metamorphosis on pages 42-43.)

COLLEMBOLA: the springtails

The springtails get their name from the last segment of their abdomen, which bears a forklike jumping apparatus called the furcula. These tiny insects, less then 1.0 millimeters (mm) long, have short antennae and are wingless. Generally, all growth stages resemble the adults. Most Collembola live in moist habitats. To find these insects, search through wet soil, woodland humus, moss, fungi, lichens, and decaying fruit and animal matter; also look beneath stones and driftwood and in greenhouses.

How to Collect

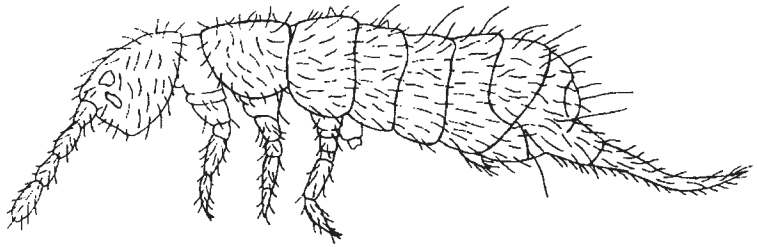
1. Pick up with an alcohol-moistened brush.
2. Suck up with an aspirator.
3. Extract from soil, debris, or leaf litter with a Berlese funnel.

Short-term Storage

Collect in 70% ethanol.

Long-term Preservation

Mount in balsam on microscope slides.



Springtail, order Collembola

Protura

Rarely collected, proturans are strange insects. Blind and lacking real antennae, they use their front legs to help them maneuver through terrestrial habitats. They are very small (about 1-3 mm long), have sucking mouth parts, are wingless, and undergo a gradual metamorphosis. Proturans can sometimes be confused with Collembola except for the forward, antennae-like positioning of the proturans' front legs.

How to Collect

Proturans can be found in soil, on leaves, in humus, and amid fungi on bark. Capture these insects with an aspirator or a moistened brush, or process debris in a Berlese funnel. Collect large series (many specimens from the same locale) of these specimens when possible because characters used in their identification are often destroyed in handling.

Short-term Storage

Collect in 70% ethanol.

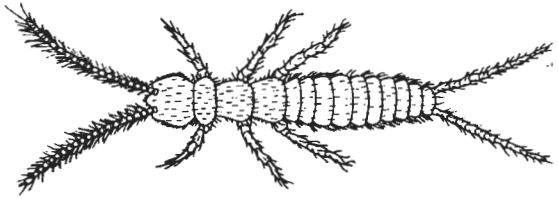
Long-term Preservation

Mount in balsam on microscope slides.

Proturan, order Protura

Diplura

Diplurans are extremely small and quick-moving insects. They live under stones and leaf litter and in other places that are very moist. White with long antennae, they are equipped with either two fairly long tails, called cerci, or a forceps-type structure at the end of a slender body.



Dipluran, order Diplura

How to Collect

1. Pick up with a moistened brush.
2. Aspirate.
3. Extract from leaf litter using a Berlese funnel.

Short-term Storage

Collect in 70% ethanol.

Long-term Preservation

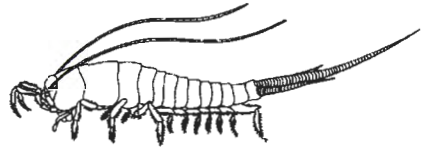
Mount in balsam on microscope slides or maintain in 70% ethanol.

Microcoryphia: the bristletails

The soft-bodied, grayish bristletail can be identified by the long "tail" filament that is flanked to the right and left by two much shorter projections (cerci) at the end of the abdomen. The bristletail's thorax is strongly humped. The long mouth parts move up and down. These primitive, tiny, wingless insects can also be recognized by their jumping ability.

How to Collect

During the day, bristletails can be found in cracks and rock crevices. At night, they come out to eat lichens, algae, and vegetable debris. Collect by hand and drop into ethanol or use a Berlese funnel to process debris and litter.



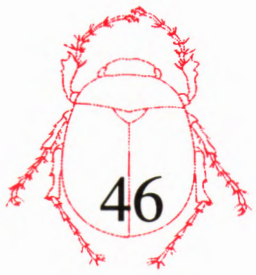
Bristletail, order Microcoryphia

Short-term Storage

Collect in 70% ethanol.

Long-term Preservation

Preserve in 70% ethanol.



THYSANURA: the silverfish and firebrats

Silverfish and firebrats range in size from 2 to 20 mm. Two slightly shorter cerci flank the middle filament at the end of the abdomen. The many-segmented antennae range from short to as long as the insect's body. These soft-bodied plant feeders are found under bark, stones, and logs, and in leaf litter, caves, and houses. Some species can be found in ant or termite nests. Resembling the colors of their habitat, they can be gray, brown, or white.

How to Collect

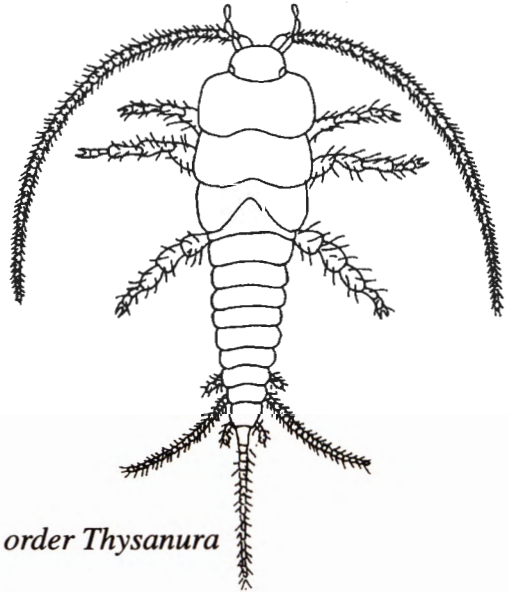
1. Use a small brush dipped in alcohol to pick up smaller individuals.
2. Aspirate.
3. Extract from soil, leaf litter, and debris using a Berlese funnel.

Short-term Storage

Collect in 70% ethanol.

Long-term Preservation

Store in vials containing 70% ethanol.



Firebrat, order Thysanura

EPHEMEROPTERA: the mayflies

Mayfly nymphs take many different forms. They have short antennae, long legs, and long tails at the end of the body. Living at the edge of the lake or stream from which they emerged, adult mayflies have two or three long tails trailing like streamers, very long front legs, short antennae, usually two pairs of wings, and virtually no mouth parts.

How to Collect

Mayflies have an unusual type of metamorphosis. Nymphs emerging from streams or lakes have wings but will molt one more time before becoming adults. Collect the nymphs by sifting the mud, sand, or gravel from the bottoms of lakes, streams, or ponds. Mayflies in immature stages can also be collected by hand from beneath stones, submerged branches and trees, and debris in the water.

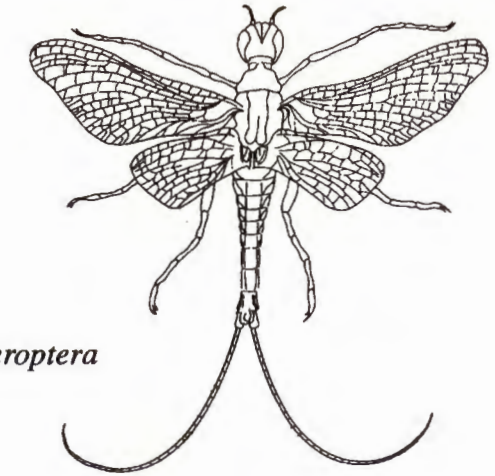
Adults generally remain near the water from which they emerged. Check for mayflies at dawn and dusk and collect them with jars around lights. Mayflies also swarm in bright sunlight on windless days. Capture these with a net. When they are not swarming, adult mayflies rest on the underside of leaves and in protected areas. Gently sweep and beat plants and trees. The mayflies are fragile, so be careful when netting.

Short-term Storage

Collect in 70% ethanol.

Long-term Preservation

Preserve permanently in 70% ethanol.



Mayfly, order Ephemeroptera

ODONATA: the dragonflies and damselflies

The nymphs (naiads) of dragonflies and damselflies are aquatic. They are stout-bodied with no tail or are slender with three large leaflike gills extending from the end of the abdomen. The adults are quite beautiful, graced with two pairs of wings that are intricately netted with veins. Dragonfly adults are thick-bodied with differently shaped front and hind wings and are strong fliers. Damselflies have slender bodies, their front and hind wings are similar in shape, and they tend to be weaker fliers than dragonflies.

How to Collect

The odonates can often be seen flying in sunshine near marshes, ponds, and streams, chasing mosquitoes and other insects. Net them quickly from behind after approaching the insects with slow, cautious movements.

Short-term Storage

Nymphs should be collected in 70% ethanol. Adults should be kept in an ethyl acetate jar, then placed on absorbent tissue in a small box or placed in glassine envelopes or papers.

Long-term Preservation

Nymphs are permanently stored in ethanol-filled vials. Adults are placed in glassine envelopes along with locality and identification information on a notecard. They may also be pinned and spread.

Dragonfly, order Odonata

PLECOPTERA: the stoneflies

Stoneflies range in size from 3 to 50 mm, have slender, leathery bodies, and often have cerci that are long with numerous segments. Adults are poor fliers and have wings that are neatly folded over the abdomen when in the resting position.

How to Collect

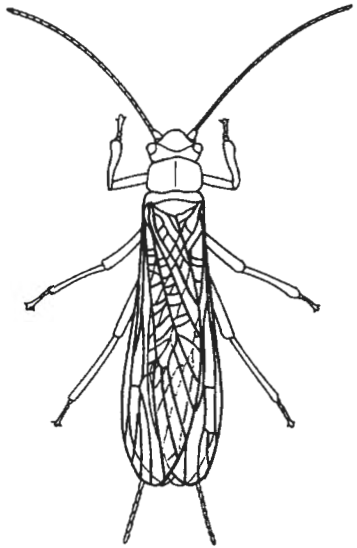
The immature stages of the stonefly are dependent upon clean, flowing water. Many of these naiads, which live under rocks, emerge as adults from streams or rivers during winter. Collecting in snow and ice (winter stoneflies) is a bit more challenging. In summer, collect stoneflies around lights and by sweeping vegetation near streams and lakes.

Short-term Storage

Collect in 70% ethanol.

Long-term Preservation

Preserve in 70% ethanol.



Stonefly, order Plecoptera

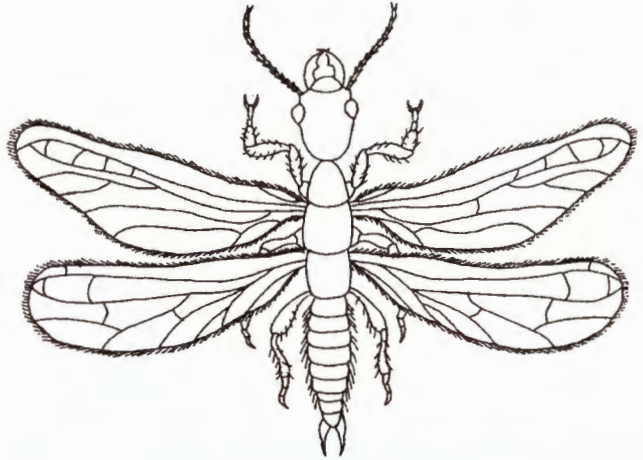
EMBIOPTERA: the webspinners

Primarily tropical, the webspinners live a hidden life in mazes of silk. Found in soil, crevices, and under bark, they feed upon dead leaves, lichens, and the surface of bark. Long-bodied and slender, they have two segmented cerci extending from the tip of the abdomen. The front legs of all species are enlarged because of the presence of numerous silk glands. Adult males have wings; adult females are wingless.

How to Collect
Search for the webs in the variety of habitats listed above.

Short-term Storage
Collect in 70% ethanol.

Long-term Preservation
Preserve in 70% ethanol.



Webspinner, order Embioptera

Walkingstick, order Phasmatodea

Cricket, order Orthoptera

Cockroach, order Dictyoptera

PHASMATODEA: the walkingsticks

Also known as stick or leaf insects, walkingsticks resemble the twigs or leaves on which they reside. Although they can look like mantids, walkingsticks, unlike mantids, do not have front legs that are adapted to seize prey.

ORTHOPTERA: the crickets, grasshoppers, and katydids

Grasshoppers, crickets, and katydids are large insects, but because of their ability to both jump and fly, they can be difficult to catch. Most have a leathery appearance, two pairs of wings, biting mouth parts, and lengthy, segmented antennae.

DICTYOPTERA: the cockroaches and mantids

Cockroaches are scavengers, whether they reside in your home or in the woods. They are characterized by their biting mouth parts; oval shape; unhardened, leathery consistency; and dark, reddish-brown to black body. Mantids have large, heavily muscled front legs that are lined with spines to help capture and hold onto their prey while eating.

How to Collect Orthoptera, Phasmatodea, and Dictyoptera

1. Sweep low vegetation.
2. Beat trees and shrubs.
3. Use your fingers or forceps to collect the sedentary creatures under stones and logs.
4. Net quick-flying and jumping orthopterans.
5. Set up bait traps.
6. To track some of the orthopterans, follow the sounds of their singing.

Short-term Storage

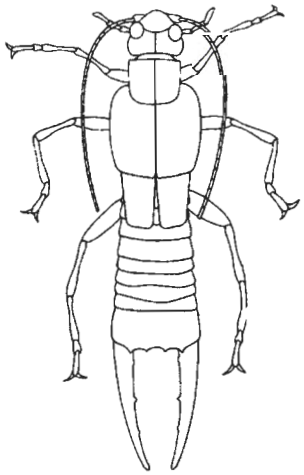
Collect most orthopterans, phasmatodeans, and dictyopterans in a killing jar. Grasshoppers do not die quickly in ethyl acetate, so allow for more time in the killing jar. Camel crickets dry out, so collect these insects in ethanol.

Long-term Preservation

Pin insects of these orders soon after their death. Support body parts with extra pins until dry. Mount small grasshoppers and crickets on points. Large specimens need to be slit open and have the insides removed to prevent molding. Store walkingsticks in glassine envelopes along with locality and identification material printed on a notecard.

DERMAPTERA: the earwigs

The forceps-like cerci at the end of the abdomen help to distinguish earwigs from other orders. Earwigs range in size from 4 to 25 mm, have long, leathery bodies, and are brown to blackish. They dwell in humid places and are often found in soil, under bark, or in crevices and cracks.



Earwig, order Dermaptera

How to Collect

Hand-collect earwigs under fallen branches and trees, stones, or other debris. Sweep and beat vegetation.

Short-term Storage

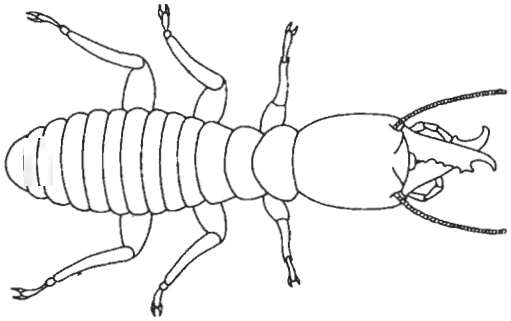
Place in a layer of absorbent tissue.

Long-term Preservation

Pin as soon as possible after collecting.

ISOPTERA: the termites

Termites are fragile or soft insects with chewing mouth parts. Although they resemble ants somewhat, termites have little or no constriction (narrowing) where the abdomen and thorax are joined as ants do. The antennae are straight, not elbowed as are the antennae of ants. Reproductive (mating) forms are dark brown and have two similar pairs of delicate wings, with a fine network of veins. Workers and soldiers are white and soft-bodied and live in colonies in soil and wood.



Termite, order Isoptera

How to Collect

Termites are social insects and feed on wood. Search through fallen logs and pry off bark. Use a screwdriver as a wedge to break into wood to find termites.

Short-term Storage

Collect in 70% ethanol.

Long-term Preservation

Mount in balsam on microscope slides or store in 70% ethanol.

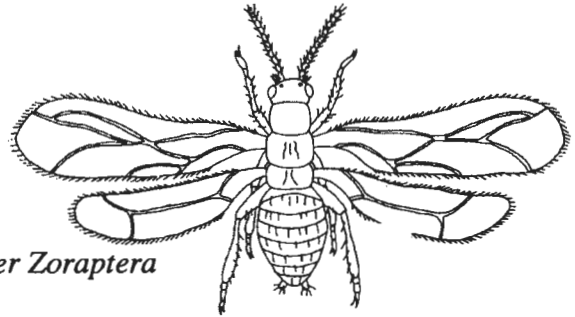
Zoraptera

These small, rare insects are found in sawdust piles, rotten wood, and under bark. Zorapterans are pale and have beadlike antennae with nine segments, short cerci, and an oval abdomen; they can be either winged or wingless.

How to Collect
Search through sawdust and wood or under bark.

Short-term Storage
Collect directly into 70% ethanol.

Long-term Preservation
Permanently preserve in ethanol.



Zorapteran, order Zoraptera

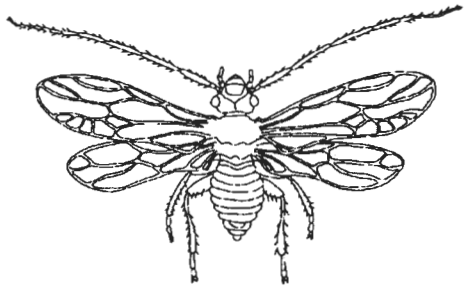
Psocoptera: the booklice

Booklice and barklice are very small and have soft, oval bodies without cerci. They have long antennae and biting mouth parts. As their name implies, booklice often feed upon and are found in books. Also, old papers and stored food such as cereal are favorite diet items. Barklice normally feed upon algae, fungi, and lichens. Psocopterans live on the bark and leaves of trees and also can be found in bird nests, beehives, wasp nests, and caves.

How to Collect
Collect by beating and sweeping vegetation and by searching through undisturbed books, papers, and nests. Sift through debris and soil, or process samples using a Berlese funnel.

Short-term Storage
Collect small specimens in 70% ethanol; collect larger specimens in an ethyl acetate jar.

Long-term Preservation
Larger specimens can be pinned. Smaller specimens can be mounted in balsam on microscope slides.



Booklouse, order Psocoptera

MALLOPHAGA: the chewing lice

Chewing lice are wingless, flattened insects with short antennae, short legs, and inconspicuous mouth parts.

How to Collect

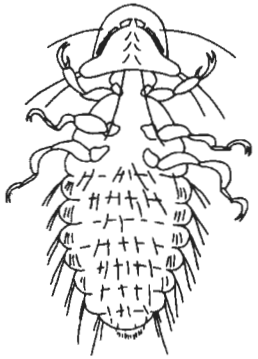
These lice live on the outer surface of birds and mammals. Depending on the species, they can feed upon blood, feathers, hair, or skin. On recently killed birds and mammals, the lice will move to the edge of the animal. Meticulously search for lice with forceps through the fur or feathers.

Short-term Storage

Collect in 70% ethanol.

Long-term Preservation

Mount in balsam on microscope slides.



Chewing Louse, order Mallophaga

ANOPLURA: the sucking lice

Sucking lice are pale and somewhat flattened and have a small head that is much narrower than the thorax. They have very short antennae. The large claw found at the end of the legs is a characteristic of this order.

How to Collect

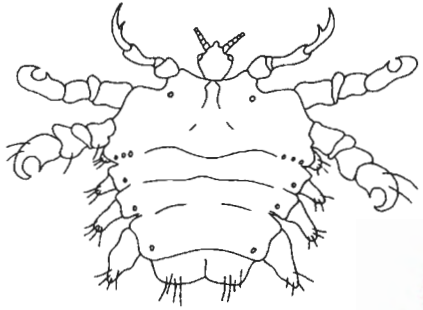
The sucking lice, including body or crab lice, live on the skin of mammals and feed by sucking blood. Collect by carefully searching through animal hair (recent road kills are a good source) with a pair of fine forceps.

Short-term Storage

Place in vials of 70% ethanol.

Long-term Preservation

Mount in balsam on microscope slides.



Sucking Louse, order Anoplura

HEMIPTERA: the true bugs

The true bugs constitute one of the larger groups of insects. The name Hemiptera means "half-winged," and this name describes the major character that distinguishes hemipterans from other insects; that is, the bottom half of their wings are thin membranes while the other half appears solid. Hemiptera have flattened wings that cross at the tips, forming an X-like pattern across the top of the abdomen. They range in size from 1 to 50 mm and are variable in shape. The antennae are short, having only four or five segments. Most hemipterans feed upon plants, piercing and sucking the juice with their beak, but many are also predaceous.

How to Collect

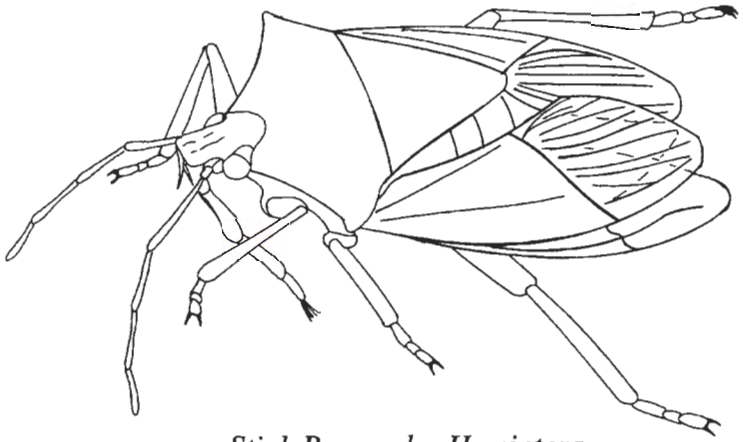
Summer is the best time to collect true bugs. Sweep, beat, and hand-search a variety of vegetation types. Aspirate the smaller specimens. Use a separator to find bugs in decaying vegetation.

Short-term Storage

Collect semiaquatic and aquatic bugs in 70% ethanol. If terrestrial specimens cannot be pinned in the field, place them on absorbent paper in a box.

Long-term Preservation

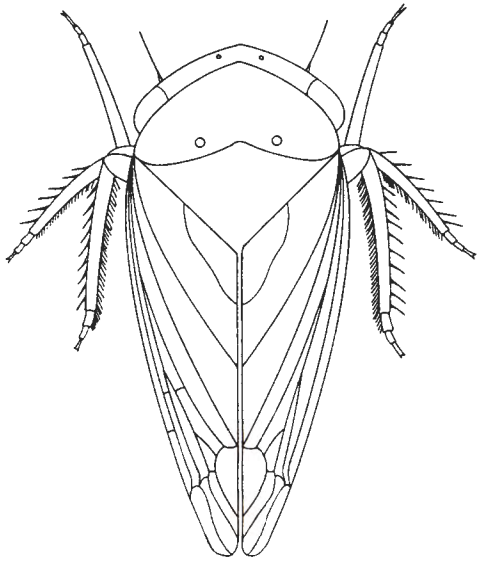
Softer-bodied semiaquatic and aquatic specimens should remain in ethanol. Pin or point the dried terrestrial specimens.



Stink Bug, order Hemiptera

HOMOPTERA: the cicadas, leafhoppers, aphids, and scale insects

Cicadas, leafhoppers, aphids, and scale insects make up this diverse group. The mouth parts of these plant feeders are of the sucking-piercing variety, differing from the hemipterans in that the beak arises from the base of the head rather than the front. In the winged homopterans, the wings (when folded) meet in the middle, forming a tentlike shape over the abdomen. The antennae can have 3 to 10 segments. Body size varies from a few millimeters up to 55 mm.



Leafhopper, order Homoptera

How to Collect

Sweep fields, beat vegetation, and search through flowers and foliage. It is important to record host information while collecting members of this order because it will aid in identifying the specimen.

Short-term Storage

Collect aphids and scales in ethanol. Cicadas, planthoppers, and leafhoppers should be pinned or pointed in the field or stored in a box lined with absorbent tissue.

Long-term Preservation

Aphids and scales should be mounted in balsam on microscope slides. Cicadas, leafhoppers, and planthoppers should be pinned or pointed. Softer-bodied homopterans should be preserved in 70% ethanol.

THYSANOPTERA

Thrips can be distinguished from other insects by the fringe of hair on their two pairs of wings. These tiny insects feed on plants, mites, and smaller insects.

How to Collect

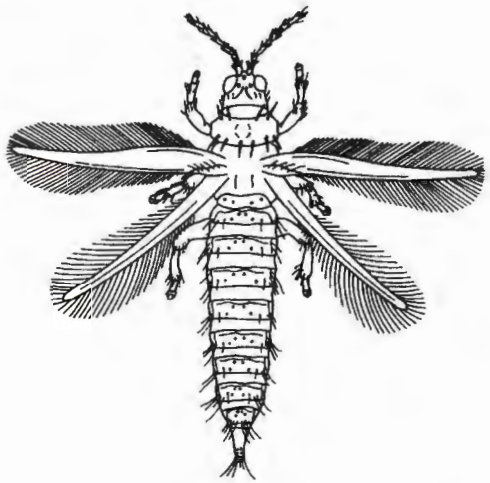
Thrips can be found in both growing and dying vegetation, flowers, shrubs, leaves, mosses, fruits, twigs, bark, dead branches, and fungi. Recording the host data is important in helping to identify these insects. Sweep and beat vegetation. Sift humus, bark, and leaf mold, or process samples using a Berlese funnel. Collect thrips with a moistened brush.

Short-term Storage

Collect in 70% ethanol.

Long-term Preservation

Mount in balsam on microscope slides.



Thrips, order Thysanoptera

NEUROPTERA: the lacewings, antlions, dobsonflies, and alderflies

The lacewings, antlions, dobsonflies, and alderflies belong to this order. The wings of the adult neuropteran are distinguishable from the wings of the other orders because front and rear wings are similar in size and the netlike composition of veins characterizes the two pairs of wings. The wingspan of some of these insects can be as great as 160 mm. The young of this order are entirely unlike the adults and are grublike, often with massive, menacing jaws.

How to Collect

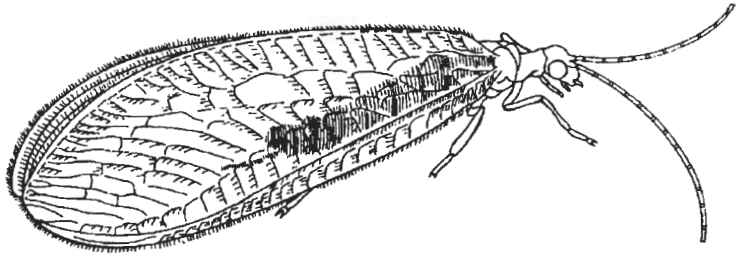
For dobsonflies and alderflies, sweep and beat vegetation near streams, lakes, or ponds. These insects are also attracted to light. Be careful when handling the dobsonfly because it can inflict a sharp bite. Well known to fishermen, dobsonfly larvae (helgrammites) are often used as fish bait. To collect lacewings, sweep and beat vegetation. Some insects in this order are attracted to ultraviolet light.

Short-term Storage

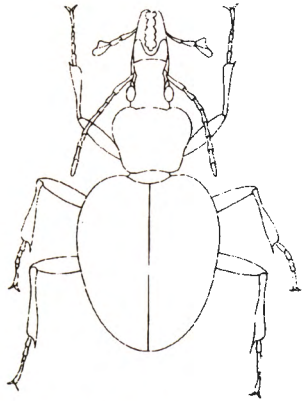
Collect both larvae and adults in 70% ethanol.

Long-term Preservation

Preserve permanently in 70% ethanol.



Lacewing, order Neuroptera

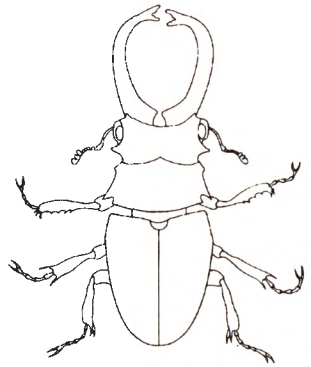


Ground Beetle, order Coleoptera

COLEOPTERA: the beetles

Commonly known as beetles, the order Coleoptera is comprised of more species than any other order in the animal kingdom. Beetles are extremely diverse, occupying almost every type of terrestrial and aquatic habitat.

Beetles have two pairs of wings. The outer or front wings, called the elytra, are leathery or shell-like and hide the inner, more fragile hind wings when the insect is at rest. Adult beetles range in size from 0.25 mm to 150 mm long. Beetles have chewing mouth parts.



Stag Beetle, order Coleoptera

How to Collect

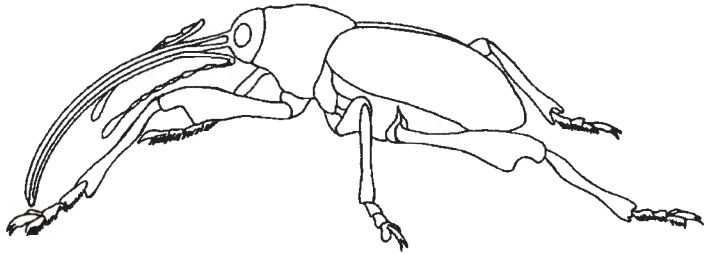
Because beetles can be found in almost every type of habitat, they can be collected by many methods. Look for beetles beneath stones, rotten logs, loose bark, boards, and other cover. Search through mold, mosses, lichens, fungi, flowers, vegetables, plant stems, decaying animals and plants, dung, and soil. Bait traps, light traps, and aquatic nets also work well.

Short-term Storage

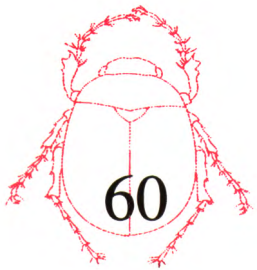
Terrestrial specimens that cannot be pinned in the field should be placed in an airtight container lined with absorbent paper. They can be kept in the refrigerator for about one week—longer in the freezer—without becoming moldy. Soft-bodied aquatic specimens should be placed directly into 70% ethanol.

Long-term Preservation

Pin larger terrestrial beetles and point smaller specimens. Keep soft-bodied aquatics in 70% ethanol.



Weevil, order Coleoptera



Strepsiptera

This group is not very well known and is considered by some to be a part of the order Coleoptera. The elytra of parasitic Strepsiptera are much shorter than elytra found in beetles. Male Strepsiptera are black, have fanlike wings, and fanlike or comblike antennae with 4-7 segments. As adults, males do not feed, but exist only to mate. The adult females are larvalike and are parasites of bees, wasps, and leafhoppers.

How to Collect

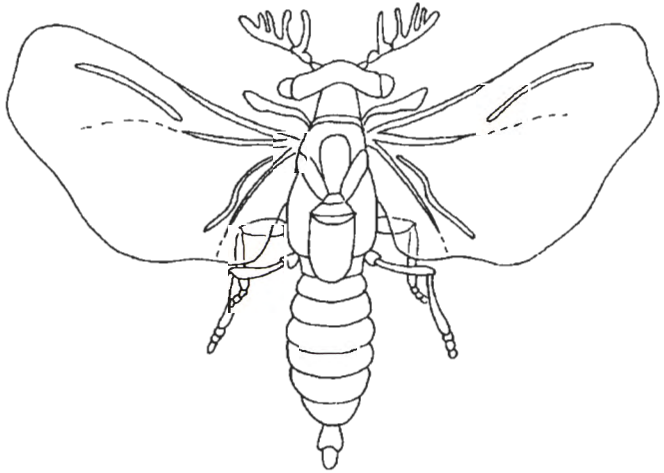
Keep a host alive until the males have emerged. Dissect a host to obtain the female Strepsiptera. Insects that have been parasitized by Strepsiptera often have misshapen or distorted abdomens.

Short-term Storage

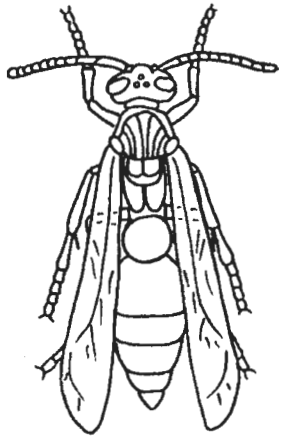
Place directly into 70% ethanol.

Long-term Preservation

Store permanently in 70% ethanol.



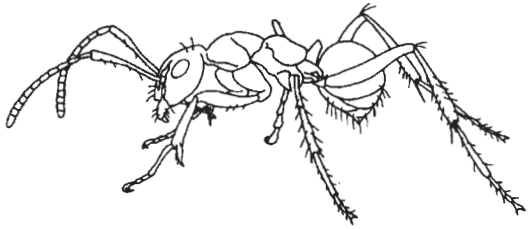
Strepsipteran, order Strepsiptera



Wasp, order Hymenoptera

HYMENOPTERA: the bees, wasps, parasitic wasps, ants, and sawflies

This very large order includes bees, wasps, parasitic wasps, ants, and sawflies. Typically, the Hymenoptera have two pairs of wings, antennae of various lengths, and chewing mouth parts. Many of the adult members of this group lack wings; these include all the ants, which are without wings except for the sexual forms produced at the time of nuptial flights. The wings, when developed, have few veins and no scales; the hind wings differ in shape and size from the front wings.



Ant, order Hymenoptera

How to Collect

To collect bees and wasps, search hot, dry habitats and flowers. Collect by sweeping or carefully hand-capturing. To locate the parasitic wasps, search moist environments. Sweep for the flying insects over shrubs, leaves, and grasses, while they visit flowers, and around tree trunks. The sawflies are active during sunny days. They emerge during middle and late spring. Search through marshes, shrubby areas, young forest stands, and tree farms. Collecting techniques for the very small Hymenoptera include sweeping vegetation, aspirating, using a malaise trap, and using a Berlese funnel to separate them from vegetation. To collect ants from nests, use an aspirator, or separate from soil and litter using a Berlese funnel.

Short-term Storage

Larger bees, wasps, and sawflies should be pinned in the field or stored on absorbent tissue in a box. Temporarily store smaller specimens on absorbent tissue. Ants can be placed on the absorbent tissue or collected directly into 70% ethanol.

Long-term Preservation

The bees and wasps should be pinned or pointed. Very small specimens can be pointed or mounted in balsam on microscope slides. Ants can be pointed or stored in 70% ethanol.

TRICHOPTERA: the caddisflies

The caddisflies have two pairs of wings, poorly developed chewing mouth parts, and long antennae. At rest, the wings are held rooflike over the body. Their wings have only a few longitudinal veins that are not connected by crossveins and do not form a network. Neither the body nor the wings are covered with scales. The larvae live in streams, ponds, and lakes. Many build cases of sticks, stones, or sand and move about with only the front end of the body protruding from the case. When disturbed, the larvae withdraw completely into the cases and are very difficult to detect.

How to Collect

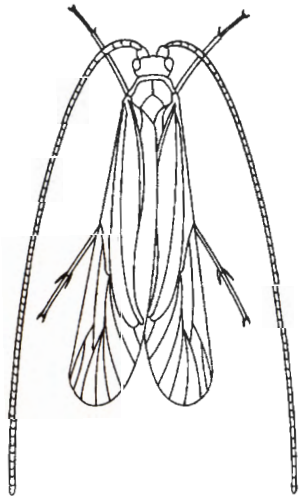
Larval Trichoptera are aquatic insects, so search for them in lakes, streams, and rivers. Capture the flying adults with an aerial net. At night, adults are strongly attracted to lights.

Short-term Storage

Collect both the larvae and the adults in 70% ethanol.

Long-term Preservation

Preserve permanently in ethanol.



Caddisfly, order Trichoptera

LEPIDOPTERA: the moths and butterflies

Moths and butterflies generally have two pairs of wings, moderately long antennae, and mouth parts that form a long sucking tube. The immatures are known as caterpillars. Wingless adult forms exist, and they can be identified as lepidopterans by the large number of scales on their body. The habits of Lepidoptera are diverse. Most larvae are leaf eaters, but some bore into trunks of trees and stems of plants. Some of the smallest species live and feed between the upper and lower surfaces of leaves and are called leafminers. Others live in the ground, where they eat roots; and a few are aquatic, living in clear, rapidly flowing streams.

How to Collect

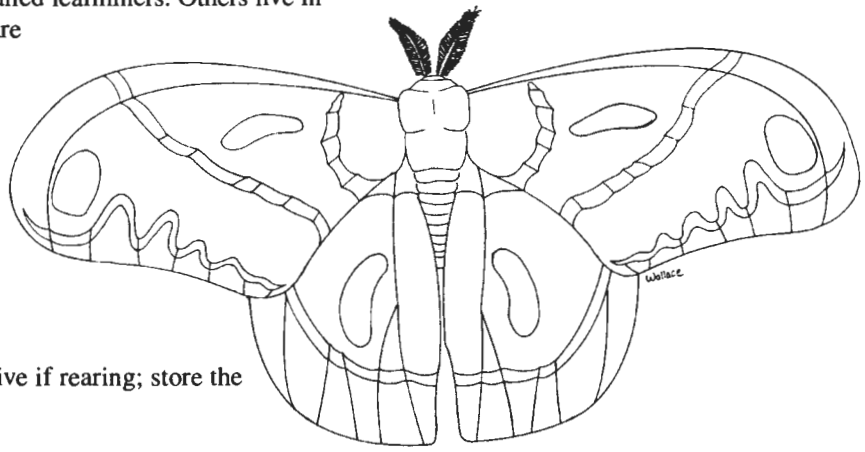
Capture adults with aerial nets. Handpick larvae from vegetation. The larvae can be reared into adults. Many moths are attracted to lights at night.

Short-term Storage

Collect the larvae in 70% ethanol or keep alive if rearing; store the adults temporarily in absorbent tissue.

Long-term Preservation

Store larvae in 70% ethanol. Pin and spread adults.



Moth, order Lepidoptera

MECOPTERA: the scorpionflies

Scorpionflies have two similar pairs of delicate wings, each with a medium network of veins. At rest, the wings are laid almost flat over the back. The mouth parts are fitted for chewing and generally are lengthened into a beaklike structure. In certain genera, the adult male's genitalia form a bulblike structure at the end of the body that resembles a scorpion's stinger, but is harmless. Larvae develop in damp woods and are difficult to locate. Adults are active in early summer and can be seen flying through the undergrowth of shaded woods. Some of the wingless forms can be found in the winter on snow.

How to Collect

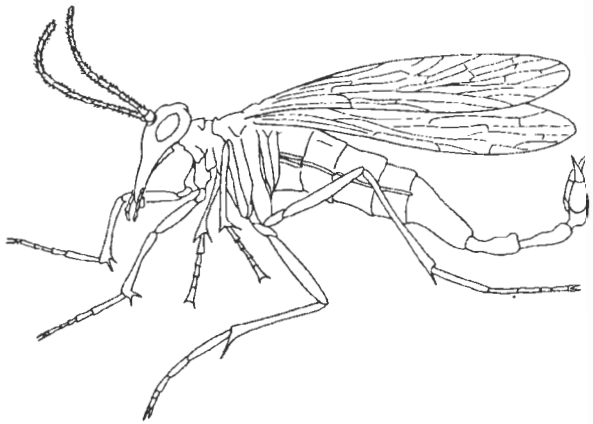
Net the flying adults. Malaise traps can be set up to capture these insects. Larvae can sometimes be extracted from the soil using a Berlese funnel.

Short-term Storage

Adult specimens can be preserved directly into 70% ethanol or placed on an absorbent tissue. Larvae should be put in ethanol.

Long-term Preservation

Store adult specimens on pins or points. Preserve them in 70% ethanol. Larvae should remain in ethanol.



Scorpionfly, order Mecoptera

DIPTERA: the mosquitoes, punkies, black flies, horse flies, and house flies

Mosquitoes, punkies, black flies, horse flies, and house flies are well-known members of this group. The presence of only one pair of wings with a limited number of veins distinguishes this group from other orders. Other characters, such as mouth parts and antennae, can be extremely variable. Search through flowers, shrubs, leaves, bases of grass clumps, tree trunk holes, leaf litter, and dead animal and plant material. Most immature stages are maggotlike and nearly always live in some protected situation, such as within the tissues of a plant, in water, in leaf mold, or in the tissues of animals.

How to Collect

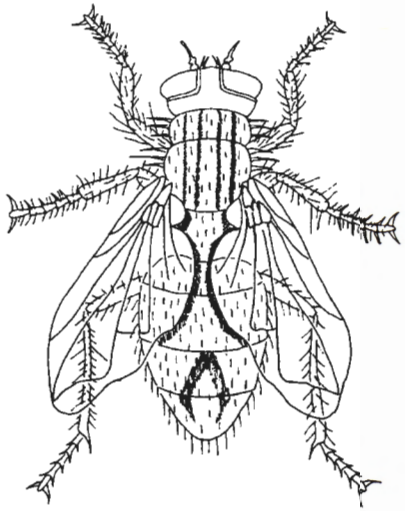
Diptera may be collected using a number of methods, including sweeping with aquatic or aerial nets, aspirating them from vegetation, attracting them with artificial light (especially porch lights), and capturing them with malaise and pan traps.

Short-term Storage

Specimens to be pinned or pointed should be stored in absorbent tissue in a box. Keep aquatic specimens or larvae in 70% ethanol.

Long-term Preservation

Pin or point terrestrial specimens. Keep aquatic and terrestrial larvae in ethanol. Tiny flies or dissected parts such as genitalia can be mounted in balsam on microscope slides.



House Fly, order Diptera

SIPHONAPTERA: the fleas

Fleas are wingless insects that are greatly flattened sideways. They have stout spiny legs, numerous spines covering the body, inconspicuous antennae, and sucking mouth parts, which they use to feed on the blood of birds and mammals. They range in color from yellowish brown to almost black. Fleas are powerful jumpers. The young stages are slender, white, and wormlike. They live in the nests of various animals (also in wool carpeting) and are seldom collected. Adult fleas are found on their host animals or around their nests.

How to Collect

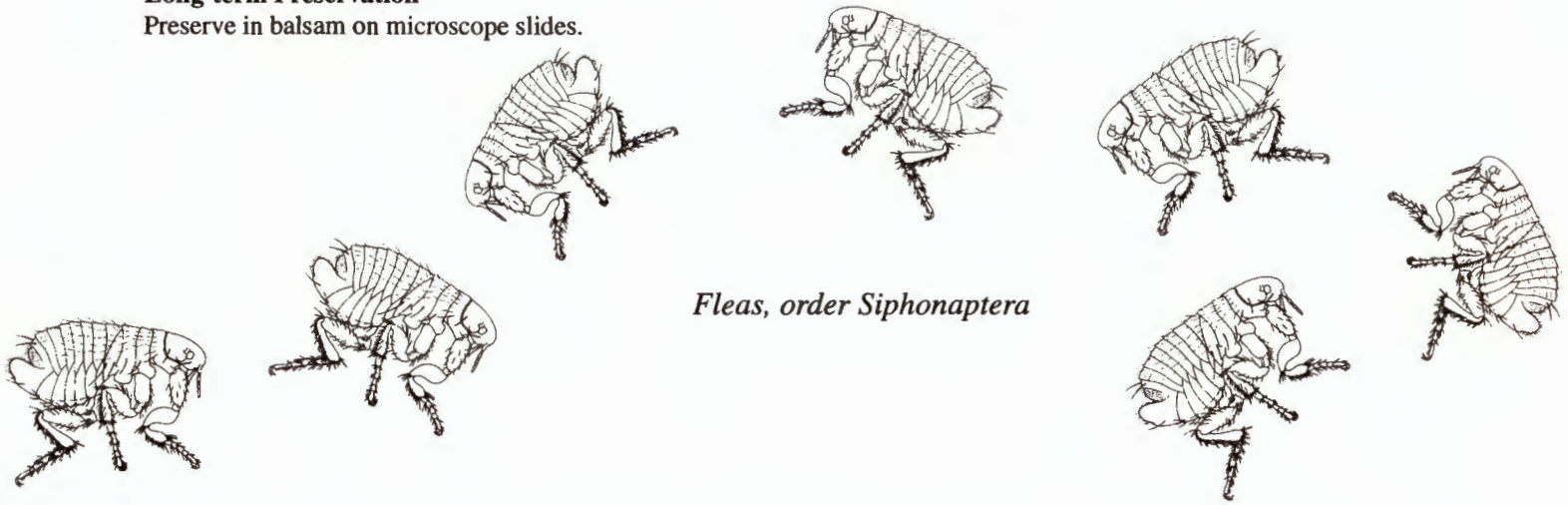
Fleas are ectoparasites of mammals (they live on the outer surface). Carefully search both living and newly dead birds and mammals and use an aspirator or small jar to trap fleas.

Short-term Storage

Place freshly collected specimens in ethanol.

Long-term Preservation

Preserve in balsam on microscope slides.



Fleas, order Siphonaptera

IDENTIFYING SPECIMENS

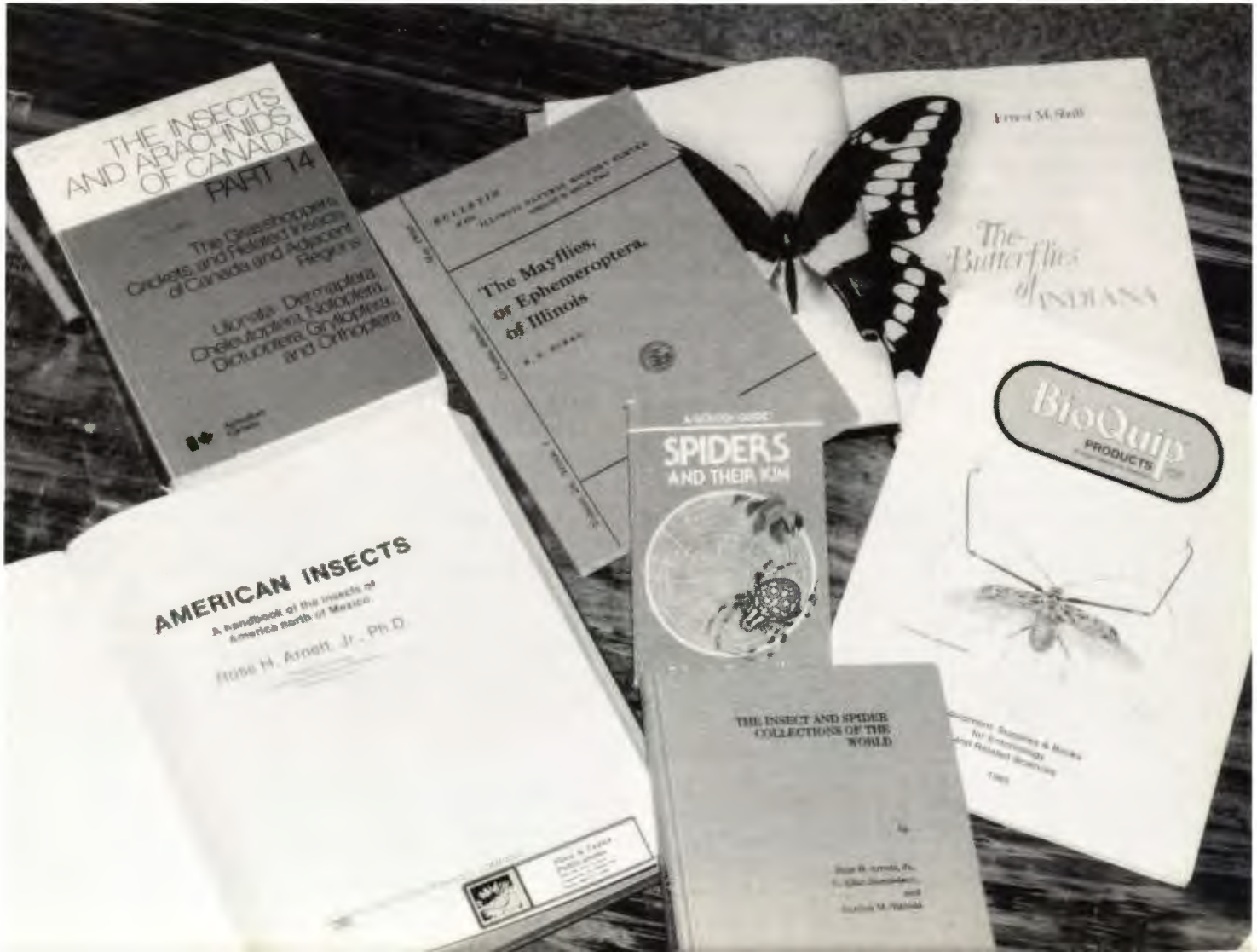
Identifying insects to species level can be very difficult. Begin by using basic keys or prior experience to identify the order to which an unknown specimen belongs. (A key is an arrangement of information that requires the user to choose between two alternative characters. Each alternative is associated with another pair of characters. The user proceeds until the organism is identified.) Then use a general guide to insect identification to determine the family represented by the unknown specimen. Even this level of identification can be difficult for some insects, especially those that are very small. Beginning collectors show good judgment by not attempting a more precise identification than they are able to accurately accomplish. Only the most common and well-known insects can be identified to the species level using general guides for insect identification.

Where species identification is absolutely necessary, specimens should be sent to specialists or entomological museums for determination. The arrangements under which specialists will undertake the work vary, but experts often will study well-preserved and labeled collections in return for duplicate specimens. After an identification has been completed (at the order, family, or species level), label the specimen with the appropriate scientific name.

ILLINOIS NATURAL HISTORY SURVEY INSECT COLLECTION

The insect collection at the Illinois Natural History Survey contains over six million curated specimens and is one of the largest insect collections in North America. All insect orders, plus numerous related noninsect groups, are represented in the collection. Outstanding holdings occur in many orders. Because of its size, its historical holdings, and its wide breadth of coverage of certain groups, the insect collection is an important national and worldwide resource.

So large is the field of insect classification that many gaps exist in our collections and in our knowledge of insects. Gifts of well-prepared specimens to the INHS collection are greatly appreciated. Many such gifts have filled important gaps in the collection and added valuable information about the distribution of species.


THE INSECTS AND ARACHNIDS OF CANADA
PART 14
The Grasshoppers, Crickets, and Related Insects of Canada and Adjacent Regions
The Mayflies, or Ephemeroptera, of Illinois
AMERICAN INSECTS
A handbook of the insects of America north of Mexico
Ross H. Arnett, Jr., Ph.D.
SPIDERS
AND THEIR KIN
THE INSECT AND SPIDER COLLECTIONS OF THE WORLD
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BIOLOGICAL AND ENTOMOLOGICAL SUPPLY COMPANIES

All of the equipment mentioned in this publication can be purchased from one of the suppliers listed below. Please note that this list is by no means complete and that it is not intended to be an endorsement of any of these suppliers.

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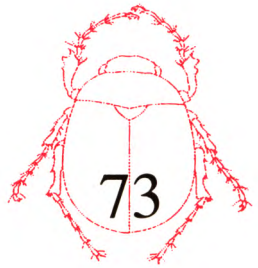

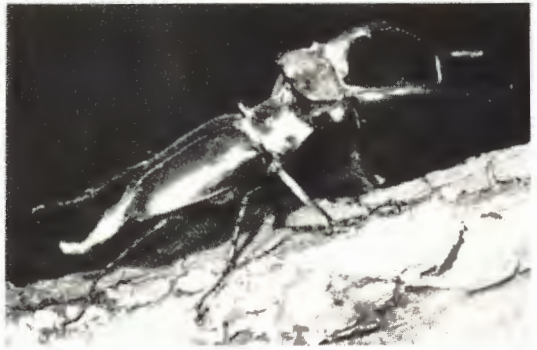

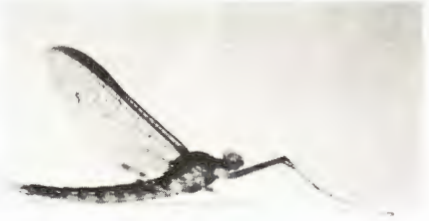

ILLINOIS NATURAL HISTORY SURVEY PUBLICATIONS

The Illinois Natural History Survey produces a number of publications about the state's biological organisms and systems. A few of the publications in which readers of this book might be interested are listed on the right.

If you would like to obtain our free publications catalog, please contact us at:

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413	The dunesland heritage of Illinois.	H.H. Ross	$3.00
430	Pleasure with plants.	L.R. Tehon	$3.00
462	Field guide to freshwater mussels of the Midwest.	K.S. Cummings C.A. Mayer	$15.00
467	Wetland wonders.	M.R. Jeffords A.S. Hodgins S.P. Havera	$7.00
468	Biodiversity in Illinois: activities for young people.	M.R. Jeffords	$3.00
473	Legacy of a pest: teachers guide for activities dealing with biological problems.	L.J. Case J.L. Wissmann M.R. Jeffords	$5.00
482	Illinois' living alphabet. (contains coloring poster and workbook)	M.R. Jeffords	$.50
483	The INHS poster pack. (contains 6 posters to color)	M.R. Jeffords	$.25 per pack
484	Biodiversity in Illinois (coloring poster)	M.R. Jeffords	$.25 per poster
485	The fishes of Illinois.	P.W. Smith	$35.00

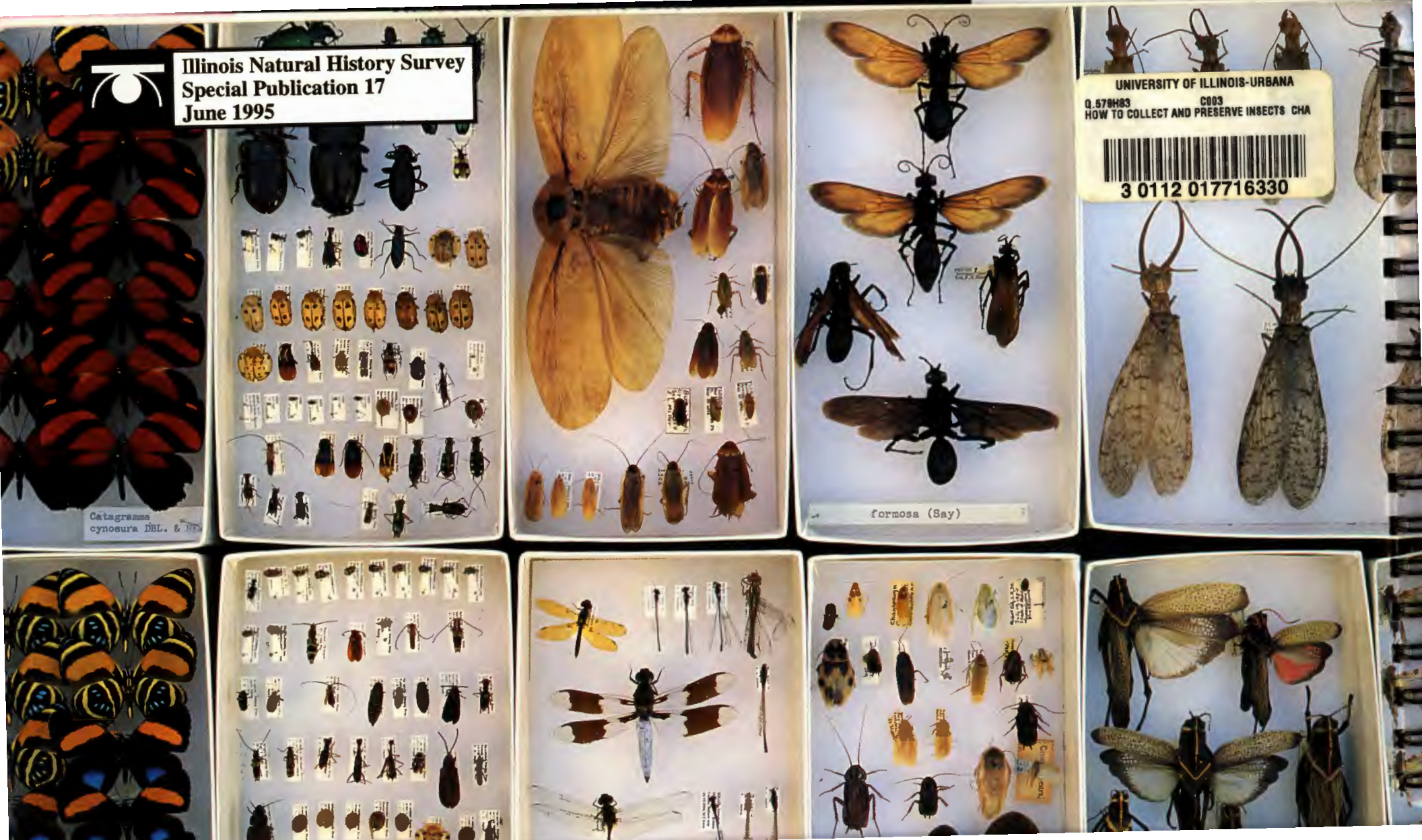
ABOUT THE AUTHORS

Kathleen Reid Methven is the Insect Collection Manager in the Center for Biodiversity at the Illinois Natural History Survey. Her primary responsibilities include the care and upkeep of the 6 million insects and related arthropods in the collection. The insect collection is often described as a "library of insects," where the insects are frequently loaned to other scientific institutions and fellow researchers around the world. Kathy is responsible for managing these loans, data requests, spider identifications, computer databasing, tours, and anything and everything else that might pertain to the collection. Her other research interests include the natural history of spiders; their morphology, life history, and behavior. Prior to working at the Survey, she managed the Arachnology Laboratory at the University of Tennessee, where she was involved with many different research projects including using spiders as biological models for game theory research and as biological control agents of insects in small agricultural ecosystems. She received her bachelor's degree in zoology from the University of Tennessee-Knoxville in 1982.

Michael Jeffords began collecting insects at age 10 and has made a career of studying them. After graduation, with an M.S. and Ph.D. in entomology from the University of Illinois, Dr. Jeffords accepted a position at the Illinois Natural History Survey in Champaign. He currently is a professional scientist at the Survey, an associate professor of entomology in the UI College of Agriculture, and the public relations and education liaison for the Survey. He has written numerous scientific publications and has been photographing and writing about the Illinois landscape for nearly 20 years.

Richard Weinzierl is an Associate Professor and Extension Specialist in Agricultural Entomology at the University of Illinois and an Associate Professional Scientist in the Center for Economic Entomology at the Illinois Natural History Survey. Dr. Weinzierl completed a B.A. degree in biology at Concordia College in Moorhead, Minnesota, in 1975, an M.S. in entomology at North Dakota State University in 1979, and a Ph.D. in entomology at Oregon State University in 1984. His work at the University of Illinois and the Illinois Natural History Survey includes teaching, research, and extension programs in general entomology and insect pest management. He presents educational programs to children and to farmers, teaches a graduate course in insect pest management, and conducts research on alternatives to conventional insecticides for the control of insect pests of fruits, vegetables, and livestock.

Kathryn C. McGiffen began collecting insects when she was eight years old, but it was not until much later that she decided to make entomology her career. She attended the University of Connecticut, where she received her degree in education, then taught both primary and junior high school. After teaching, she decided to go back to school. Kathy then attended North Carolina State University, where she received her master's degree in entomology. While at NC State, she worked as a biology instructor and as a survey entomologist. Her primary interest was immature Lepidoptera. After moving to Illinois, Kathy accepted a position as Insect Collection Manager at the Illinois Natural History Survey. Presently, she is working as a research assistant in biological control at the University of California-Riverside.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