HOW TO MAKE AN INSECT COLLECTION

Published by

Ward's Natural Science Establishment, Inc.

Rochester New York

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Containing suggestions and hints designed to aid the beginning and less advanced collector. This booklet is based on the experience and methods developed during years of collecting insects by members of Ward's Entomological staff.

Published in the Service of Entomology by

Ward's Natural Science Establishment, Inc.

P. O. Box Beechwood Station

Rochester 9 New York

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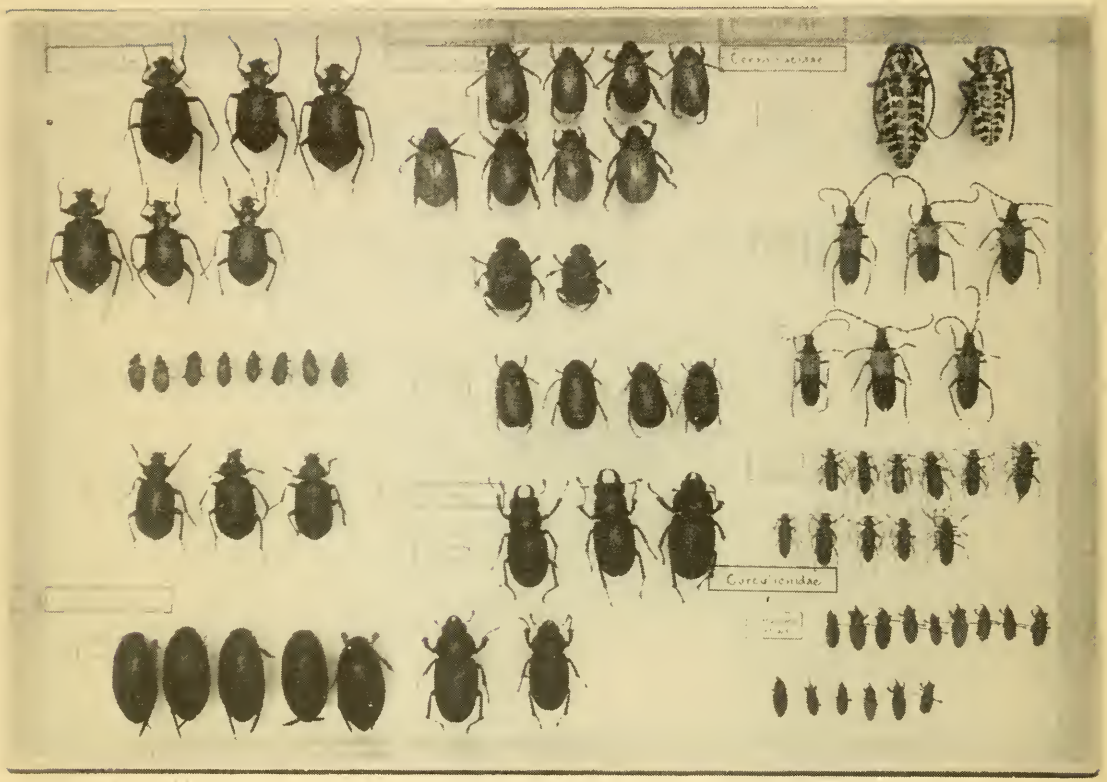


Fig. 1. A scientific collection of insects.

NOTE: This booklet is designed to replace *Directions for Collecting and Preserving Insects* by Dr. A. B. Klots which is now out of print. The current publication is a co-operative affair written by members of Ward's own staff. The preliminary work was done by Mr. Richard L. Post before he left Ward's to resume his graduate studies at Oregon State College. It is intended primarily to give instruction in entomological technique and methods to the less experienced collector. We do not desire to be dogmatic in our presentation and our readers are urged to remember these are suggested methods only since each individual will develop his own special variations and technique as he becomes more experienced.

Why Collect Insects?

If a hostile race of men attacked this country every year, doing damage to nullify the labor of a million workers, if they injured and destroyed our crops, infected us and our domestic animals with fatal diseases and even attacked our homes, extraordinary measures would be taken to ward off these attacks. Yet this is what insects do to us, often without our realizing the extent of their depredations.

It is true that the harm done by some insects is somewhat offset by the good other insects do in supplying man with products he can use, by pollenizing flowers and by helping to keep in check man's insect foes, but this is not sufficient to over-balance the harm done. About 75% of all known living species of animals are insects, in fact about 650,000 different species have been described. In view of the size and importance of this group and the incalculable

Fig. 2. Equipment needed for collecting insects.

losses incurred from its depredations, it would seem imperative to know as much as possible about them. The first step in this direction would be to form a collection, at the same time attempting to learn as much as possible about the immature stages and the insects themselves.

A job worth doing at all is worth doing well, and a scientific collection of insects cannot be obtained unless certain fundamental methods are followed. We have prepared these instructions so that any person without previous experience can start this most fascinating and instructive of occupations.

Supplies and Equipment Needed

One cannot take pictures without film and camera nor can he collect and prepare insects without a few necessary items of equipment (Fig. 2). These can be homemade but the average person will find it more satisfactory to purchase them. They need not be expensive, in fact, it costs surprisingly little to do really creditable work.

Essential Items. The following are the essential items you will need:

1. Collecting net light in weight but of strong, durable construction with a bag of good quality, lock-stitch netting.

2. Killing jar with cyanide, properly made for maximum efficiency and safety. The 16-ounce size is probably best for most types of specimens.

3. Insect pins of double japanned steel wire with especially sharp points and heads that will not come off. Sizes 1, 2 and 3 are most widely used.

4. A spreading board with adjustable groove can be used with a wide variety of specimens. Spreading boards should be carefully constructed to work with ease and a minimum of difficulty.

5. Insect storage boxes constructed to be as air tight and pest-proof as possible will give adequate protection for a carefully made insect collection.

6. A permanent field note book of a size that may be conveniently carried in the pocket or collecting bag is essential for the noting of necessary collecting data.

7. A camel's hair brush will be found useful when handling minute specimens.

8. A few small jars and vials containing 75% alcohol are necessary for preserving many types of insects.

9. A supply of folded paper triangles, glazed paper or cellophane envelopes should be carried to use when collecting butterflies or large specimens that will later be pinned.

10. A well made forceps with slender points and a length of 4" or 5" will be very useful for handling some of the specimens you will collect.

Accessory Items. A few additional items are desirable if really serious work is to be done or when the beginner is collecting several orders of insects.

1. Two extra cyanide killing jars. A small 4-ounce jar for small delicate insects and a large quart jar to be used exclusively for butterflies and moths.

2. An unbreakable celluloid killing tube with cork.

3. Sweeping or Beating net.

4. Metal box with layers of cellucotton for storing insects until they can be relaxed and mounted.

Where to Look for Insects

Insects can be found almost "everywhere," in fact it is hard to find a place where they cannot be collected. The beginning collector will not see as many insects as one who is more advanced, but as he progresses he will be able to find them in some stage of their development at all times almost everywhere. He will see them in the grasses of fields and meadows; in woods, under leaves and in the soil of the forest floor; in flowers, in rotten wood, under bark; beneath stones or boards, in slow and swift streams or in lakes and ponds and at lights. Insect hunting is one sport from which the collector always returns with game. Definite instructions as to where to collect insects are futile and we can only say "seek and ye shall find."

Land Collecting

The Aerial Insect Net. The most essential item of insect collecting equipment is the net. An aerial net should be designed to give the maximum strength, rigidity and durability without sacrificing the light weight so important to the collector. The necessary parts of an insect net (a) are the handle (b), a ferrule (c) for attaching (d) the hook or ring, and a bag (e) hung from the ring. See Fig. 3.

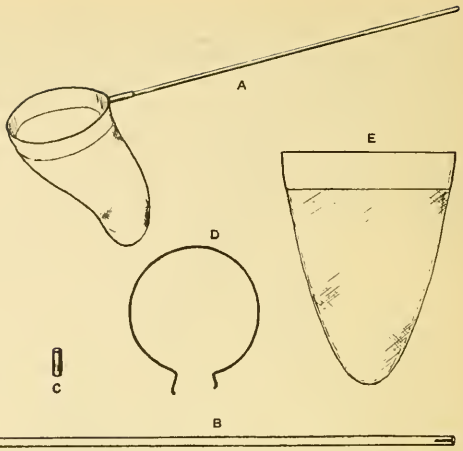


Fig. 3. Parts of an insect net. A. The assembled net. B. The handle. C. The ferrule. D. The ring. E. The bag.

Flowers, herbs, and boughs should be swept with a sidewise motion, giving the net a half turn on the back stroke so that the vegetation always passes across the face of the open bag (See Fig 4). This will get more insects than an upward or downward sweep and at the same time will do less damage to the plant. If care is taken the same patch of flowers or plants may be visited several times.

Do not chase insects on the wing as they will become alarmed and not return. If a flower visiting kind is disturbed and flies away, wait patiently with net ready for a few minutes and it will likely return. Sweeping can be done with the ordinary aerial net but it is better to use a more sturdily constructed one having a scrim bag with a canvas top. A very useful net for sweeping is shown in Fig. 5.

The Sweeping Net. Sweeping is by far the most productive method of collecting insects as far as numbers are concerned. By sweeping the net over vegetation (in sweeping the net is used like a broom), especially when the latter is in flower or fruit, one can secure many specimens that can be obtained in no other way.

When sweeping, only a few strokes should be made before emptying the net as otherwise many specimens will be damaged by shaking them about with the débris. When one stops swinging the net the end of the bag containing the mass of débris should be swung over the outside of the ring (See Fig. 11a), effectively locking the insects in and preventing their escape.

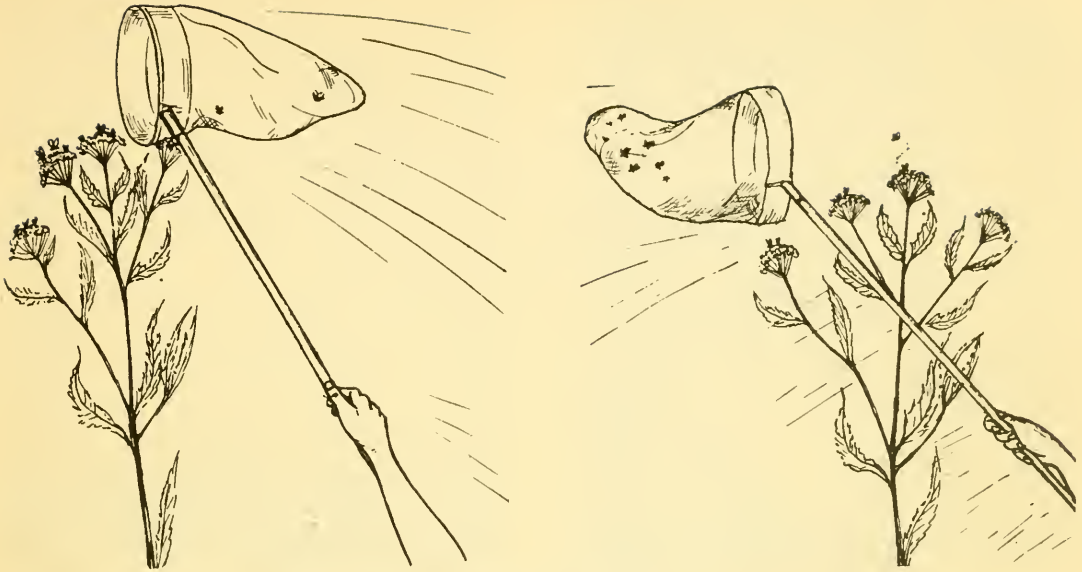


Fig. 4. A. Sweeping across flowers.

Fig. 4. B. Sweeping in grass and low vegetation.

Some insects fly up into the end of the net when captured, others drop down and try to escape by crawling under the edge of the net ring. With experience the collector will soon learn what to expect of the captured insects. (See Fig. 11 illustrating removal of insects from the net.)

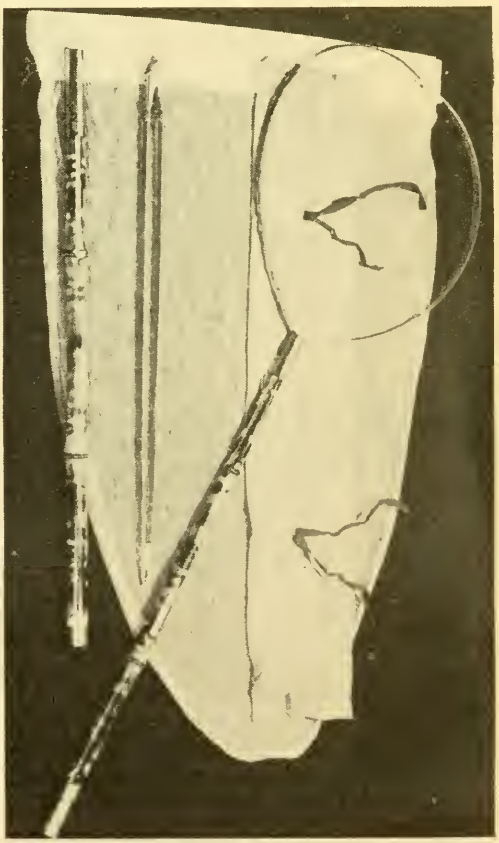


Fig. 5. Sweeping net.

The Care of Nets. All insect nets are easily ripped and should be kept away from barbed wire and thorny trees. Keep the nets dry; moisture rots the fabric making it more easily torn and in addition ruins all insects caught in the net when it is wet.

Other types of collecting equipment such as beating nets, aspirators, traps, etc., are described later in this manual.

Aquatic Collecting

The early stages of many groups of insects as well as adults of others live in the water. Special collecting equipment and different methods must be employed for collecting these forms. The beginning collector should devote as much attention to water insects as he does to land collecting.

Fig. 6. Aquatic net.

The Aquatic Net. Water insects may be collected by a heavy dip net swept thru the water at various levels and thru the mud and débris at the bottom. The frame must be strong to withstand this severe use and one of coppered steel spring wire $\frac{1}{4}$″ in diameter has proven most effective. The diameter of the net ring should be 10 or 12 inches. It is preferable that the end of the handle and ferrule should be made of brass so that no water can reach the wood and thus cause binding and swelling. The rigid frame is easily removed by pushing back the ferrule. (Fig. 6.)

The bag should be made from extra heavy scrim with a canvas top. Grommets or slits should be placed on the canvas rim so that the water will drain quickly from the top portion when the net is removed from the water.

The net bag need not be deep, as aquatic insects are usually quite helpless out of their natural environment. A broadly rounded net bag 18″ deep is the proper depth for a frame 12″ in diameter. All aquatic insects can be picked up with forceps and dropped into the vials or jars of 75% alcohol. If you use your fingers to pick out aquatic insects be sure to watch out for species which bite. Data labels written in pencil should always be placed in each vial.

All-Purpose Net. For collectors who will wish to look for specimens in a variety of habitats, an all-purpose net such as that illustrated here (Fig. 7) will be ideal. It may be obtained with a selection of three bags having zippers for easy removal and quick changing. These are aerial, sweeping and aquatic respectively. The handle is tapered so that the weight is more adequately distributed and balanced, furthermore, the tapered handle prevents binding when used in aquatic collecting and the ferrule is easily adjusted at all times.

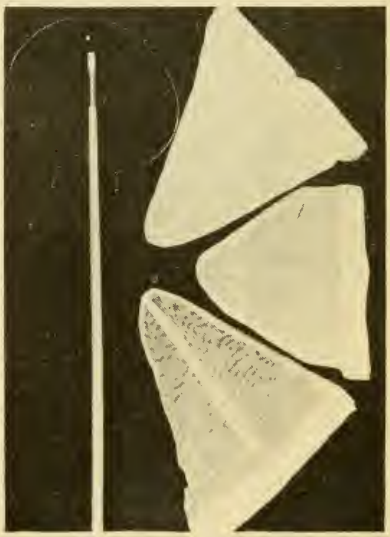


Fig. 7. All purpose net.

Scraper Net. The scraper net is the most practical piece of equipment ever devised for digging and scraping the bottom of ponds and streams. Material can be dragged up and piled on the bank where the collector merely waits for the specimens to disentangle themselves and then be captured as they crawl away. The Scraper Net illustrated here (Fig. 8) was designed by Dr. J. G. Needham. It is built to withstand the toughest kinds of usage with a frame and reinforcement of heavy galvanized iron and the sides and bottom of $\frac{1}{8}''$ mesh galvanized wire screening. The ferrule is provided with a thumb screw so that any size handle may be used.

Fig. 8. Scraper net.

Apron Net. The Apron Net (Fig. 9), also designed by Dr. Needham, is especially constructed for collecting in water weeds. It is covered with a coarse-mesh top which keeps out débris and aquatic plants but allows aquatic insects to enter. The back portion of the top is hinged and covered with a finer meshed screen to prevent escape of insects as the net is pushed thru the water. The pointed nose permits pushing the net thru dense growth of aquatic plants. The cover is easily flipped back and the captured insects can be selected with forceps or fingers and dropped into 75% alcohol.

Seine. A seine made of fine strong wire netting and fastened along its edges to two wooden handles is a light useful piece of collecting apparatus. A good seine may be made from the adjustable window screens that may be purchased at any hardware or ten-cent store. Pull the two halves of the screen apart, knock off the wooden strip forming the side, leaving the two short strips at the ends to serve as handles

Fig. 9. Apron net.

for your seine. In collecting insects from fast flowing streams the seine is held against the current with the top slanting down stream and its bottom tight to the floor of the stream. If stones are lifted or disturbed or the bottom violently dug up by an assistant, insects will be carried by the current directly into the seine where the specimens may be picked off.

Tangles and Hooks. By using a handle with a hook on the end or a piece of barbed wire one can pull out dense masses of Chara and other weeds from ponds and ditches. An ordinary potato hook is excellent for this purpose. After pulling the aquatic plants to the shore, spread them out on the bank and many water insects can be collected as they crawl out.

Where to Look for Aquatic Insects. In shallow water, stones and logs should be turned over and leaf tufts pulled apart.

Searching beneath boards and other cover near the margins of ponds and streams reveal many ground beetles and semi-aquatic forms.

Look for insects floating to shore on the windward side of a pond or lake after a warm night. Also follow the shore line of lakes and ponds and examine the débris early in the morning before the gulls and crows do their entomological collecting.

Killing Insects

The Cyanide Killing Jar. The best killing bottles are charged with potassium or sodium cyanide. These compounds give off deadly fumes sufficient to kill most insects in a short time. The cyanide jar (pint size) is made by covering a $\frac{3}{8}$" layer of cyanide in the bottom of the jar with a blotter cut to fit the inside diameter. A $\frac{1}{2}$" layer of sawdust is added and covered with another piece of stiff blotting paper. A thin layer, about $\frac{3}{16}$", of plaster of paris is poured on top and allowed to set with the cover off (See Fig. 10.) Other size jars should have these layers in proportion but smaller jars will require thinner layers.

A freshly made bottle should be allowed to set several days before using, and unless one is used to handling chemicals or poisons the killing bottle should be purchased as the making of these bottles by amateurs is very dangerous.

Important! Cyanide bottles should be labeled "Poison," kept tightly corked, and placed where children cannot reach them. To prevent breakage several layers of adhesive tape can be applied to the bottle, covering the bottom and extending an inch or two up the side. If the bottle should break, pour water over the cyanide and the poison will soon be dissipated. A cracked jar should be buried, first making sure to smash the jar with a spade before covering it with earth. Remember, both the cyanide gas and the solid are poison—don't breathe the gas and wash your hands carefully after handling the solid.

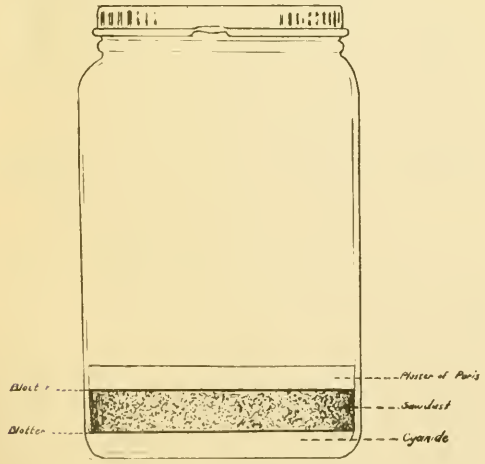


Fig. 10. Killing jar.

Use of Cyanide Killing Jar. There are, of course, many ways to remove captive insects from the net bag for transference to the killing jar. As previously recommended, when enough specimens are in the net, swing the end of the bag over the loop or ring in order to prevent their escape (See Fig. 11a). The bag may then be laid on the ground and specimens removed by slipping the hand under the rim as in Fig. 11b, or the entire catch killed at once as in 11d. Sometimes with large specimens one will want to use the method shown in Fig. 11c. Another approved method for removing insects is to hold the net in an upright position, end of the handle on the ground. Hold the net in position by crossing a leg over the handle and remove specimens by running the jar or killing tube into the net bag. (See Fig. 13 for the proper method of using a killing tube.)

The specimens should not be left in the killing bottle longer than 3 to 8 hours because insects become brittle and some colors fade after exposure to the fumes for a greater length of time. Thirty minutes exposure to cyanide will kill all but the toughest forms. Snout beetles require several hours.

It is necessary to keep the inside of the the bottle dry to prevent the killed specimens from becoming discolored. This may be avoided by shredding some paper toweling or filter paper and placing a few pieces in the killing bottle. Moisture will not only be readily absorbed but specimens will also be kept from shaking about by the toweling. It should be replaced when it has become overly moist. When collecting butterflies, moths and other delicate winged insects, place a layer of soft cotton in the bottom of the jar instead of paper toweling.

To revive an old killing bottle that has become weak, drill a hole thru the plaster with a darning needle or piece of wire and add a few drops of vinegar or other dilute acid.

Collectors of delicate moths and butterflies frequently put a few drops of ether or chloroform in their killing jars before starting out. This is done to quiet the insects at once because the cyanide fumes kill slowly.

Butterflies often batter themselves when placed in the killing jar. They may be stunned by pinching the thorax between

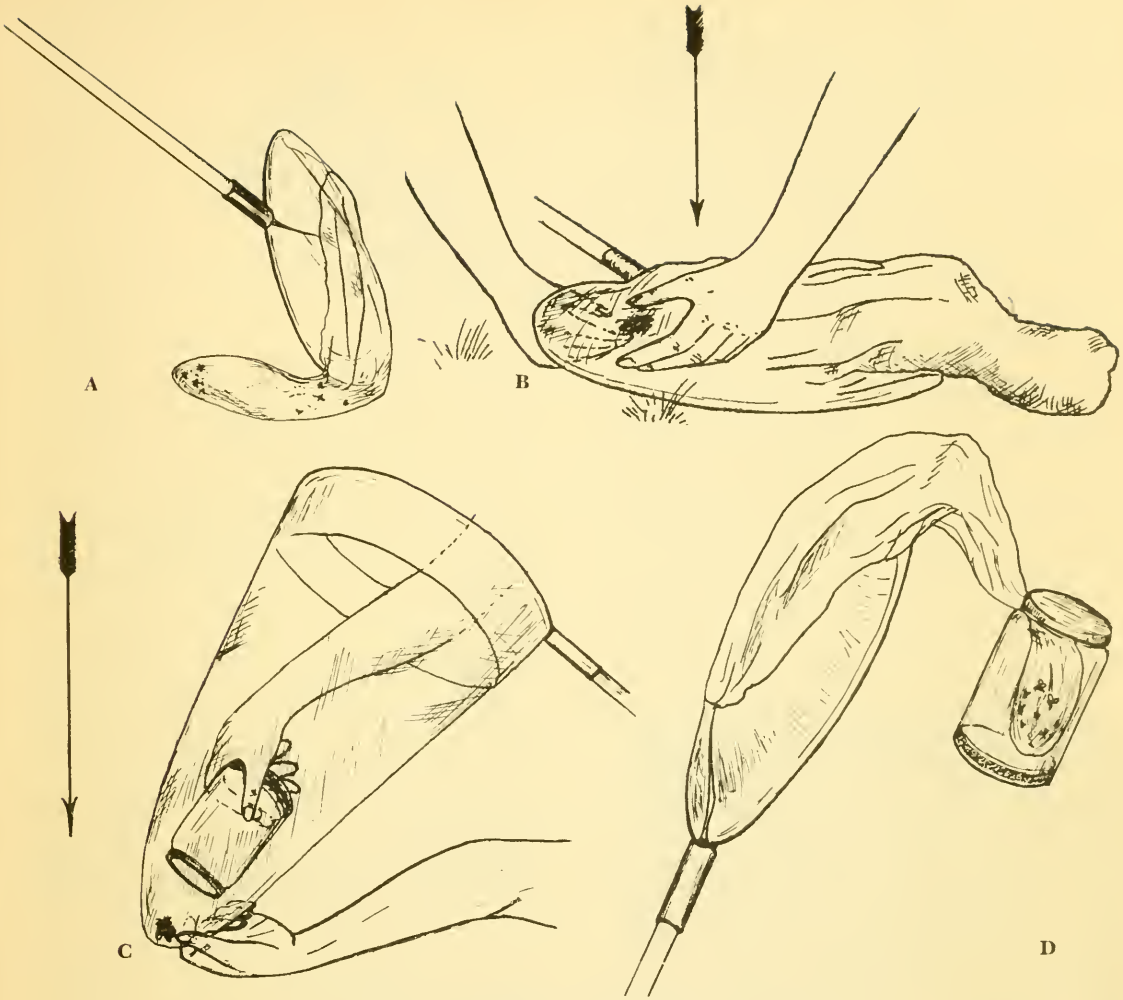


Fig. 11. A. Locking specimens in net. B, C, D. Various ways of removing specimens from net.

the thumb and forefinger before placing them in the cyanide jar (See Fig. 12).

Many butterflies when dying fold the wings below the body. These should be taken out of the killing bottle and the wings folded up over the back within a few minutes after their struggles have ceased. Otherwise, their muscles will stiffen making it hard to mount the specimens without rubbing the wings.

Anyone engaged in extensive collecting should carefully follow the rules given below:

1. *Keep small, delicate insects in a bottle by themselves.* Insects such as large beetles are apt to mutilate small flies, etc., if kept in the same bottle.

2. *Keep a special bottle for moths and butterflies.* These insects shed large quantities of scales which have a tendency to cover the bodies of other insects.

3. *Use a killing tube for small insects.* This may be made of glass, using a so-called ignition tube or an unbreakable celluloid tube. The cork can be removed and the tube held in one hand, with the thumb kept over the opening. Specimens crawling up the sides of the bag can then be captured easily. (See Fig. 13.)

4. *Keep the inside of the bottle dry.* Moisture from the insects and plaster condenses on the inside of the bottle. This will mat hair and appendages as well as discolor many specimens. Change toweling or cotton when moisture appears on the side of the jar.

5. *Remove insects as soon the they are dead.* Cyanide fumes soon turn many yellows to red or orange and also make many small specimens

brittle so that the appendages break off easily.

6. *Empty the jar of insects before too many have accumulated in a mass at the bottom.* This will prevent damage to the smaller specimens and avoid discoloration due to "sweating."

Care of Insects after Capture

Preservation in Alcohol. It frequently happens that the collector cannot attend to his catch at once and it may be even months before he is ready to mount the insects collected. If this is the case many specimens may be dropped directly into 75% alcohol. All hard-shelled insects such as *Coleoptera* (beetles), as well as *Orthoptera* (grasshoppers, cockroaches, etc.) can be placed in alcohol as soon as captured to be pinned and dried later. All soft bodied insects such as mayflies, stoneflies and all immature stages must be kept permanently in alcohol since they will shrivel when dry.

If alcohol is not available, 4% formalin may be used, but this is not recommended because it renders insects so brittle that legs and antennae are apt to break off.

Very small insects are best handled with a camels-hair brush such as is used for water colors. Moisten the brush with alcohol to make the insect adhere to it, then immerse the brush in the preserving solution where the specimen will drop off and sink to the bottom of the vial. Data should be written in soft pencil or India ink on a good rag bond paper and placed inside each container. (See Fig. 14.) (Instructions regarding data will be given later.)

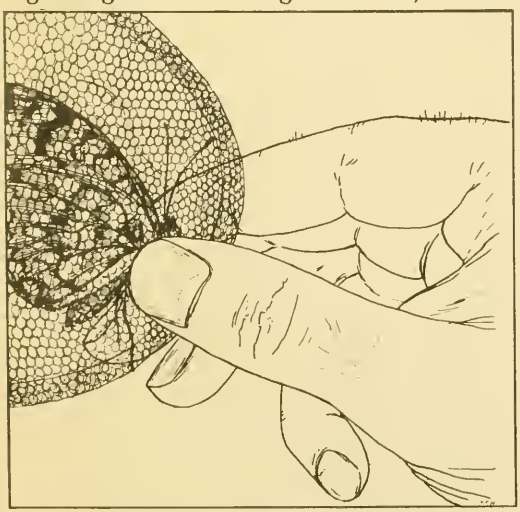


Fig. 12. Stunning a butterfly.

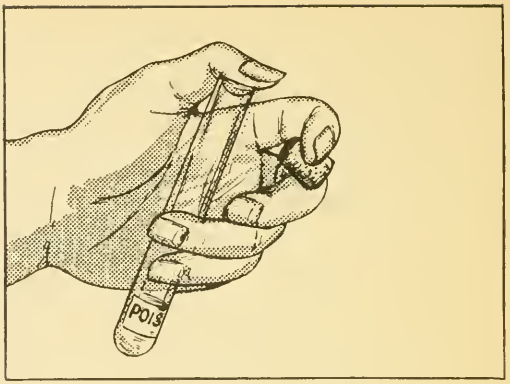


Fig. 13. Proper way to use a killing tube with small insects.

The preserving fluid in vials should be changed within a day or two from the date of capture to prevent dilution of the preservative by the body fluids, as well as discoloration of the insects from the stained preservative.

Dry Preservation. All hairy, scaly, green or fragile-winged insects should be preserved dry. Such specimens are butterflies, moths, lace wings, damsel flies, dragonflies, etc.

Fig. 14. Data label in vial.

Paper Triangles and Glazed Paper Envelopes. All larger specimens which must be preserved dry may be placed in paper triangles or glazed paper envelopes. The latter not only save time but are semi-transparent, thus making sorting and identification of the papered specimens easier.

Paper triangles may be made from any rectangular sheet of paper folded thru the successive stages diagrammed here. (See Fig. 15.) The size of the sheet used depends upon the size of the insects.

Never place more than one specimen in an envelope and always be sure to write the date and localtiy of capture on the flap of the triangle or envelope.

Packing in Boxes. In caring for smaller specimens it is often more convenient to store them between layers of cellu-cotton and place them in cigar, small cardboard or metal boxes. *Never* pack moist insects

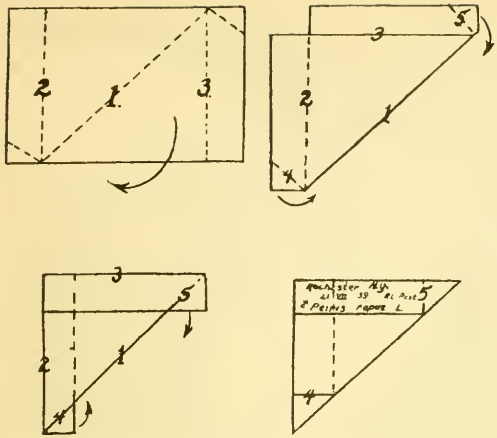


Fig. 15. Folding paper triangles.

in a tin box and never tightly close a wooden or pasteboard box until the insects are thoroughly dry. If this precaution is not taken the specimens will mold and be destroyed.

Many layers of cellu-cotton or cotton can be used with small forms, a surprisingly large number of which can be placed in a small container. A little fumigant, made of equal parts of paradichlorbenzene and naphthalene crystals can be placed on the top layer of cellu-cotton to keep out ants and museum pests. (Paradichlorbenzene and naphthalene crystals can be purchased at any drugstore or scientific supply house.) A tablespoonful of fumigant will be sufficient for a container the size of a cigar box.

Paper Tubes. Beetles and similar insects may be kept in tubes made by rolling unglazed paper around a lead pencil, or other object with a diameter larger than that of the insects after first writing the data on that part of the paper which will be on the outside of the tube. Close one end at once by folding or twisting the paper. The tube is then nearly filled with freshly killed insects and the other end closed by folding in the paper or twisting. These tubes can be packed in a cardboard or wooden box containing fumigant.

Pinning and Mounting Insect Specimens

Relaxing Specimens. Freshly killed specimens may be pinned upon returning from the field if desired, and left to dry on pinning boards. Insects preserved in alcohol are usually flexible, and can be taken from the solution and treated in the same manner as recently captured material. (Descriptions of methods for expanding *Lepidoptera* will be given later.)

Dried insect specimens may be relaxed and softened for mounting by merely keeping them in a very damp container from 12 to 24 hours. Any nearly air-tight metal or earthenware container having a layer of wet sand, sawdust, or cotton will serve as a relaxing box. However, a non-corrosive, patent relaxing box is best. (See Fig. 16.) Moisture is provided by dampening sheets of coarse paper toweling and placing layers of insects between them. It is well to place a few drops of carbolic acid on the balsa-wood bottom of this box, to prevent mold.

Papered or pinned beetles, grasshoppers and other forms that are not hairy or covered with scales may be dropped into warm water (that is, just simmering) which will relax them completely in a few moments. *Caution!* Do not leave specimens in hot water for too long a time or they will be ruined.

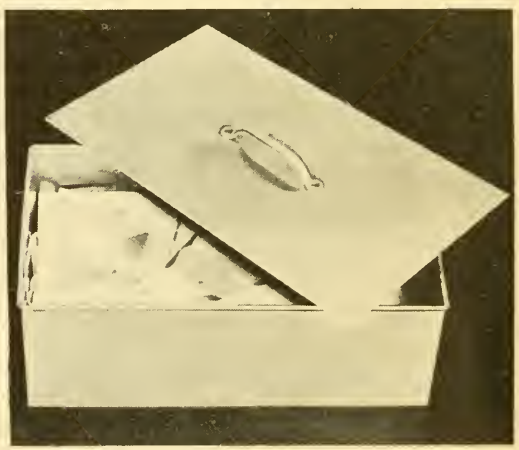


Fig. 16. Relaxing box.

Insect Pins. It is extremely desirable to use only special insect pins for specimens for they have been designed to meet the requirements of the entomologists, and makeshifts and substitutes will only cause trouble.

Insect pins are sharply pointed, slender, and usually 37 mm. long. They are made of stiff, excellent quality non-corrosive steel or are so thoroughly japanned as to be nearly rustless. The finish of the pin is smooth and polished so that it can be

pushed thru the specimen and thrust into the pinning bottoms of storage containers without grating or catching.

Pin Holder. The preparator usually wishes to keep a number of different sizes of insect pins available. A convenient means of doing this is to place them in a wood block containing a number of holes about a quarter of an inch in diameter and slightly shallower than the length of the pin. (Fig. 17.)

Fig. 17. Insect pin holder.

Size of Pin to Use. Insect pins are available in various sizes from 00 to 7. The beginner needs but three sizes, numbers 1, 2 and 3.

For pinning small insects the size of butterflies such as spring blues and beetles such as cucumber beetles, #1 pins are used.

Specimens the size of bees, deer flies, cabbage butterflies and tiger beetles are pinned with #2 pins.

Large specimens as May beetles (June bugs), horse flies and monarch butterflies are pinned with #3 pins.

If the collector is specializing on a group containing very large forms such as the giant water bugs, Saturniid moths and stag beetles, it is advisable to use #4 pins for the largest specimens.

Mounting on Point. All insects which are too small (small ants, beetles, bugs with hard shells, etc.) to be pinned on a standard pin or too hard to mount on a minuten (a very small insect pin) may be mounted on a point. This is a small piece of cardboard or celluloid thru which a #3 pin is thrust. Punches can be purchased

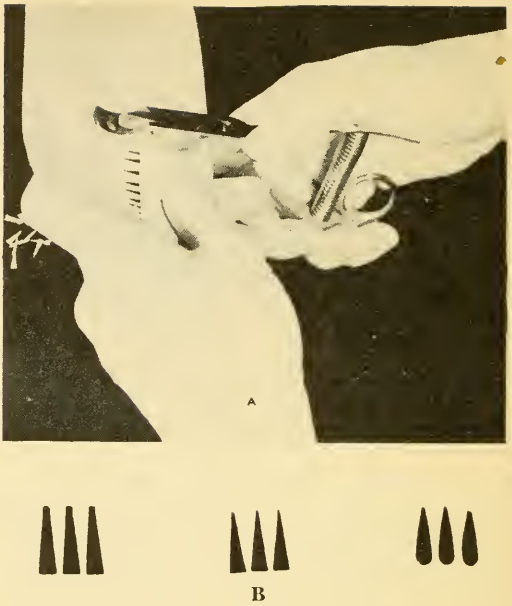


Fig. 18. A. Punch for making points. B. Various styles of points.

which are made to cut these points, several standard sizes and shapes of which are commonly used. (Fig. 18.)

To mount insects on points proceed as follows: (Fig. 19.)

1. Lay out the insects to be mounted.
2. Thrust a #3 pin thru the broad end of the point and raise it to the proper height.
3. Bend the tip of the point downward using forceps or fingers.
4. Place a small drop of glue or cement (DuPont's Household) on the bent tip of the point.
5. Grasp the pin as shown in Fig. 19 and touch tip to side of thorax of insect.
6. Arrange insect so that head points forward when point projects to the left.

Where to Pin Specimens. Not all orders of insects are pinned thru the same parts of the body as they differ so much in structure. *Beetles* (Fig. 20a-1) are pinned near the front margin of the right wing close to the middle line. *Grasshoppers* (Fig 20a-2) are pinned thru the back part of the prothorax just to the right of the middle line. *Butterflies, bees, flies* and all the other orders of insects (Fig. 20a-3–4) are pinned thru the thorax a trifle to the right of the middle line.

The insect should be mounted so that it is held at right angles to the pin, both from side to side and from front to back, as il-

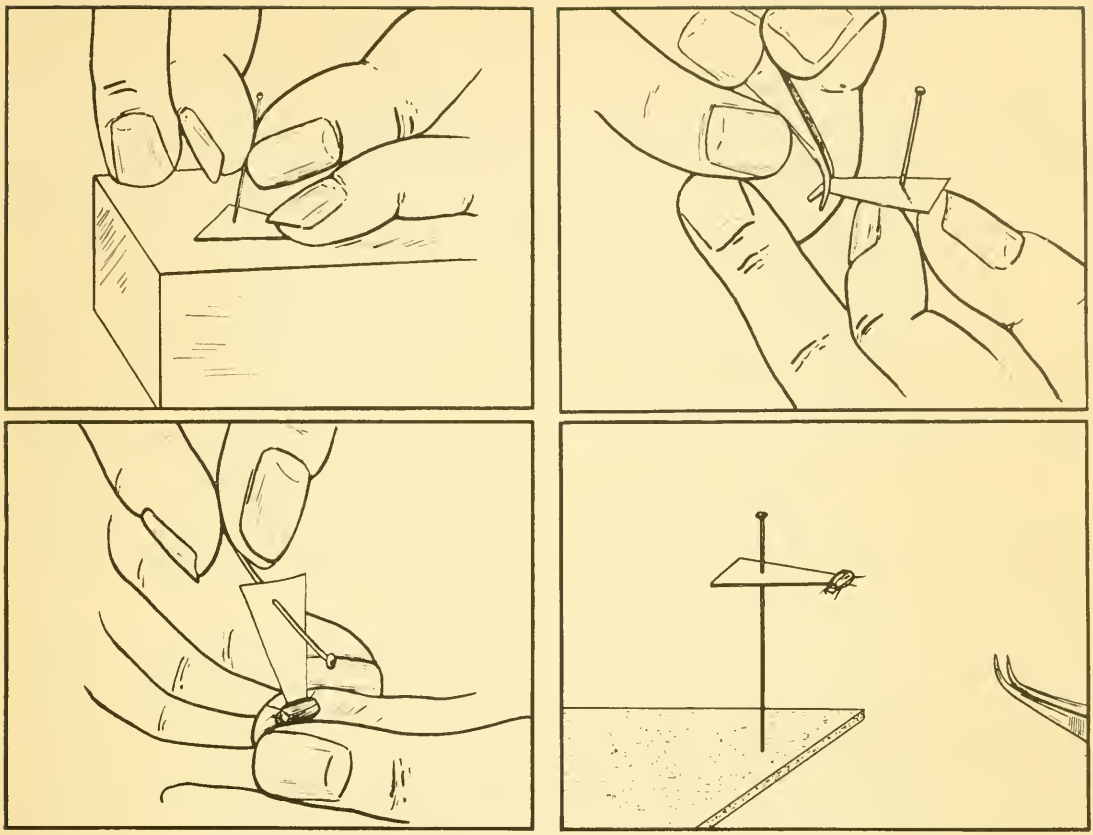


Fig. 19. A. Placing point on pin. B. Bend tip of point slightly downward. C. Placing insect on point. D. Proper arrangement of insect on point.

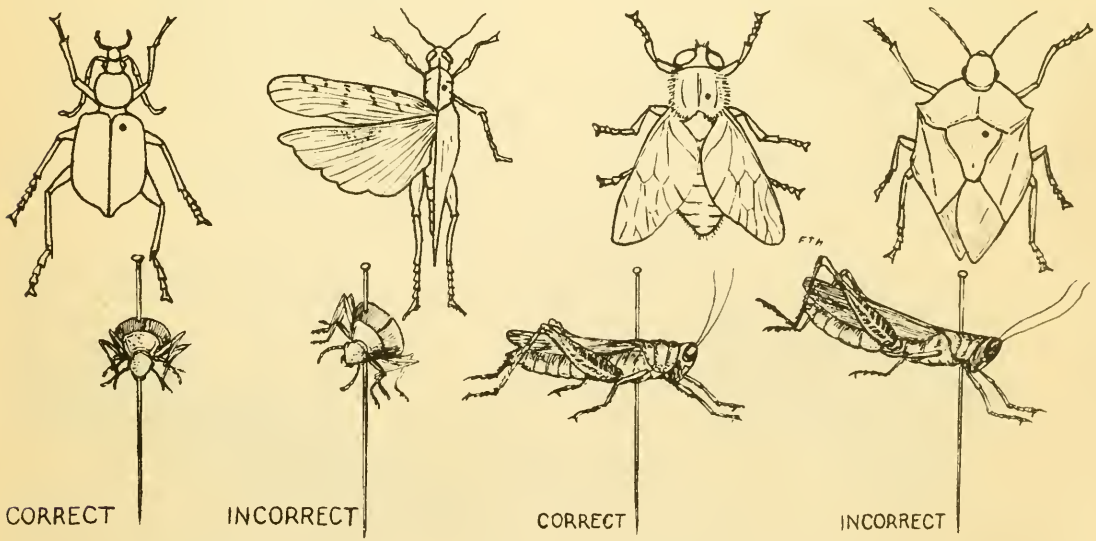


Fig. 20. Proper ways to pin insects.

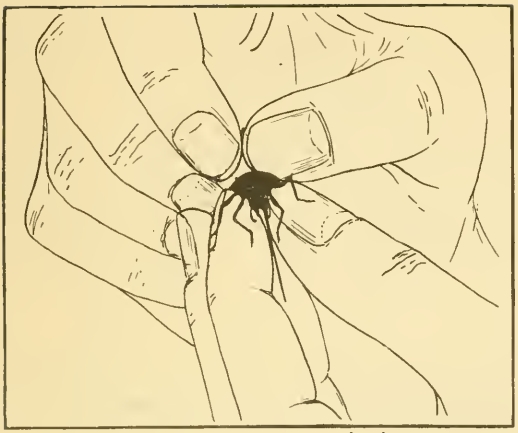


Fig. 20. Proper ways to pin insects.

lustrated. (Fig. 20 b, c.)

Height of Specimen on Pin. Holding the specimen in the left hand and the pin in the right (reverse if left-handed), the pin is thrust thru the insect (see Fig. 20d) until about one-fourth of its length is exposed above the specimen. This allows room for handling the pin with the attached insect.

It is advisable to have a pinning block in order that each specimen may be placed at the proper distance from the head of the pin. Two types are generally used—the three-step block and the three-hold type. (See Fig. 21.) The insect is placed on the pin and the head of the pin is inserted in hole number one of the 3-hole block or the low step of the 3-step block and the specimen pushed down until the back touches the block.

If one is doing much pinning he will soon learn to gauge the proper height with his eye and will need to use the pinning block for an occasional specimen only. To help gauge the distance a piece of paper can be placed on a pin at the proper height by using the deepest hole in the block. This pin can be used as a guide, and when in doubt the height of the specimen can be compared to the regulated height. See Fig. 24 for proper order of labels on pin.

Mounting on Minuten Nadeln. Minuten nadeln are short and extremely delicate steel pins, without heads. These are thrust thru the body of the insect and into small pieces of pinning cork, pith or other substances which, in turn, are mounted on standard #3 pins. This method of mounting is especially desirable for minute moths and soft-bodied fragile forms such as small lace wings, flies, etc.

Proceed as follows in pinning specimens on minuten nadeln:

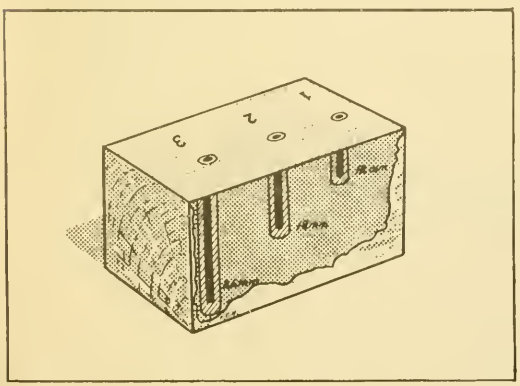
1. Hold the specimen carefully between thumb and forefinger and push the minuten thru the insect with forceps (see Fig. 22a). Push the minuten until enough of it comes thru on the ventral side, where it can be grasped by forceps. (Warning: Be careful not to force the minuten into the finger tip.)

2. Grasp the minuten with forceps *below the specimen* and thrust into a cork block. (Fig. 22b).

3. A #3 insect pin is then thrust thru the cork block (Fig. 22c).

4. The cork block is then raised to the proper height by using the #2 step or hole of the pinning block. It should be about 18 m.m. from the point of the pin. (Fig. 22d.)

Expanding or Spreading Specimens. Specimens of most the orders of insects can



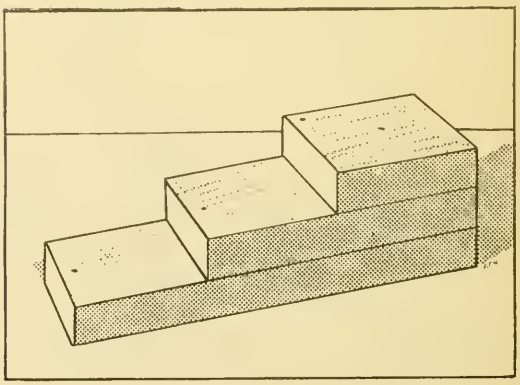


Fig. 21. Two types of pinning blocks.

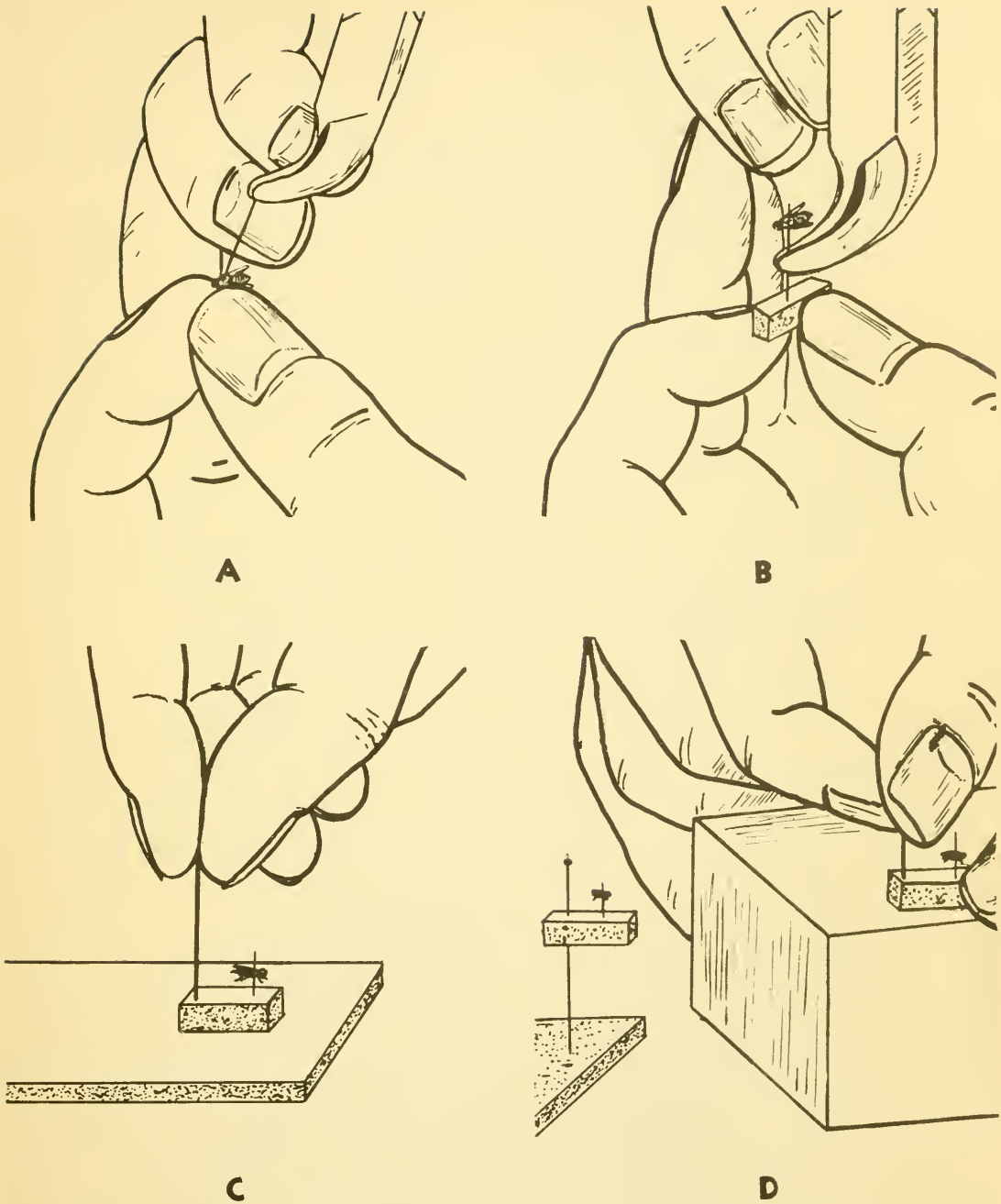


Fig. 22. Mounting an insect on minuten nadeln.

be pinned and placed directly into the collection without special treatment. In the butterflies and moths, however, it is necessary to expand the wings to show a view of their venation and markings.

The Spreading Board and How to Use It. In order to keep the wings in a uniform position a spreading board is used which consists of two pieces of smooth board with a slight upward slant. The

pieces are separated by a central groove with a pinning strip of soft material thru which the pins are thrust. The width of the central groove should be such that the body of the insect will slip into it altho it should not be more than $\frac{3}{32}$" wider than the body of the insect. In order to insure this, a supply of different sizes should be kept on hand, or a board should be used in which the width of the central groove can be changed. The former are called standard boards and the latter are adjustable spreading boards.

To spread an insect, proceed as follows:

1. Two paper or tracing cloth strips a little more than half the length of the spreading board and varying in width from $\frac{1}{16}$" to $\frac{1}{8}$" should be cut and pinned on the board beside the grooves. (Fig. 23d.) Slender steel mounting needles with rounded heads are ideal for this purpose, and for manipulating and holding the wings in position. It is easier to begin in the middle of a board and work toward one end, as this avoids long reaches.

2. Take the relaxed specimen from the moisture chamber. (Fig. 23a.)

3. Remove it from the paper triangle and squeeze the sides of the body just below the wing bases with the forceps. This opens the wings so that a pin can be thrust thru the thorax. (Fig. 23b.)

4. Hold the butterfly with forceps in one hand and with the other thrust the insect pin thru the center of the thorax. (Fig. 23c.)

5. Push the insect pin thru the pinning bottom in the center of the spreading board groove until its point touches the bottom. The wings should then be level with the top of the board. (Fig. 23d.)

6. Raise the paper strips over the antennae and wings and pin the strips on both sides in position. (Fig. 23e.)

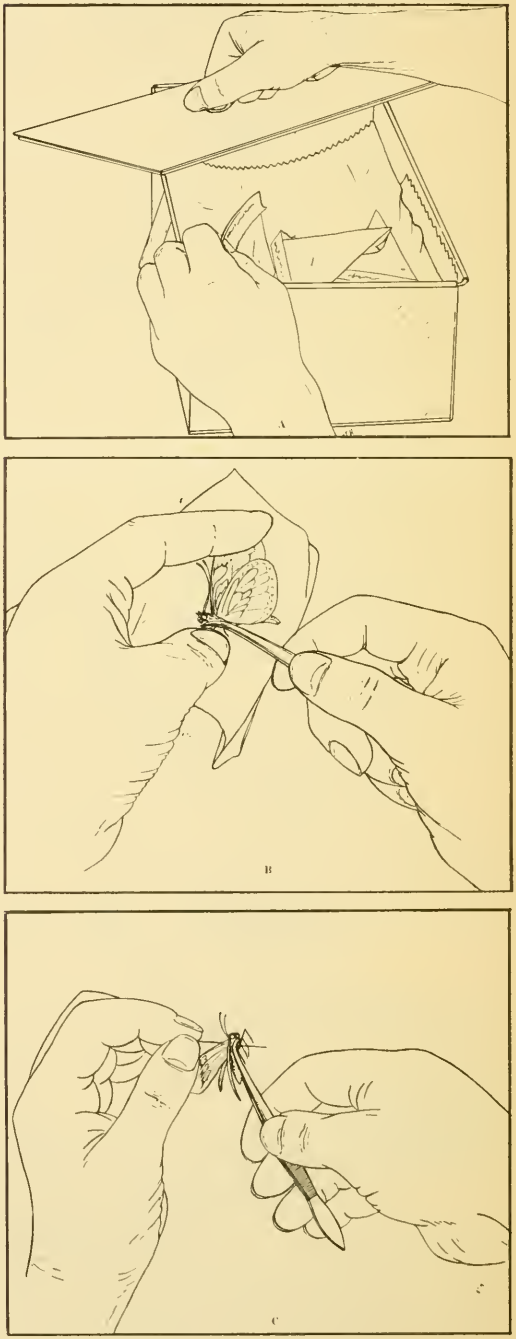
7. Put an insect pin at the left side of the body to prevent the specimen swinging out of line during the manipulation of the wings. Then, holding the left hand strip over the wings loosely, thrust the mounting needle thru the base of the wing back of the strong vein that is found just behind the front margin of the forewing. Move the wing forward until the rear margin is at right angles with the long axis of the body but not so far that the hind wing will slip out from under it. Hold it in this position by lightly pushing the needle into the board. (Fig. 23f.)

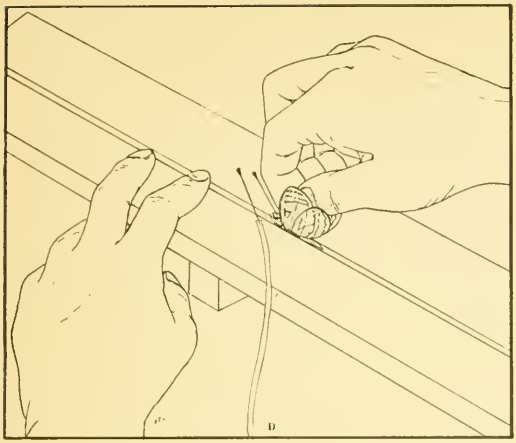
8. In the same manner move the hind wing forward until a small portion of the hind wing is overlapped slightly by the forewing. Pull the paper strip tight and pin in position. Repeat these operations for the opposite side. The antennae should be parallel to the margins of the frong wing as shown in Fig. 23g.

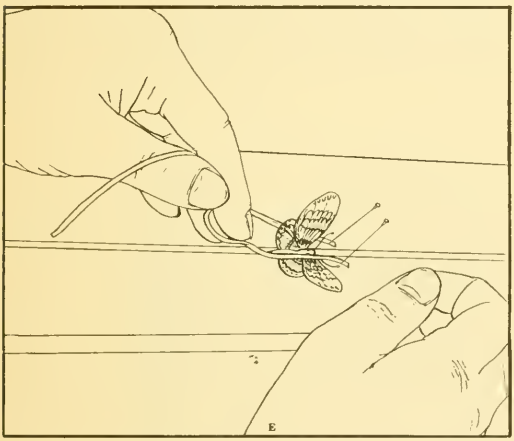
9. Strips of glass or blank microscope slides are placed over the wings as they will otherwise curl up while drying. Care should be taken not to scratch the wings. Fig. 23g.

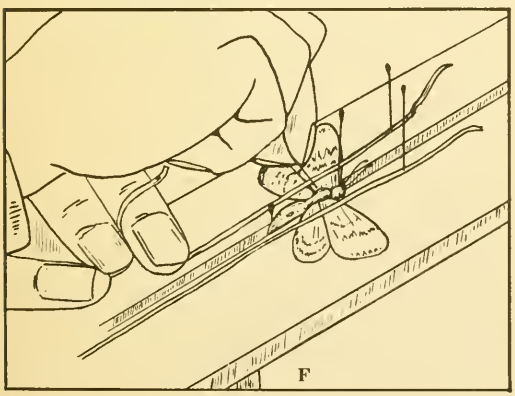
10. Data from the triangles is placed on a pin and thrust in the end of the board. To avoid any confusion it is advisable to number the data labels. A complete board with spread specimens and data pinned on the ends are shown in Fig. 23h.

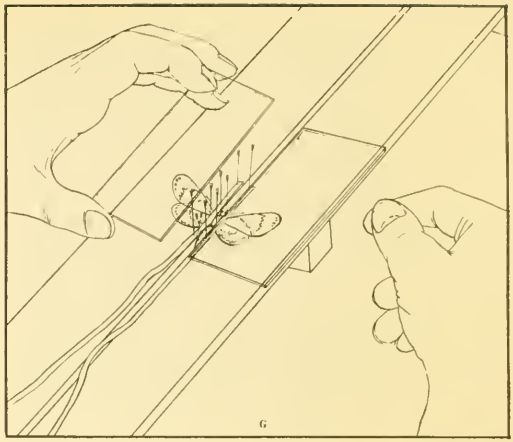
11. The specimens are now ready to be placed in a drying cabinet.











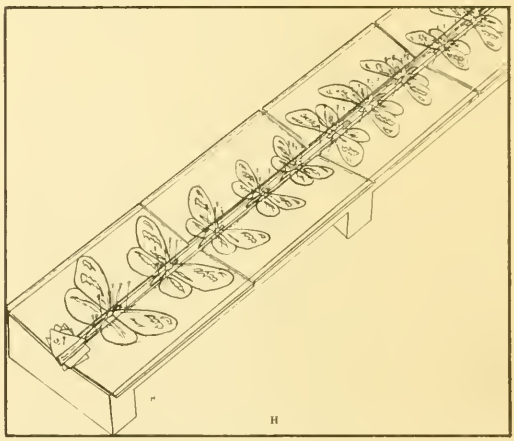


Fig. 23. Expanding and pinning Lepidoptera.

Drying Spread Specimens. Many an entomologist has experienced the visits of ants or mice to his spreading boards when they were full of specimens. It is therefore desirable to make some sort of a cabinet or a box with at least two sides of wire netting and with shelves on which the spreading boards can rest. If the box can be placed near a radiator or furnace quicker drying will be assured.

Occasionally mites, silver fish, book lice, and other small pests gain entrance to the cabinet and when this happens it must be thoroughly cleaned and fumigated with kerosene or sodium fluoride.

Length of Drying Time. Fresh specimens that are pinned or expanded usually take from three days to a week depending upon the size of the specimen. Relaxed specimens are usually dried within two days, except for large Saturniids which should be left on the board four days.

The specimens are taken off the boards by carefully removing the glasses, pins and strips. The pinned specimens are then ready to be labelled.

Labeling the Specimen

Dr. Lutz of the American Museum of Natural History has the following to say

regarding the importance of accurate data: "Do not forget that information about the insect is usually of as much value as the specimen—or more." Dr. A. B. Klots of the College of the City of New York also states: "A specimen without data is hardly anything more than a mere object of curiosity, and the necessity of keeping accurate and complete data *permanently attached to every specimen* cannot be too strongly impressed on the collector."

To be useful to the entomologist, the specimen must be accompanied by such information as the *name* of the specimen, *locality* and *date* of capture and *biological data* regarding habitat or host. This information is obtained from permanent records which every careful collector will make in his field notebook. Lack of sufficient data has destroyed the value of thousands of specimens that might have been of great scientific importance. Do not neglect this very important matter.

Recording Data. The source of the information which is to be placed on the data labels is the field notebook in which detailed notes have been recorded. A *field notebook*, carefully kept, is not only of immense importance in enabling the collector to label his specimens accurately but it also may be of great assistance to later workers who may study your collections.

It is only by chance that the beginner gets a new or very rare species on ground that has been worked over by experienced collectors but even the beginner may add to scientific knowledge if he keeps his field notes well. *Date of capture* and *locality* are of prime importance. Record any observations made of their habits. On what are the insects feeding? Under what conditions are they found—and when, day or night, winter or summer. Train yourself to observe accurately and carefully record these observations.

The best type of field notebook is one which will fit the pocket and one which is bound with a strong and durable cover.

Numbering the Specimen. A catalog or accession number should be given each specimen or lot of specimens bearing identical data. This number should appear in the field notebook and should be placed with the specimens. In this way it is not necessary to place any further data with the specimens until the data labels are affixed to them after pinning. For easy reference it is desirable to place the accession number on either the "Collection of—" label or the "data" label.

Pin Labels. Data concerning each specimen is placed on labels which are attached to the insect pin. Only the best rag bond paper should be used as this will not curl or yellow with age. Printed labels are preferable but they may be hand lettered if neatly done with India ink. The following instructions are given to make it possible for every collector of insects to label his specimens correctly. Nearly all entomologists have adopted certain uniform labels to bear all of the necessary data concerning an insect specimen. These are usually placed on the pin in the following order, listing from top to bottom. (See Fig. 24 showing proper position of each.)

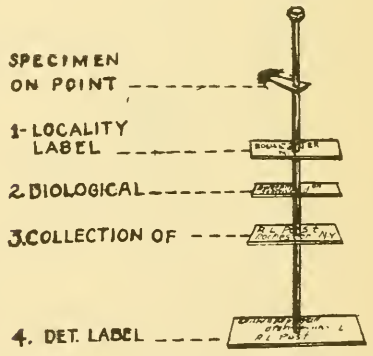


Fig. 24. Positions of data labels accompanying pinned insect.

1. Locality label.
2. Biological Data label.
3. Collection of—label.
4. Determiners' label.

Note: When affixing labels use great care not to damage specimens. Do not touch the specimens or handle roughly or antennae and legs will be lost. Use pinning forceps and grasp the pin below the insect when possible.

The Locality Label. Locality labels should always include the following data:

a. Locality of capture.
b. Date of capture.
c. Name of collector.

For the sake of uniformity the date

should be written as follows, with the month in Roman numerals:

10.VI-36 (day, month, year).

The Biological Data Label. This should bear information regarding habitat or host and adds considerably to the value of the specimen.

"The Collection of—" Label. If one trades specimens or sends them out for determination it is worth while to have labels printed as follows: "Collection of John Smith." This enables the taxonomist to determine from whose collection the specimens originally came.

The Determination Label. If a specimen has been determined by an authority, use a label showing the scientific name of the specimen, name of the determiner and date of determination.

The Care of Pinned Specimens

Handling Pinned Insects. After specimens have been placed on the pins and the labels affixed, they may be placed in storage boxes as dried and pinned insects are very fragile and must be handled carefully. Be especially careful not to let the fingers come into contact with any part of the specimens and use regular pinning forceps in handling the insects.

Pinning forceps are almost a necessity for sinking the pins firmly into the pinning composition. Several types are available but we are recommending only two, the best being the Cresson type, used by most professional entomologists, and the Akhurst type, inexpensive forceps satisfactory for the beginning collector (Fig. 25).

How to Use Pinning Forceps. The forceps should grasp the pin as near the point as possible so that the pin may be thrust firmly into the bottom of the insect box. Until the collector has gained experience, it is safer to support the top of the pin with the index finger while pushing the point into the pinning bottom. (Fig. 26.) This method should be followed in the case of rare specimens to take up any shock or stop any vibration when the pin is released.

The Unit Tray System of Insect Storage. The most flexible of all methods of storing pinned insect specimens is the unit tray system. Most of the important North American collections, as well as many of the smaller private collections, are now stored in this way.

Fig. 25. A. Cresson pinning forceps. B. Akhurst pinning forceps.

In brief, this method consists of pinning specimens into special trays with pinning bottoms of balsa wood rather than directly into the bottom of boxes and of storing these trays in large glass-topped cabinet drawers. Each species or distinct series may be pinned into a separate tray. (See Fig. 27.) The trays are of different sizes so as to accommodate different sized species or series. The various sizes are in multiples of each other; that is, the largest tray is twice the length of the next, that again twice the length of the next, and so on. The trays are made to fit the two standard insect drawers, the Cornell type and the U. S. National Museum type.

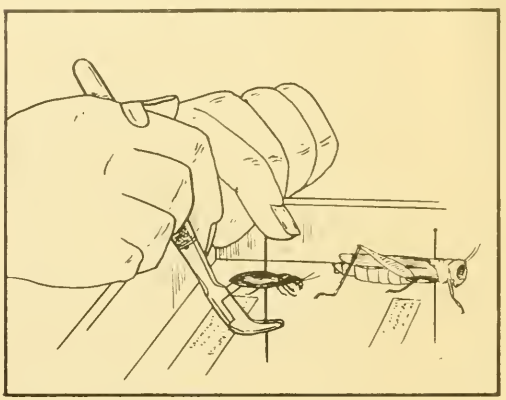


Fig. 26. Use of pinning forceps.

Fig. 27. The unit tray system affords one of the most satisfactory means of storing a large insect collection.

The advantages of this system of storage are manifold, its most important one being its greater flexibility. Additional specimens or groups to be included in the collection are merely pinned into a suitable sized tray and the other trays in the drawer are moved along to make room for the additions in their proper places. There is no necessity for repinning a whole drawer of insects because several insects must be added, nor any need for leaving large open spaces to accommodate future acquisitions.

Because trays are built to absorb considerable shock before transmitting it to the specimens, danger of breakage is lessened. An occasional "floating specimen" can endanger only those in the same tray. Lost parts, automatically retained in their proper tray, may be replaced with certainty and speed.

Labels bearing the name of the species and author may be placed in the tray with the specimens, they may be pinned on the tray bottom or they may be pasted on the inside back of the tray. (See Fig. 27.) A plan used with the large Ward Collection is to paste the labels to a piece of stiff cardboard of a size to fit vertically against the back of the tray. This label can be held in position by two large insect pins. An advantage of this label card is that a large amount of space is this saved and the labels may be transferred and the trays reused. In large collections, "label blocks" may be used to spot the beginning of each genus. Pieces of $\frac{1}{4}$-inch soft wood, cut to correspond in size to the back wall of the tray, are stood on edge before the first tray of the genus. A label showing the name of the genus and the author is placed on the top of the block. (See Fig. 27.)

Trays are available for both the Cornell University drawer ($15\frac{3}{16} \times 17\frac{5}{8} \times 2\frac{3}{8}$″ inside) or the U. S. National Museum drawer

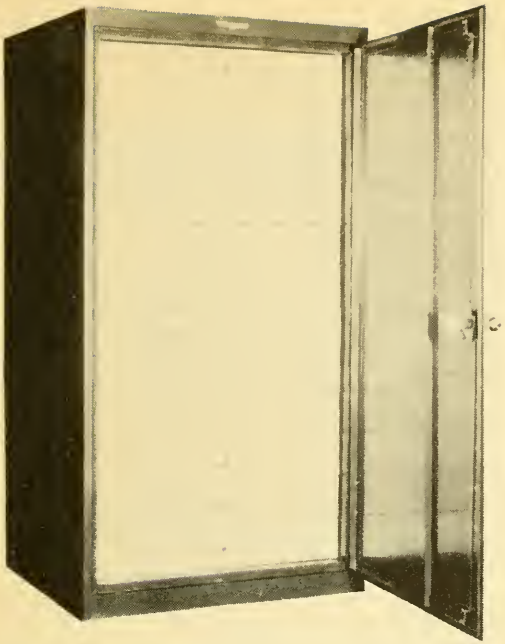


Fig. 28. Insect storage drawers in steel cabinet.

($16\frac{1}{4}$ x $15\frac{7}{8}$ x $2\frac{5}{16}$″ inside), the various sizes being:

For Cornell Type Drawers:

$1\frac{3}{8}$ x $7\frac{9}{32}$ x $1\frac{5}{8}$″
$4\frac{5}{8}$ x $3\frac{21}{32}$ x $1\frac{5}{8}$″
$4\frac{3}{8}$ x $1\frac{13}{16}$ x $1\frac{5}{8}$″
$4\frac{3}{8}$ x $1\frac{9}{16}$ x $1\frac{5}{8}$″

For U. S. National Museum Cabinet Drawers:

8 x $7\frac{5}{8}$ x $1\frac{5}{8}$″
4 x $7\frac{5}{8}$ x $1\frac{5}{8}$″
4 x $3\frac{13}{16}$ x $1\frac{5}{8}$″
4 x $1\frac{7}{8}$ x $1\frac{5}{8}$″
4 x $1\frac{1}{4}$ x $1\frac{5}{8}$″

Glass-topped cabinet drawers should be arranged in racks, leaving as small amount of space as possible between the drawers. Wooden cases, or preferably steel cabinets (See Fig. 28), should house the drawers and protect the specimens from dust and insect pests. Practically all large collections are now stored in this type of cabinet.

Insect Storage Boxes. Specially constructed boxes are used for storing insect specimens. Do not use old cigar boxes or shoe boxes for storage. Carefully prepared and labeled insects deserve proper storage in pest-proof containers. Wooden insect boxes should be used for permanent storage but well constructed cardboard boxes may be used for temporary purposes (See Fig. 29).

Wooden boxes are available in a variety of types but all should meet the following requirements:

1. They must be as nearly air tight and dust proof as possible in order to protect their contents against the attacks of museum pests.

2. The bottoms of the boxes should be lined with a substance for receiving and holding the pins. This pinning composition must allow the pins to enter easily and must be resilient enough to hold them firmly so that they cannot shake out. Patent entomological cork, balsa wood, or celotex are the best pinning substances. Avoid any substance which is made with an acid filler as the insect pin will soon corrode, stick to the pinning bottom and break off easily when considerable corrosion has occurred.

3. Boxes must be sturdily constructed and not be easily broken or otherwise damaged.

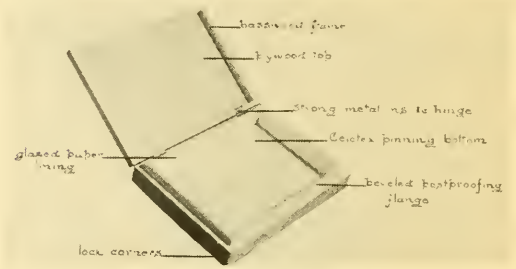


Fig. 29. Especially constructed wooden boxes are best for storing the small collection.

Protection against Pests. Museum pests will feed upon and entirely destroy a collection unless the specimens are protected against their attacks. Various materials are used to prevent their entrance into the insect box or to kill them once they have entered. The substance most generally used is naphthalene, either in flake or moth ball form. It volatilizes slowly, remains in crystalline or in solid form for several weeks, and it serves as a repellent to keep pests from entering the box and as a killing agent if they are present.

Paradichlorbenzene volatilizes much more quickly and is excellent for the fumigation of collections that have been attacked by pests, but it cannot be depended upon to provide continued protection such as naphthalene gives.

In Ward's insect collection the specimen containers are fumigated regularly twice each year with an equal mixture of Paradichlorbenzene and Naphthalene crystals which kills any pests and yet gives the desired repelling effect. A heaping tablespoonful to the insect box is a sufficient quantity for 6 months' protection.

Carbon disulphide, carbon tetrachloride and other liquids can be used to fumigate the collection to rid it of pests immediately. These, however, have no protective effect against reinfestation after three or four days.

Fumigant Holder. The most satisfactory method devised for holding fumigant is the *Ward Fumigant Holder.* (See Fig. 30.) This consists of a small cardboard box which is filled with repellent and has a fine wire mesh cover. The fumigant holder is securely pinned in one corner of the box. The lower right hand corner is recommended for this purpose. The fumes pass thru the wire mesh but none of the substance itself can shake about and damage specimens.

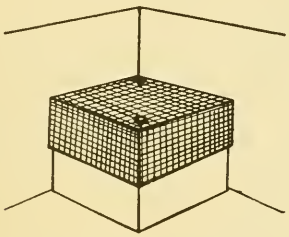


Fig. 30. A convenient and safe device for holding fumigant.

Storing Preserved Specimens. The storage of specimens preserved in alcohol presents several problems. It is necessary that the bottle or vial in which the specimens are kept be stored so that they can be inspected periodically and the vials easily refilled with preservative. The containers should be stored upright so that the liquid does not come in contact with the cork. An excellent means of accomplishing this with a minimum amount of space is used in the Cornell University collection. It consists of fashioning a copper wire hook around the neck of each bottle, (See Fig. 31a). These are then hung in vertical frames of galvanized wire mesh by means of the hook. (See Fig. 31b). The frames are made to slide into runs or grooves in a cabinet and large numbers of specimens can be stored in a relatively small amount of space where they are readily available for inspection or removal.

The best liquid preservative is 75% alcohol.

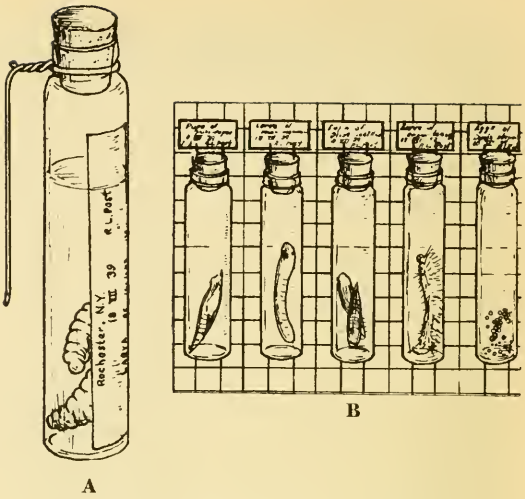


Fig. 31. Storing insects in alcohol.

Naming the Insects

Why the Scientific Name? We have already discussed the mechanics of storing and housing an insect collection. In addition, advice and information on labels, data, field and accession notes has been given. Whenever possible in arranging specimens in an insect collection, it is best to follow taxonomic order: i. e., a systematic scheme based upon the scientific classification and names of your specimens. The scientific name of an animal is made up of two parts; the first of which is known as the generic name (for example, genus *Papilio*), and the second or specific name (species *ajax*). The first is always capitalized while the second is never capitalized.

The uninformed layman frequently asks "Why use these long scientific names for insects?" If one stops to consider, however, common names really do not mean much to scientific workers because several insects may have the same common name. Take the potato beetle for example. Some people think of the striped Colorado Potato Beetles, others the Black Potato Beetle or the Blister Beetle, and a few may think of the little flea beetle which makes "shot holes" in the leaves. On the other hand many insects have different common names; the Corn Ear Worm, for example. In trucking sections the growers call it the Tomato Fruit Worm, because it feeds on tomatoes, and in the south it is called the Cotton Boll Worm. If we call it *Heliothis obsoleta*. anyone working in the field of

entomology, whether he be in New York, Louisiana, England or Japan knows just what is being talked about.

How to Determine the Names of Insects. The beginning collector and student of entomology will undoubtedly do his first determining by comparing his specimens with pictures in reference books. This method is not only unscientific but will soon prove to be most inadequate and one should learn to use a key as soon as possible. A key may be defined as a list of characters so arranged as to force a choice between contrasting characters, thus gradually eliminating the possibilities until one is led to the proper conclusion—the name of your specimen. Keys to the orders and families of insects are found in nearly all good entomological textbooks. Many states have prepared check lists of the insects that have been collected within the boundaries of the state. Such lists from your own and neighboring states will prove invaluable and should be followed in the arrangement of your collection. Later in this booklet a bibliography of entomological publications that have proven helpful in the determining of insects will be given.

As one becomes more proficient and begins to specialize in particular groups, it is well to contact specialists who are willing to determine specimens. As most determiners have several years' work piled up, it is well to know how to proceed in obtaining their co-operation.

1. Write to the determiner, telling him how many specimens you have on hand, where they were collected and how they were prepared. He will then tell you whether or not he can determine them for you.

2. Be sure every specimen is accompanied by complete data. If the specimen is pinned, be sure the data is placed on labels as previously described. If the specimens are in alcohol, place data on good grade of paper with India ink. Don't gather up a miscellaneous lot of insects and send them to a determiner. He will only have to send them back.

3. Pack your specimens carefully so that they will not be damaged and so the determiner can remove them from the containers without difficulty. (See instructions on packing insects at end of this section.)

4. Understand that taxonomists should be privileged to retain as many specimens as they desire, including all of a series if needed. Specimens are of most value to science when placed in the collection of an active worker in the group and because of this the determiner should feel free to retain material sent in.

5. Be prepared to wait a long time before insects are returned from determiner. Remember specialists are almost sure to be busy men and rapid service is not to be expected.

6. When the determiner returns the specimens, the collector should offer to procure additional specimens from that locality if he wishes them.

7. Do not trouble the professional entomologist until every other method has been exhausted by the collector. Entomologists are constantly pestered by collectors who are too lazy to identify their own specimens and pass them on to the specialist to determine.

How to Pack Specimens for Shipment. Insect specimens must be carefully packed if they are to be shipped. As nearly all beginners and many professional collectors do not know how to prepare insects for shipment, we are offering the following suggestions in the hope that many scientific specimens may be saved.

First of all, select a strong but lightweight box into which a tightly fitted pinning bottom of celotex or cork may be inserted. If you can afford to purchase ship-

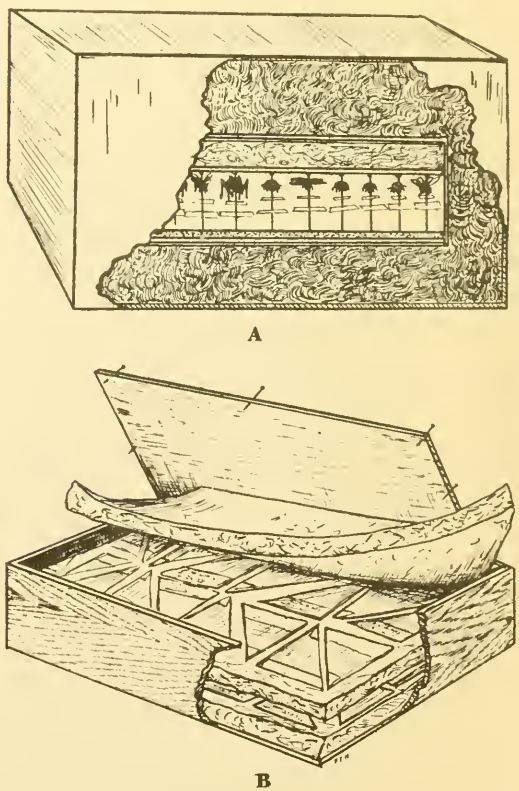


Fig. 32. Pinned and papered specimens should be securely packed for shipment.

ping boxes, you will find it advisable to do so. Ward's supplies containers especially made for the purpose of shipping fragile, pinned insect specimens. (See Fig. 32a.) See that all pins are thrust firmly into the pinning composition of the shipping box. One "floater" will ruin many specimens. Unless absolutely necessary, do not use corrugated paper as a pinning bottom for a shipping box containing pinned insects. The paper will not always prevent the pins from coming loose. If corrugated paper must be used, be sure to have this material in double thickness. The layers should be placed so that the corrugations are both lengthwise and crosswise.

Thrust extra pins of the same height in each corner of the box and over the whole lay a piece of thin cardboard which has been cut to fit the inside of the box snugly. Over the layer of cardboard place a layer of cotton thick enough to press firmly against the cardboard when the top is closed. The layer of paper held down by the cotton will prevent the pins coming out of the pinning bottom. Wrap the box in paper and pack it in a larger box protected by a layer of excelsior or crumpled paper at least 2″ thick on all sides.

Papered specimens may be shipped in any container that will not crush in the mail. (Fig. 32b.) Alternate layers of papered specimens with layers of cotton or cellu-cotton cut to just fit the container may be used. Fill the box so that the triangles cannot shake about and pile up in one end. Never place cotton in vials of alcohol as this is sure to entangle the legs and antennae so that these parts will be broken off in transit or when they are removed. Fill the vials or jars with alcohol, eliminating the air bubble as much as possible. Place the data label inside the vial but leave out the cotton.

Mounting Insects for Display

The preceding instructions are adequate for the storage of insects and their arrangement in a collection. Insects also lend themselves to attractive and educational displays which may demonstrate the life cycle of the insect, show typical examples of particular groups (taxonomic collections, collections of insect pests, etc.) or be so-called "biological collections" that include examples to illustrate particular biological principles.

Display Containers

Various types of display containers, of which the following are most common, are used for this purpose.

Wooden Glass-topped Display Cases. These cases are constructed of wood and are provided with tight-fitting glass tops. The bottom of the case is composed of a sheet of pinning composition that is covered with white glazed paper and the sides of the frame are likewise covered with white flint paper or painted flat white. (See Fig. 33.)

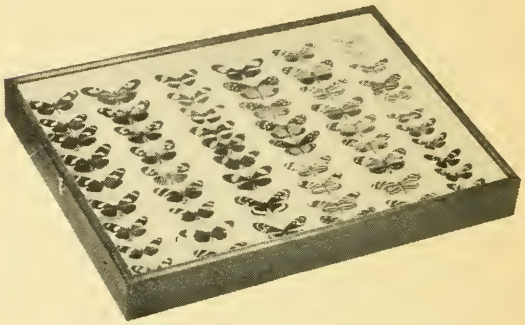


Fig. 33. A glass-topped exhibit case for displaying specimens.

Cardboard Display Cases. These are of two types, the larger case with a depth of 2½″ and the smaller with a depth of 1″. The sides are made of several layers of heavy cardboard to give rigidity and the glass top fits as tightly as possbile, altho one can never be sure of as much protection from pests with a cardboard display case as with a wooden one. However, this type of container is much cheaper than that constructed of wood, and if fumigated regularly it will be satisfactory. (See Fig. 34.)

The smaller type of display case looks something like a larger Riker Mount. The glass-topped box is made of cardboard, a sheet of pinning composition placed in the bottom of the case and a thin wood frame is made to fit tightly around the inside to give rigidity and to hold the pinning bottom firmly in place. The smaller display cases are usually made in two sizes, 6½ x 8½″ and 8 x 12″. The depth is about one inch which is less than the height of an insect pin, therefore it is necessary to clip off the top of the pin so that it will not

interfere with the placing of the cover.

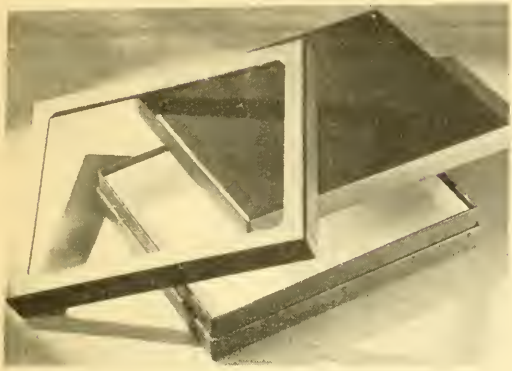


Fig. 34. Cardboard display containers.

The Riker Mount. This is a cardboard, glass-topped display case containing cotton. Specimens and labels are arranged on the cotton and held in place by the glass top. This type of mount has been widely used for school displays of insects but is not too practical because it is difficult to render pest-proof. Another objection to it is that when fumigating the Riker Mount it is necessary to remove the glass cover and in so doing the specimens and labels invariably become disarranged.

The Metal Display Mount. . This is a mount patterned after the Riker Mount. The shell is made of metal, the top is of glass and the case is filled with cotton. The top is set in a plastic moulding compound such as "plastocene." As far as pest-proof qualities are concerned, this case is only slightly better than the Riker Mount since the plastocene "seal" eventually dries and cracks and insect pests can gain entrance readily.

How to Mount Insect Life Histories. Insect life histories are important educational preparations because they assist in identifying serious insect pests and point out methods of controlling them. In sections about to be invaded by the Japanese Beetle, for example, as many people as possible should be familiarized with the various stages so that they can be recognized, destroyed and reported to federal or state agencies. Furthermore, a thorough knowledge of the life history is important in controlling dangerous insects. Almost every pest is vulnerable at some stage in its development and it is at this point that control measures must be applied for the greatest effectiveness.

Collect the different stages of insect pests, egg, various sizes of larvae, pupae and adults of both sexes, as well as examples of the damage done. Prepare the specimens according to methods already given. Soft bodied insects may be placed in small vials of 75% alcohol and the vials tightly corked. The cork may first be soaked in hot paraffin and then inserted so that as small an amount of air as possible remains in the vial. (It is impossible to eliminate the air bubble completely.) Now dip the cork and the top of the vial in black asphaltum or other sealer, allow it to dry and dip again. Three coats are advisable with each successive coat overlapping the previous one slightly to insure a fast seal.

Mounting in Display Cases. Pin the specimens in the display case in an orderly arrangement. Vials may be attached to the background by cementing with Duco cement. Print labels neatly and using Duco cement glue them to the background beneath the specimens. (See Fig. 35.)

Fig. 35. Specimens and labels should be neatly arranged for dislpay.

Mounting in Riker Mounts. Remove the glass cover of the Riker Mount and lay the expanded and dried specimens on the cotton lightly so that they can be moved when the insects are arranged in an attractive way. Also, do not press the cover down on the specimens firmly until they are finally arranged and the mount ready to close. If specimens are pressed into the cotton firmly, appendages and antennae will catch in the cotton and break off when their position is changed. Saturniids and other large bodied insects may require the removal of some of the cotton below the body. When the specimens have been adjusted, place the cover over them

very lightly and mark the places on the top of the glass where the labels are to be located. Now remove the cover and cement labels on the under side of the glass cover, using just a trace of cement. This will hold the labels in place when the glass cover is placed over them. If the labels are laid on the top layer of the cotton they are almost sure to become disarranged when the glass cover is put on. Nothing so detracts from the appearance as labels which are out of alignment.

Fumigant may be placed in a small envelope and this should then be put on the bottom of the mount beneath the layers of cotton.

Now close the mount and insert the pins which hold the cover in place. A strip of transparent scotch tape may then be run around the bottom to close the space between the cover and the shell of the case. This closes the case and prevents the entrance of insect pests. If it comes loose a new strip can be applied.

How to Inflate Larvae. The larvae of butterflies and moths may be inflated and dried and when properly done, very attractive and realistic preparations result. The only equipment needed is an inexpensive inflating outfit, an oven and a source of heat. Complete outfits may be purchased. Instead of purchasing an oven, a tin can may be used. Place a couple of inches of sand in the bottom of the can and heat this over a gas burner or electric grill. Notch the top of the can and hold the specimen where it will be exposed to the warm air coming from the sand.

Proceed as follows to inflate larvae:

1. The larva is placed on a blotter or paper towelling and a slit is made around the anal opening to free the rear end of the alimentary canal from the body. (See Fig. 36a.)

2. The larva is then flattened by a round pencil or glass rod gently rolled from the head toward the rear. If this is carefully done practically all the contents may be squeezed out without breaking the skin. (Fig. 36b.)

3. A glass canula is inserted in the anal opening and the spring clip fastened to hold the larva in place. (See Fig. 36c.)

4. Air is forced into the larva and any necessary minor adjustments made. (See Fig. 36d.) The larva is then placed in the heat and air is maintained in the body by means of the double bulb. (See Fig. 36d.) Care must be taken so that no more pressure is applied than is necessary to distend the skin to its natural proportions. While this is being done the canula should be turned so as to dry the specimen on all sides. As soon as the larva holds its natural position upon release of pressure it is ready to be removed from the canula. To test whether the drying is done, press gently on the head—if the "neck" bends, heat it until it remains rigid.

5. A piece of balsa or other soft wood is inserted in the anal opening. (See Fig. 36e.) Shellac or other adhesive should be applied to the plug to hold the specimen firmly in place.

6. An insect pin is thrust thru the balsa block and the larva placed in the collection. (See Fig. 36f.)

Fleshy larvae of many of the other orders of insects can be so treated, however, best results are obtained with the *Lepidoptera* (butterflies and moths).

Special Collecting Methods

Sifting and Separating. Many small, inconspicuous insects occur in masses of trash or leaf mould, and a sifter net is a handy device for collecting these forms.

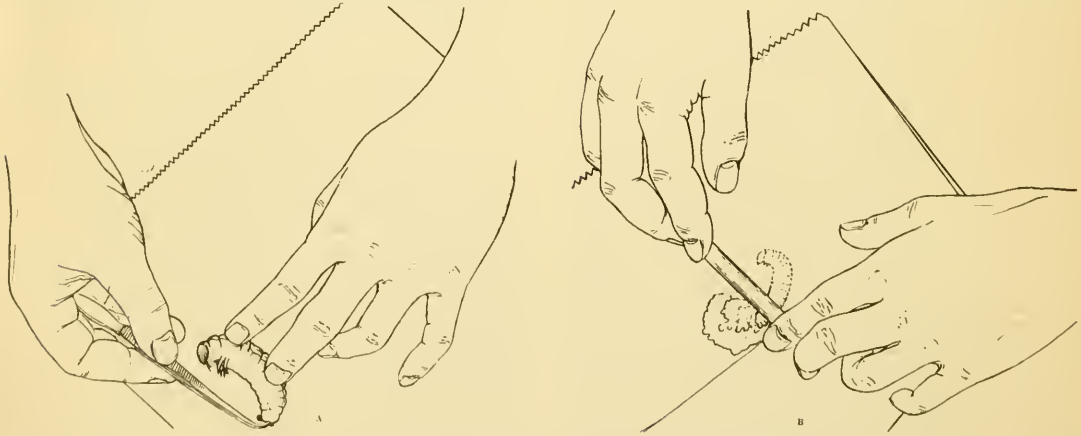


Fig. 36. Procedure followed in inflation of lepidopterous larvae.

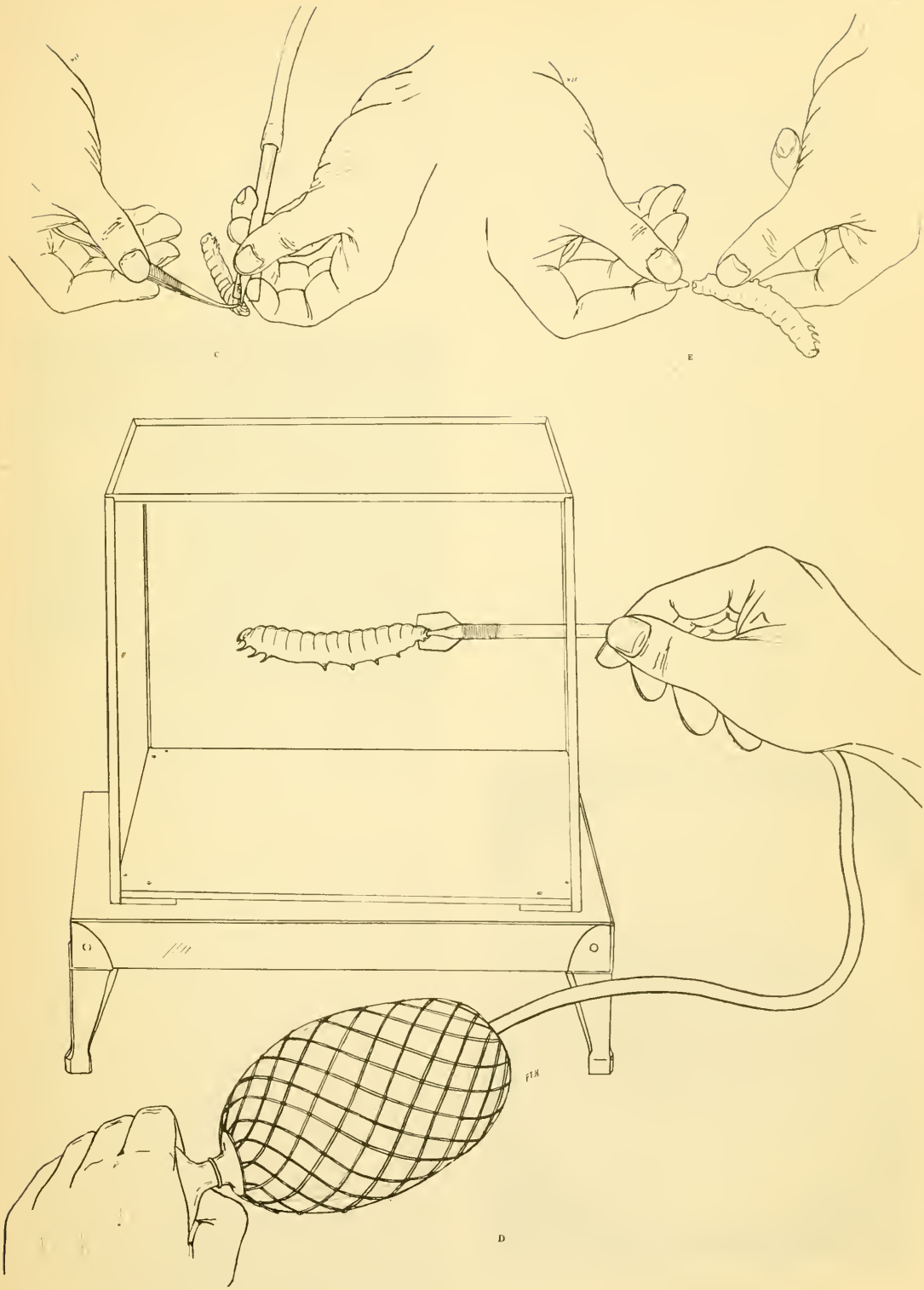


Fig. 36. Procedure followed in inflation of lepidopterous larvae.

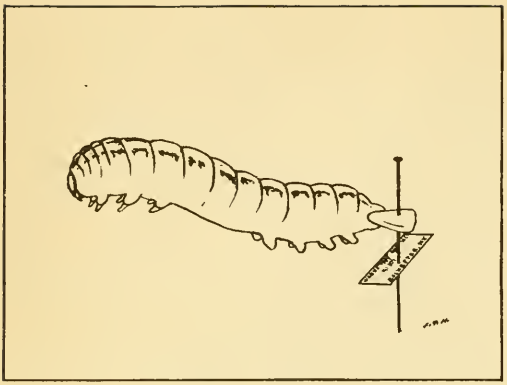


Fig. 36. F

The sifter net (See Fig. 37), is made of heavy muslin or canvas sides with a rigid wire ring above and a circular bottom of galvanized wire mesh as illustrated. Place in it the trash, leaves or rotten wood to be sifted and shake over a white cloth. As the specimens drop thru the screen onto the cloth, they may be picked up with the aspirator or forceps.

In the wintertime, bags full of leaves, pieces of bark from trees or decayed stumps containing hibernating forms may be brought from the woods into the cellar. In a few hours the insects will become active and they may be sifted from the material in the warmth and security of the basement while the storm rages without.

Fig. 37. Sifter net.

Collecting with the Aspirator. The aspirator is especially designed for collecting small, soft bodied and delicate insects which would be difficult to capture unharmed with forceps or fingers. Specimens are drawn into the collection vial by a sudden inhalation of the mouth tube or by squeezing a rubber bulb as in Fig. 38. A fine wire mesh covering the inlet of the mouth prevents the inhaling of débris or insects. An aspirator may be used in collecting termites, ants, small bees from flowers and minute insects living under stones and in crevices.

Fig. 38. Aspirator.

Bait Traps. Many sorts of insect traps can be devised. Probably the simplest and most effective are olive bottles and fruit jars buried with the open top of the jar level with the surface of the ground and baited with molasses. Boards daubed on the underside with molasses or with meat placed under them are very good. A large tin can with meat scraps can be placed in a field and visited every morning before going to work or school. It is well to bury the can so that the edge is level with the surface of the soil. If skunks or other animals molest the bait trap, those unwelcome visitors may be kept away by thrusting sticks and twigs around the trap, forming a corral. Rain water can be drained off by placing a few small holes in the bottom of the trap. Specimens collected at bait traps will become greasy unless a fine

screen is placed just above the bait. Greasy specimens should be cleaned by washing in alcohol to which a grease solvent such as carbon tetrachloride (Carbona) has been added at the rate of one part grease solvent to ten parts of 80% alcohol.

Trap Lights. Lights attract many sorts of insects besides moths, and street and porch lights are fruitful hunting grounds. A lamp by an open window makes the room a splendid trap. A white sheet illuminated by a gasoline lantern hung in front of it or a tent with a strong light inside attracts many night flying species. One may drive to the woods or favorite collecting ground, hang up a sheet, and train the headlights of the auto on it and reap the harvest of insects that will soon begin to come. If the lower edge of the sheet is turned up to form a trough, many of the insects that fall when they strike the sheet or when they are disturbed can be easily collected.

A light suspended over a tub containing water covered with a thin film of kerosene can be used to collect and kill most insects except moths and fragile winged or hairy insects. Specimens collected in this manner will have to be cleaned as above.

Trap light collecting works best on warm, cloudy nights where there is a variety of vegetation. The point at which a woodland passes into a swamp or where there is an abundance of second growth is the best location. Trap light collecting is the only successful method of capturing many groups of insects. If crumpled paper is placed in the bottom of the trap insects crawl beneath it and become quiescent and may be collected the next day. This prevents lepidoptera from flying about and becoming battered.

Many insects attracted to light can be grasped with a pair of curved forceps and dropped into the killing jar instead of placing the jar over the specimen waiting for it to drop into it. One becomes quite adept with the forceps and with a little practice and will soon use them for all except the large forms.

Sugaring. Sugaring for moths is often successful in attracting many specimens, especially the under-wings (Catocala). With a whitewash brush, paint a fermented fruit and sugar mixture on tree trunks, stumps, and fence rails. This can be done from early spring to late fall.

Two concoctions which have produced good results are:

1. A mixture of fermented peaches and cane sugar. (Fresh peaches are preferred to canned.) The peaches should be put thru a sieve after fermenting, then mixed with sugar as desired.

2. A mixture of fermented bananas, dried apricots and white or brown sugar. This fermented mass should also be sieved.

Both of these mixtures have been found to give better results than the traditional stale beer, molasses and brown sugar solution, which is made as follows:

To four pounds of sugar or molasses add a bottle of beer, and flavor the whole with a little rum.

A circular course which can be traversed in 20 minutes or half an hour can be laid out. By the time the last tree is daubed with the bait early arrivals may likely be found at the first trees and the evening fun begins. Visit each bait with a flashlight or lantern and place the killing bottle just under the specimens found feeding on the bait when the light is flashed on them. They will drop of their own accord into the bottle and you will find it easier to keep the killing jar from becoming gummed up with the bait.

A warm sultry evening with a storm threatening is the best time to sugar. The same course may be touched up with fresh bait and the second or third night will furnish even better collecting. A very interesting account of sugaring is related in Holland's *The Moth Book.*

Rearing Insects

The rearing of the various stages of insects enables the collector and student to obtain perfect specimens and complete life histories for accurate study and use in permanent collections. It opens untold possibilities for observations on food habits and the general ecology of various species. Finally, there is unlimited opportunity for experiments in breeding, hybridization, effect of environment, effect of nutrition, diseases of insects, embryological studies and countless others.

Accommodations for Living Insects. Cages and their location are of primary importance in rearing insects. For general purposes a cage such as that illustrated in

Fig. 39 is best. It measures 16″ high x 12″ long x 10″ wide, is constructed of carefully fitted sides and top of screen wire that are hooked together and can be taken apart for easy storage when not in use. A door in one end permits an entrance for cleaning, renewing food material, etc., or the top may be removed if desired. The bottom is a wooden tray 4″ deep. This type of cage will permit the simulation of a wide variety of habitats.

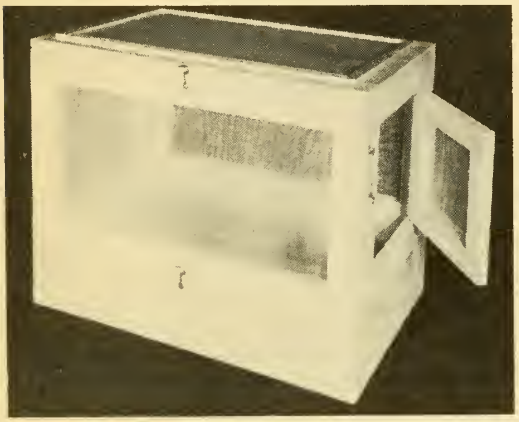


Fig. 39. Breeding cage adaptable for a variety of habitats.

Another useful breeding chamber is made with a flower pot, soil, an open jar and a lamp chimney as illustrated in Fig. 40. The flower pot is filled with soil in which the jar is buried so that the top is open at the soil surface. Water is kept in the jar and food plants have their cut ends thrust here to keep the leaves and stems fresh and succulent. The large end of a lamp chimney is embedded in the soil and a piece of gauze tied over the top to prevent the escape of the living insects. This type of cage is particularly useful for insects which require soil in which to complete their metamorphosis.

A fruit jar containing moist sand or a moist sponge is good for ground inhabiting larvae or for galls. Naked pupae may be kept in good condition thru the winter months if placed on top of one inch of moist soil and very lightly covered with just enough of the soil to bury them. (Fig. 41.) They should be sprinkled with a moderate amount of water weekly. Cocoons and chrysalids can be laid on top of the soil and the whole placed in a cool place.

Fig. 40. Breeding chamber made with a lamp chimney.

Balanced aquaria provide the most suitable habitats for aquatic insects. Small tanks or even jars of water (Fig. 42) in which a balance between plant and animal life can be maintained should be used since it is unwise to put a large number of specimens together.

An aquarium is made as follows:

1. Clean the tank or jar thoroughly.

2. Place clean sand in the bottom to a depth of an inch or two.

3. Carefully plant the roots of fresh, green *Vallisineria* or *Sagittaria* in the sand. Cut plants of *Elodea* may also be used and should have the cut ends buried. The above plants are recommended because they are good oxygenators.

4. Gently pour in water from a clear pond or stream, being careful not to disturb the rooted

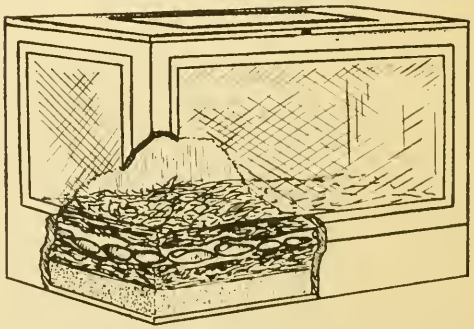


Fig. 41. Preparing naked larvae and cocoons for storage over winter.

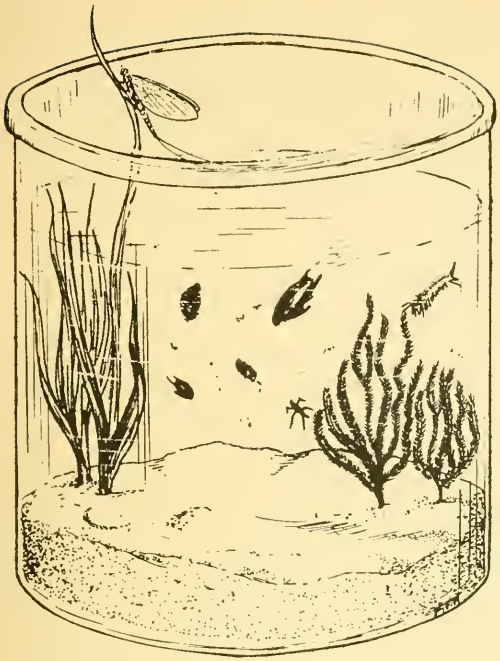


Fig. 42. A balanced aquarium can be maintained in a wide mouthed jar.

or embedded plants.

5. Keep the aquarium in good light but avoid direct sunlight. Allow it to stand a few days before any specimens are added.

6. Remove any uneaten food, dead animals or other débris within twenty-four hours to prevent decay from spoiling the balance.

7. Keep a glass or screen wire cover over the aquarium to prevent the escape of winged insects. As the water evaporates it should be replaced.

If you live near a stream a wire "pillow" cage may be used to rear and retain aquatic insects. (Fig. 43.) This is particularly useful when working with species which will not develop out of running water. A "pillow" cage is made by bending a sheet of screen wire into the shape of a pillow and fastening the ends and sides together. One end of the cage is weighted so that it will sink and the other end is fastened above water to hold the cage in place. It should be submerged for about one-half to three-quarters of its length.

Feeding Captive Insects. Insects which obtain their food requirements from plants are sometimes very specific in their tastes and will eat certain plants only. It is always wise to observe what plants the insects you wish to rear are feeding upon when taken and try to provide them with a continuously fresh supply. Cut plants should have their ends thrust in jars of water in the breeding cages so that they will remain fresh for a longer time.

Predaceous aquatic species can be fed pieces of raw beef which are suspended on string in the water. These should be removed after several hours to prevent spoiling the water. Predatory forms like mantids, ant lions, beetles, etc., will have to be supplied with living insects. For this purpose it is well to culture cockroaches, mealworms, etc. The latter can be reared in a small crock half filled with breakfast bran to which a slice of apple or banana peel is added occasionally. An ideal food for all chewing insects kept in the laboratory is given below. Cockroaches can be fed this mixture and cultured for feeding to predaceous species.

Formula for Chewing Insects. (Taken from *Journal of Economic Entomology,* Vol. 29, 1936, p. 1026.)

Corn Flour	4 parts by weight
Dried Powdered Yeast	1 part by weight
Skim Milk Powder	2 parts by weight
Whole Wheat Flour	2 parts by weight
Wheat Middlings or Bran	2 parts by weight
Honey	1 part by volume
Glycerine	1 part by volume

Mix the dry materials and sift out large particles. Mix the liquids and add to the dry ingredients until the right degree of wetness is obtained. This will depend somewhat upon the insects to eat the mixture since some species like more moisture than others. A safe procedure is to make it moist enough to hold its shape when rolled in a ball. Feed such balls with

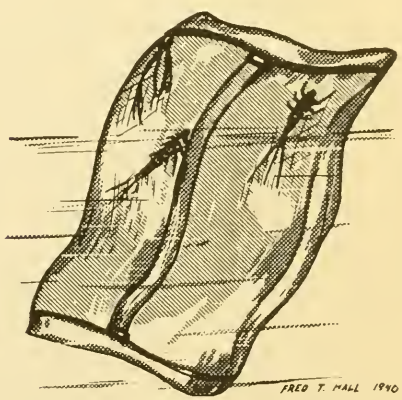


Fig. 43. A wire pillow cage is used in flowing streams.

varying degrees of liquid content until the preferred consistency is determined.

Preventing Escape of Living Insects. A line of vaseline or glycerine spread thin with the finger around the top of a container will prove an effective barrier to insects as they are unable to crawl over it. This keeps forms from escaping when collecting material or when adding food to the culture. At other times a layer of cheesecloth or other cover, held firmly in place over the cage, keeps the specimens in and allows ventilation and evaporation of moisture.

BOOKS FOR ENTOMOLOGISTS

C 601 A Glossary of Entomology; J. R. de la Torre-Bueno. This is a completely revised edition of Smith's "Explanation of Terms." The new edition of this classic work contains more than 12,00 definitions, as well as sections on biological chemistry, ecology and medical entomology. Appendix of abbreviations and signs. Eight newly-drawn plates of structures 5.00

C 607 Culture Methods for Invertebrate Animals. A compendium prepared co-operatively by American zoologists under the direction of a committee from Section F of the American Association for the Advancement of Science 4.00

C 609 A Manual of Entomological Equipment and Methods, Part I; Peterson, Alvah. Exhaustive, illustrative treatment of equipment for handling insects, especially living ones 3.75

C 610 Same, Part II. Information on how to rear and handle living insects, and containing much information on collecting, shipping living insects and collections, and insect photography 4.50

C 625 Field Book of Insects; Lutz, F. E. Third edition. Indispensable pocket companion for field and library. About 800 illustrations, many in color 3.50

C 627 The Insect Book; Howard, Leland O. A popular account of the bees, wasps, ants, grasshoppers, flies and other North American insects exclusive of the butterflies, moths and beetles, with full life histories, tables and bibliographies 5.00

C 629 An Introduction to Entomology; Comstock, J. H. 9th edition, revised. More advanced and comprehensive than the preceding. The best known American book on general Entomology. Now in press. Write for prices.

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C 639 Meadow and Pasture Insects; Osborn. Here is a unique and fresh approach to the large group of insect pests on the farm. The ecological aspects are treated as well as the systematic and much original material is presented. The book is replete with illustrations, bibliography and index 3.75

C 647 A Laboratory Guide in Entomology for Introductory Courses; Matheson, Robert. An excellent guide intended for use in elementary courses in entomology. It includes drawings the student is supposed to study and label, others of life histories, morphology and variations in insects. There are keys to the important families of the main orders annd an exercise on wing venation to assist in learning taxonomic characters of some groups 2.00

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C 706 The Butterfly Book; Holland, W. J. New, enlarged edition of this standard reference work 10.00

C 707 The Moth Book; Holland, W. J. Companion volume to the preceding and equally as well known. Best available single volume on moths 5.00

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C 736 Bees and Wasps; Latter, O. H. Cambridge Manual 1.00

C 740 Ants, Their Structure, Development and Behaviour; Wheeler, W. M. A biological classic 7.50