Direction Leaflet Number One

HOW TO MAKE AND USE SAFE INSECT-KILLING JARS

By ALICE GRAY

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A satisfactory method of killing insects may be something of a problem to the amateur collector, especially since cyanide, the substance most commonly used for this purpose, is just as deadly to human beings as it is to insects. There are liquids, such as ether, that do the job quickly and much more safely, but they are sloppy to use and evaporate so rapidly that the jar must be re-charged many times during a day's collecting. There is, however, a simple method of overcoming these difficulties.

First, find a strong glass bottle small enough to fit in your pocket and wide enough at the mouth to admit the largest insect you are likely to catch. If you are interested only in small species, a vestpocket size test tube or little vial would be handy. If you are planning to collect all kinds of insects, make it two jars at least, since butterflies and moths should have one to themselves. Some of the tiny scales with which they are covered come off in the bottle and cling to the other specimens, thus spoiling their appearance, while the weight and the kicking of one big beetle can ruin a dozen butterflies.

Each jar should have a tight stopper. A screw cap must fit closely without the usual waxed cardboard lining. The wax might soften in the fumes of the killing fluid and smear the specimens. Some collectors prefer a cork, which can be removed with one hand, especially if it has a loop handle of heavy cord, as shown in the picture. Corks of large size can be obtained from the dealers listed under "cork" in the classified telephone book. Make the cork shallow, about half an inch thick for a half-pint mayonnaise jar. Bore the holes for the cord with a small drill or gimlet, or punch them with an ice-pick or a nail. Force the ends of the cord through the holes with the blunt end of a match-stick, and tie a large knot in each. If the holes are at all too big for the cord, caulk them with soft paper and glue.

Secure some plaster-of-paris. A pound will be plenty, and can be bought for a few cents at almost any paint or hardware store.

Fill a teacup about ⅓ full of water, less if your bottle is very small. With a spoon, gently scatter the dry plaster on top of the water and let it sink without stirring. When almost all the free water is absorbed and all the plaster is wet, stir carefully until the mixture is smooth. This method of mixing prevents the formation of air bubbles in the plaster.

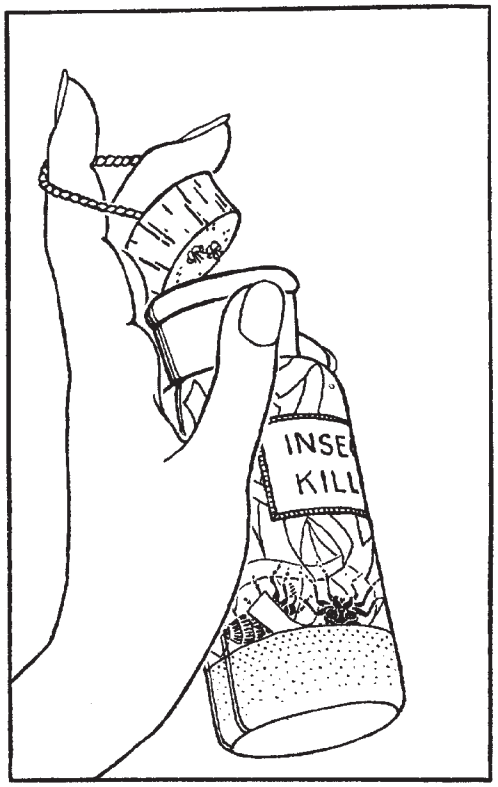
Pour the plaster into the clean bottle until it is about ¾ of an inch deep, less for a little vial. If the surface is not flat, knock the bottle gently to settle it. Then wait for the plaster to set.

If, while you are stirring, the plaster becomes too thick to pour, do not try to soften it by adding more water. Throw it away, wash the container, and start all over again.

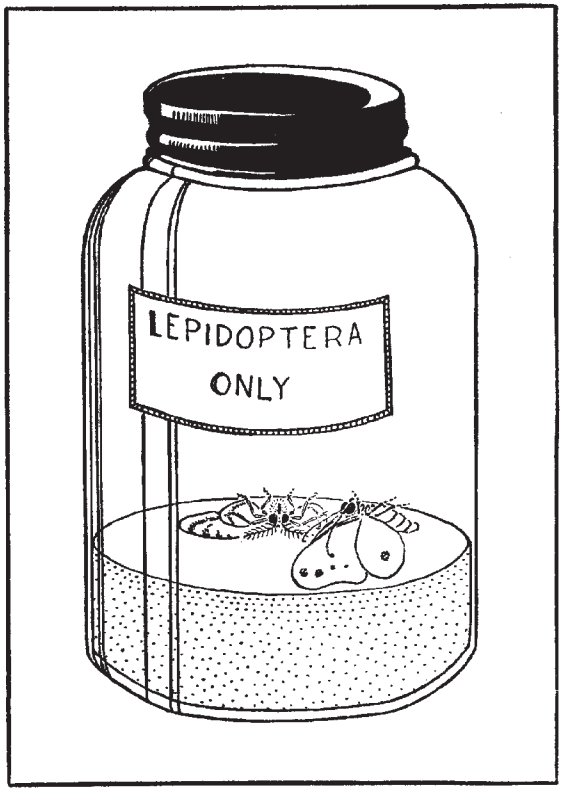
Never pour left-over plaster down the drain. It may set in the pipes and stop them up. Dump it out onto an old newspaper and put it into the wastebasket. Wash the cup and spoon right away, with plenty of water. The plaster will be very hard to get off when it's dry.

Feel the bottle while the plaster is setting. You will find it warm. When it has cooled, but while it is still damp, any plaster which may have splashed onto the sides of the bottle should be removed by scraping with a knife and dusting with a dry cloth. Label the bottle "Insect Killer" so that nobody will throw it out by mistake, and leave it open in a warm place until it is perfectly dry. This will usually take 24 hours, but you can hurry it up, if you have to, by putting the bottle on a hot radiator, or in an oven with the door slightly open.

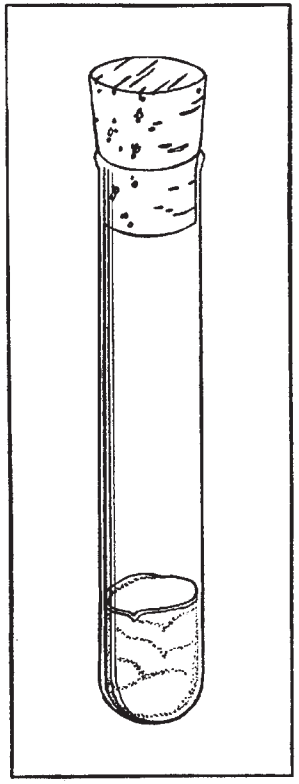
Dry plaster-of-paris is an excellent blotter, and can



A one-handed killing jar for insects.



A wide-mouthed jar for moths and butterflies.



A vest-pocket killing bottle, temporary type.

soak up an astonishing amount of liquid before becoming visibly wet. That is the secret of this kind of killing jar. If you saturate the plaster in your bottle with a volatile liquid which is poisonous to insects, it will kill your specimens quickly and safely for hours without slopping at all.

There are several fluids of which the fumes are lethal to insects but relatively harmless to people, at least in the quantities necessary for entomological collecting. Ether and chloroform are excellent, but expensive. *Ethyl acetate* is cheaper, and is preferred by some professional collectors. You can get it at the drug store, or from chemical supply houses, which are listed in the classified telephone book. When you order, ask for the technical or commercial grade. The medical quality costs more, and is not necessary. Eight ounces should last you a long time. Carbon tetrachloride, another effective killing fluid, is sold by most drug and department stores as a spot remover, under the name of Carbona, and others. No matter what they call it, the technical name is always somewhere on the label. Carbon tetrachloride leaves the specimens stiffer than do other poisons, but except in the case of butterflies which are to be mounted at once, this does not matter much.

Saturate the plaster in your jar at the beginning of every day's collecting. The liquid may be run down the inside of the bottle, or dropped in with a medicine dropper or a spoon. It will be absorbed more quickly if the whole surface of the plaster is not covered with liquid at one time, as this tends to seal in the air, which must come out before the fluid can occupy its space. The damp part of the plaster will be slightly gray, and you can watch the stain spread until it reaches the bottom all around. The bottle is then ready to use.

Keep the killing jar tightly closed except when putting in the specimens, or taking them out. Although you should not need it, you might carry a small bottle of extra killing fluid on a long trip. If the bottle is not operating efficiently, a quick sniff will tell you whether or not to re-charge it. But do not sniff too often or too long. The fumes of all those killing fluids make some people ill.

If the bottle has been over-loaded with liquid, and the specimens are dampened by it, do not be alarmed. It will dry off without doing any damage.

A jar intended for heavy bodied insects may be cushioned with several strips of paper towelling, which absorb the moisture of the specimens, and help to prevent them from clawing and biting one another. A Lepidoptera bottle should contain nothing but moths or butterflies, and not too many of them at once.

A killing jar of this kind works rapidly. It will "knock out" most insects in less than a minute, and thoroughly kill them in five. Some species, however, are very hard to kill, and, just to make sure, you had better leave everything in the jar for half an hour. It is very distressing to have a specimen come to life on the pin.

A pair of tweezers is very useful for taking insects out of a bottle. For butterflies they are essential, as these cannot be touched with the fingers without ruining their appearance. Slender, pointed tweezers can probably be bought at a drug store, but smooth broad-ended stamp forceps, which you can find in a stamp-collectors shop, are better for butterflies.

If possible, mount your specimens on the same day that you catch them. If there is not time for this, put them away between layers of thin glazed cotton or soft paper, in a tight box. The box should be left open in a warm dry place for several days until the insects have dried out thoroughly. Then, before closing, put in a teaspoonful of paradichlorobenzene moth crystals to prevent mold and keep out the carpet beetles. "Para" is sold by drug and ten-cent stores under various trade names, of which di-chloricide is one. The full chemical name is somewhere on the box in small letters.

In an emergency, when there is not time or means to make a plaster-bottomed bottle, an acceptable substitute can be thrown together with cotton and blotting paper. Pack the cotton into the bottom of the bottle as tightly as you can, and secure it with a disc of heavy blotting paper, cut to fit the inside of the bottle snugly. Such a jar works exactly like a plaster-bottomed one, but is not effective for so long a time. The cotton wad is apt to be dislodged if the bottle is jolted.

The proper methods of mounting insects, and of relaxing those which have been dried unmounted, are discussed in leaflets numbers four and five.

Direction Leaflet Number Two

HOW TO MAKE AND USE INSECT NETS

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In the popular mind the insect net is the trade-mark of the entomologist, and although a majority of insects can be captured with the fingers, a net of some sort is a necessity to every general collector. Professional collectors may have a battery of them, from a teacup-size wisp of silken gauze, for the most delicate midges, to an iron-bound canvas laundry-bin of a beating net, used to dislodge hidden specimens from bushes and trees. The amateur collector will probably require a single medium-sized net only. This may be purchased at a scientific supply house, but it is so easy and inexpensive to construct that many people prefer to make their own.

Essentially, the insect net is a cloth bag, held open at one end by a rigid hoop attached to a handle of convenient length, the whole as light in weight as is consistent with moderate durability. Any suitable materials, put together in any workable manner, will produce a satisfactory result. The directions here given are the simplest we have been able to devise, the materials such as are readily available in any neighborhood shopping center, if they are not already in the house, and the dimensions those of a good general-purpose aerial net.

MATERIALS

From the hardware store:

- 4 ft. ⅛ or 3/16 in. iron wire, or the wire hoop of a barrel or nail keg.
- A ¾ in. dowell, or old broom handle.
- 2 staples, about ¼ in. between the points.
- About 4 yd. of very strong twine.
- A very small quantity of laquer, varnish, or shellac. A bottle of clear fingernail polish will do very well.

From the dress-goods or upholstery shop:

- ¼ yd. of unbleached muslin, or any strip of strong cloth about 4 in. wide and some three inches more than long enough to reach entirely around the hoop of your net frame.
- A spool of sewing thread, no. 40.
- 1 ¼ yd. of good strong netting, 1 yd. wide. Coarse nylon marquisette is excellent, but there are several other suitable materials — heavy tulle, brussels net, and various curtain fabrics, for instance. For greatest durability, the threads should be twisted around each other at the intersections, rather than simply interwoven, although a good quality of cheese cloth will give fair service at much smaller cost. The mesh should be small enough to retain the insects, and large enough to permit the free passage of air. Color is not important. Most commercial nets are white. You can see enmeshed specimens most easily if the fabric is black, and some collectors think that a green or brown net is less visible to the insects.

Since good netting is apt to be expensive and comes in several widths, you may want to be more precise in your measurements when you buy. In that case, finish the frame of the net first, and then make a paper pattern for the bag. Take this with you, and no matter what the width of the material you select, you can easily determine exactly how much you will need to cut your bag in the most economical manner.

Before you buy any netting at all, find out whether there is not, in the family, a tulle gown which has gone out of fashion. This should keep you in insect nets for years. There is no objection to piecing the material if necessary.

TOOLS

- A pair of wire-cutters, or a hack saw, to cut off the hoop-wire, if it is too long.
- A hand drill, with bit about 1/16 in. larger than the wire.
- Sandpaper.
- A hammer.
- A piece of string.
- A saw, to cut off the handle, if necessary.
- Scissors.
- Sewing machine, if available.
- Needle.
- Pins.
- Tape measure.

MAKING THE FRAME

With the hand drill, make a hole straight through the stick, from side to side, about three quarters of an inch from one end, and another not less than half an inch below the first.

Smooth the end of the stick and the edges of the holes with sandpaper, so that no splinters remain to catch in the fabric of the net.

Make a right-angle bend in the hoop-wire about four inches from one end. You can do this with pliers, if you have strong hands, but it is much easier to clamp the short end in a vise and bend the long end over. If no vise is available, the wire may be bent over any sharp-edged object of sufficient durability by hammering; but do not try this on the dining table, for the surface is certain to be marred.

Pass the straight end of the wire through the upper hole in the end of the handle, bend it around in a loop, and pass it through the lower hole in the same direction. Pull it up until the loop is 12 to 14 inches in diameter, and mark, on the wire, the place where it leaves the handle. Pull it further through, and make, at the point marked, a second right-angle bend, so that the two ends of the wire are parallel. Do not try to do this by bending the wire against the edge of the hole, or you will almost certainly split the stick.

If the second end is much more than 4 inches long,

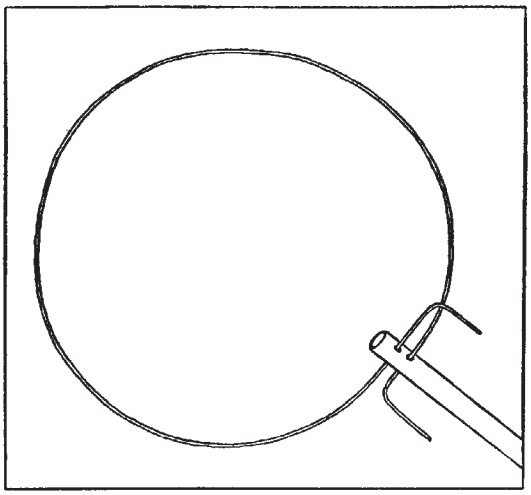

Fig. 1. Frame of insect net, before whipping.

remove the surplus. The frame will then look like fig 1.

Bring both ends of the wire to lie along the sides of the stick as closely as possible and tie a string around them, near the top, to hold them in position. Secure each end with a staple driven into the wood about an inch above the tip of the wire, as shown in fig. 2. Then remove the string.

Make, in one end of a piece of strong cord, a loop about two inches longer than the ends of the wire. Place this loop close beside one of the wires, with the closed end at the top of the stick. Leaving the short end protruding for an inch or more at the bottom, wind the long end spirally upward around the stick, from just below the ends of the wires to within half an inch of the lower bend, keeping the turns tight

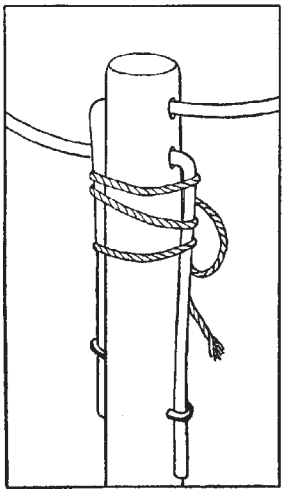

Fig. 2. Net handle ready for whipping.

and close together. When you reach the top, pass the end of the cord through the loop, as is shown in fig. 3, and pull downward on the other end. This will cause the loop to vanish into the space at the side of the wire, taking with it a loop of the free end of the cord. When the bulge in the whipping tells you

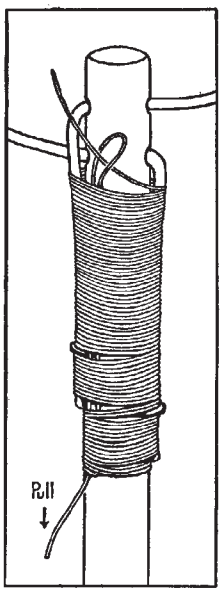

Fig. 3. Whipping the handle.

that this knot has reached the middle, cut off both ends. Then soak the whipping in laquer, varnish, or shellac, and allow it to dry over night, or longer, if necessary.

MAKING THE BAG

The bag may most easily be made of a single piece of cloth, folded double, lengthwise if the fabric is

narrow, or across the bottom if it is very wide. The shape is variable, but it should taper somewhat toward a rounded bottom without coming to a point. Specimens lodged in a sharp corner are difficult to extract. At the top edge the bag should measure about two inches more than the circumference of the hoop, much better too large than too small. In depth, twice the diameter of the hoop is satisfactory, though some collectors find 1 ½ diameters sufficient, while for others 2 ½ is not too much. Several successful shapes for net bags are shown in fig. 4.

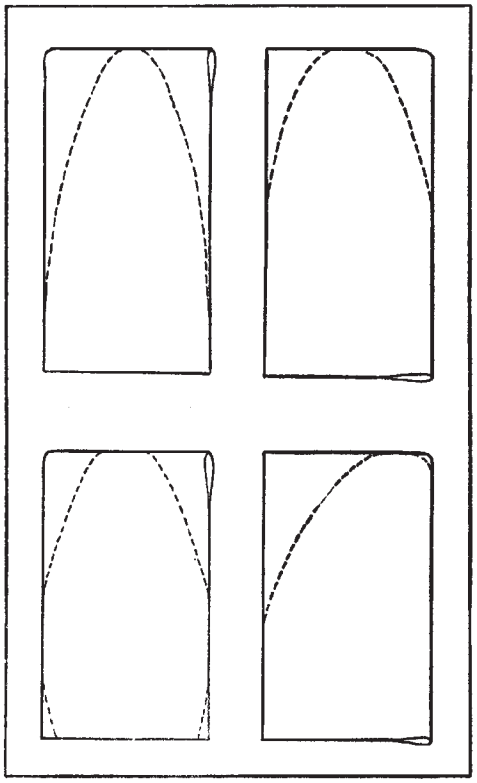

Fig. 4. Variations in the cut of insect nets.

Measure your frame carefully with the tape measure, and plan your bag to fit. If you do not care to make a paper pattern for it, you may draw the design onto the folded cloth with a crayon, or lay it out with pins. Cut the cloth to shape, and pin the edges together to hold them while you sew. Make the seam about half an inch wide, using a sewing machine, if you have one. If you have not, a small back stitch or a running stitch fastened every inch or two will do. These stitches are diagrammed in fig. 5.

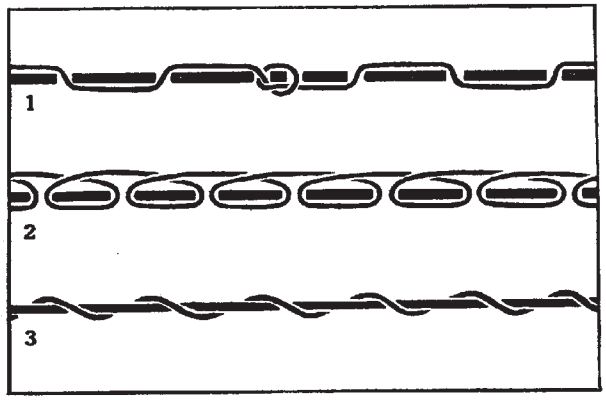

Fig. 5. Stitches useful in sewing an insect net by hand.
1. Running stitch, fastened.
2. Back stitch.
3. Overcasting.

When the seam has been stitched once, turn the raw edges under, together, and sew them down onto the body of the net. If you are using a machine, stitch as close to the fold as you can, if you must work by hand, overcasting will be more secure. This kind of flat seam is called a fell, and is illustrated in fig. 6.

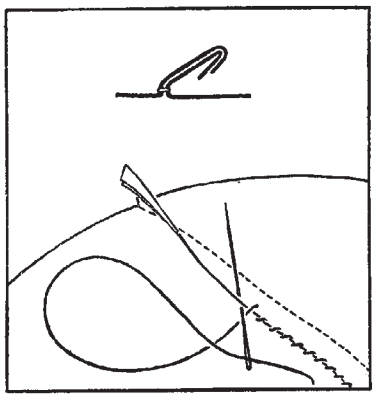

Fig. 6. A felled seam, used in sewing an insect net.

It is used because it gives the specimens no crack in which to hide, no matter which side of the net they occupy.

Make a strip of muslin or other strong cloth about four inches wide and an inch and a half longer than the top edge of the net. At each end of this, make a half inch hem, as shown in fig. 7. Pin this band around the inside of the net bag, matching one long edge with the top edge of the net. Join them with a half inch seam. If the ends of the band overlap a little, there will be less danger of ripping the net at the point of juncture when it is in use.

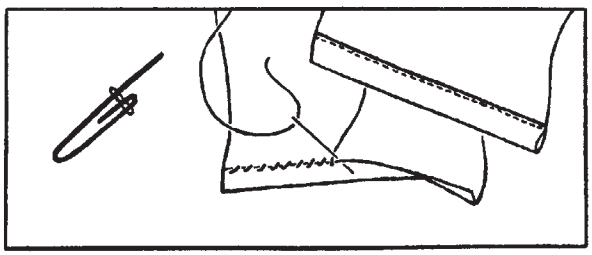

Fig. 7. Hems, hand and machine stitched.

When stitched on, turn up the muslin band to form a continuation of the bag, with the free edge of the band at the top. Turn the raw edges of the seam up onto the outside of the band. Place the bag inside the hoop with one hemmed end of the band on either side

of the handle. Fold the band down over the wire of the hoop, turn the free edge under about a quarter of an inch, and overcast it to the seam at the top of the netting, as shown in fig. 8. This strip of heavy cloth

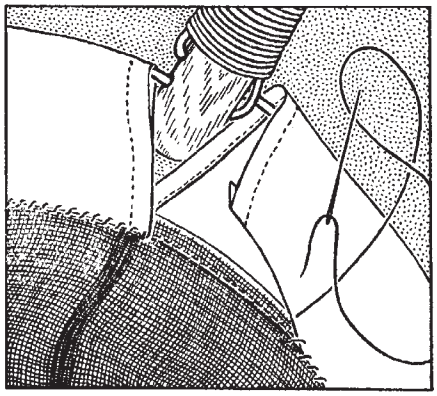

Fig. 8. Sewing the bag to the hoop.

at the rim of the net can take a great deal more abuse than can the delicate mesh, and greatly prolongs the utility of the net.

When the net is finished make a few practice swings with it. If the handle is too long for your convenience, cut it down to a length which you can manage easily. In the handling of a net, maneuverability is more important than reach.

USE OF THE AERIAL NET

A net of this kind is used principally to capture insects on the wing. Only experience can teach you how to approach each kind, for some, when alarmed, will fly upward while others drop, or dodge. Once in the net, however, a specimen may be kept there by quickly inverting the rim of the net, thus bringing the bag together and keeping it closed by its own weight. This is a basic trick of the insect collector, and should be practiced until it becomes automatic. It is diagrammed in fig. 9.

The process of getting the insect out of the net and into the killing jar although complicated to describe, soon becomes easy to perform. Assuming that you handle your net with the right hand, grasp the net fabric between the left thumb and forefinger so as to imprison the specimen in the smallest possible fold of cloth. Let go of the net handle, and, taking the killing bottle in your right hand, open it by grasping the lid or cork between the third or fourth finger and heel of the left hand. Insert the bottle into the net, as close to the specimen as you can get it. Release your hold on the net fabric and use the left hand to drop or knock the insect into the bottle and keep it there by covering the bottle's mouth with the palm. With practice, you will learn

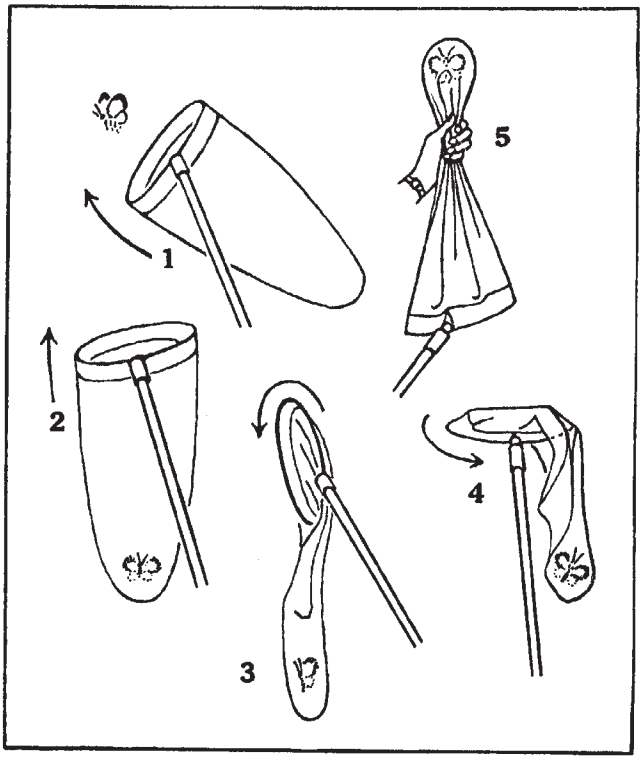

Fig. 9. Aerial net in operation.

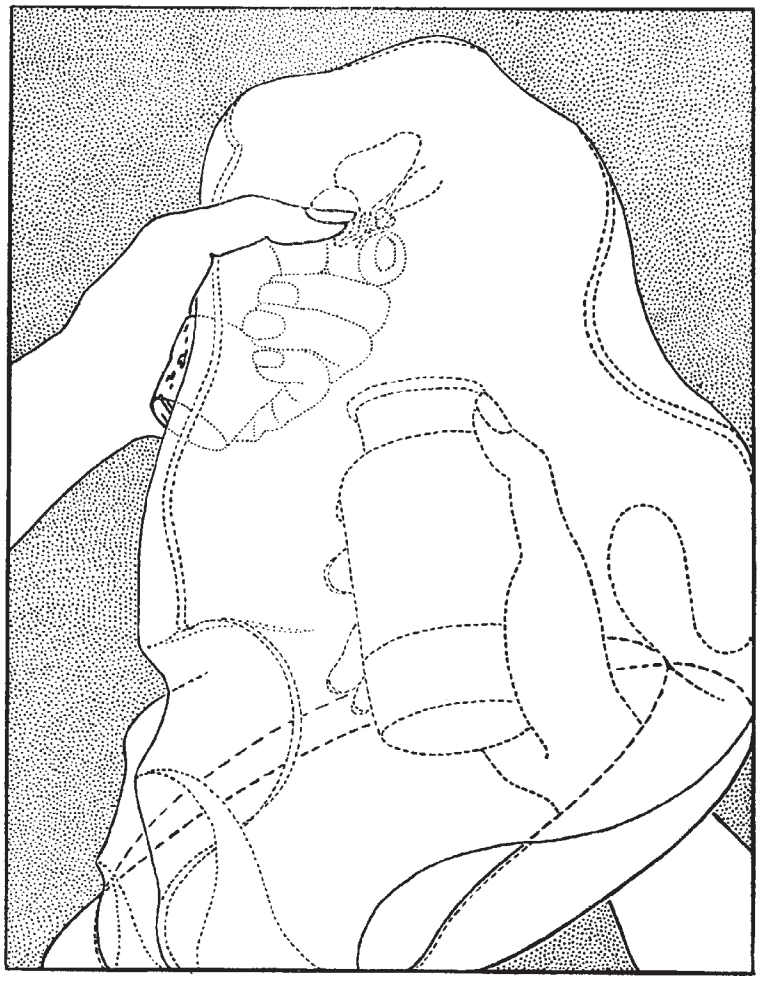

Fig. 10. Removing a butterfly from the net.

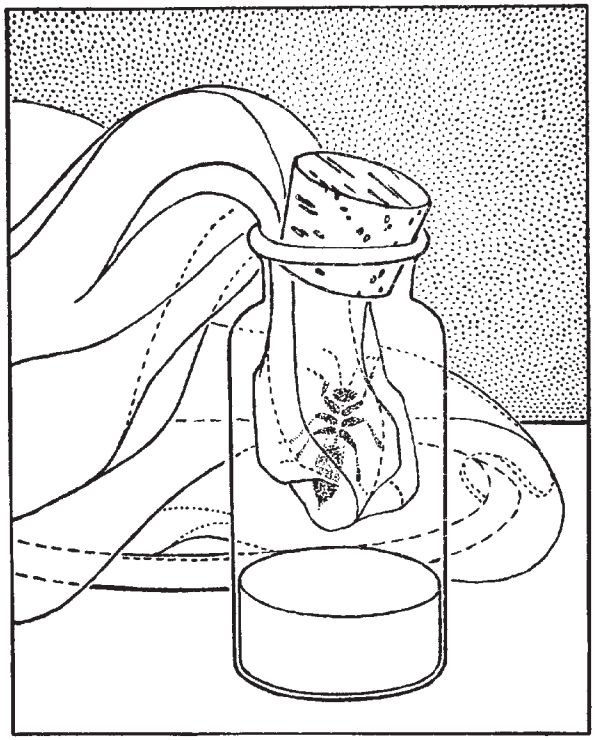

Fig. 11. A method of dealing with species that bite or sting.

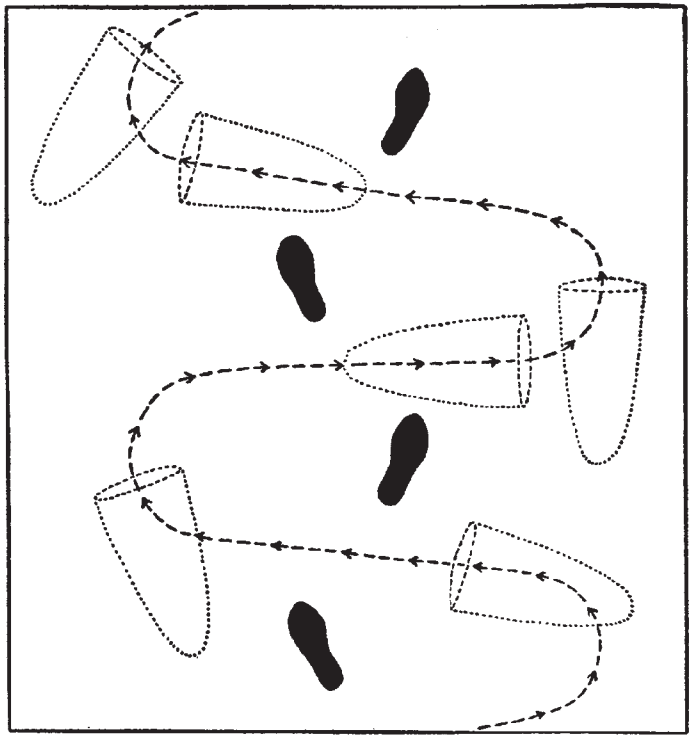

Fig. 12. The technique of light sweeping, showing the paths of the collector and his net, with the positions of the bag during the stroke.

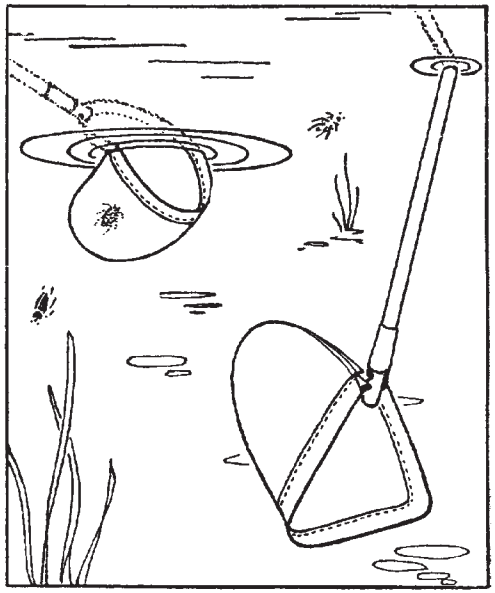

Fig. 13. Aquatic nets; dip net above, scrape net below.

to do this while retaining your grip on the stopper with the little finger. Then, holding the bottle through the netting with the first fingers of the left hand, take the stopper in the right and slip it under the net and into place.

Butterflies and large moths which flutter violently may be held through the net by the sides of the thorax, just under the wings. Some collectors claim that a hard pinch at this point will paralize the wings and prevent the specimen from battering itself as it flaps in the bottle. Others say that pinching ruins the specimen. You might try it and see. The process is illustrated in fig. 10.

Fig. 11 shows a simple method of dealing with species known or suspected to bite or sting; wasps, bees, and many of the beaked bugs, for instance. These should be corked up in the killing jar, while still enmeshed in a fold of the net, until they have stopped kicking. They may then be picked out of the net and dropped back into the bottle without danger.

SWEEPING

This is a wholesale method of collecting by swinging the net back and forth through tall grass or forest undergrowth, as diagrammed in fig. 12. The catch includes insects in all stages of development, spiders, and other creatures, together with a considerable quantity of leaves. The whole may be dumped into the killing jar at once, but as this results in the destruction of a great many harmless animals of no interest to the collector, it is probably better to open the net and pick out, with fingers or tweezers, the specimens you wish to keep, and let the others go. If too many valuable specimens escape, try putting the lot, net included, into the killing jar for a few minutes, as you would a stinging insect. When all are quiet, you can pick them over at more leasure. The rejects will shortly revive and go on about their business.

Although an ordinary aerial net may be used for sweeping where there are no bushes or brambles, a special sweeping net will give better and longer service. The hoop should be stronger than that of the aerial net, and the handle so short that the hoop just clears the ground when the hand holding the net hangs loosely at the side. The bag of this net is made entirely of muslin, no netting at all. Stronger and heavier yet is the beating net, used in sweeping bushes and the branches of trees for their hidden occupants.

AQUATIC NETS

Water is so much denser than air that an aerial net is quite unmanageable in that medium. Nets for use in water should be small, very strong, and proportionally much shallower than the aerial net. Since most aquatic insects are awkward out of their element, they need not be secured by inverting the rim of the net. To lower resistence to the water, and permit as much debris as possible to wash out of the net, the mesh should be the largest that will retain the desired specimens. In addition to the round dip net, thorough collectors may use a triangular scraping net for species which inhabit the bottoms of streams and ponds. See fig. 13.

If, in an emergency, you find it necessary to use an aerial net in the water, shorten it temporarily by wrapping the bottom of the bag around the handle, grasping it firmly just behind the rim.

Direction Leaflet Number Three

HOW TO COLLECT INSECTS AND SPIDERS FOR SCIENTIFIC STUDY

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A collection of insects and spiders, like almost any other collection, derives its value from its scope, its condition, and the extent and accuracy of the information which it conveys. A theoretically perfect entomological collection would contain many perfect specimens of both sexes of every existing kind, from every possible locality, and every day of the year, together with a complete account of the life history and habits of each creature. Of course, this ideal has not even been approached by the combined efforts of all the collectors since the beginning of systematic biology; but any student, professional or amateur, if he is a careful workman and an accurate observer, can contribute something toward its achievement. He may, quite possibly, discover one or more new species, although he must be very highly trained to recognize them. He is far more likely to record an old species from a new place, or to observe some familiar creature about its unfamiliar business. That is why the habit of note-taking is so important to the scientific collector. Virtually nothing is known about the private lives of the great majority of insects and spiders. Any one who watches them work in their natural habitats and writes down exactly what he sees, season by season, is certain, over a period of years, to amass a great deal of information hitherto unknown.

This kind of work is an important part of the science of Ecology. To do it, you need patience, persistence, and an orderly method of recording your observations. You must keep at least one specimen associated with each item of information, so that no mistake in identity is possible, and bits of an insect's story picked up at various times and places can be assembled with certainty, even though you may not know the creature's name. The species must, however, be identified before you attempt to make your observations known.

Many beginners will find it interesting and profitable to establish correspondence with professional or advanced amateur entomologists of kindred tastes. Almost any University, Natural History Museum, Entomological Society, or State Department of Agriculture could put you in touch with some of them. They are happy to guide your choice of technical literature, and to help with difficult identifications. If you happen to make an important discovery, they can tell you what to do about it. In return, they may ask you for duplicate specimens of interesting species and permission to quote you, among other observers, on topics pertinent to their own investigations. This amicable association is one of the pleasant things about a scientific hobby, and a source of satisfaction to both the beginner and the experienced student.

WHEN AND WHERE TO LOOK FOR INSECTS

Unlike some other animals, most insects stay in one general locality day and night the year round, and may be found at any time by a collector who can recognize them in all stages of development, and who knows their habits well enough to guess what they are doing under the prevailing circumstances. To be sure, you can catch more specimens per hour of collecting in summer than you can in winter; and although many insects are abroad by night you are less apt to see them than the diurnal species; but out-of-season and odd-hour collecting are much more likely to produce unusual results.

There are more species of insects in the world than of all other animals together, and probably more individual insects than any other kind of creature large enough to see with the unaided eye. As might be expected of so great a population, they inhabit practically every habitable portion of the globe. With the single apparent exception of the depths of the sea, all imaginable and some unimaginable places have their six-legged residents.

Insects abound, for instance, upon and beneath the earth itself. You can find them scuttling over bare rocks, the open sand of beaches and deserts, the loose soil of gardens, the beaten paths of the country, and the pavement of city streets. They creep about under the grass of lawns, the moss of forests, and the lichens of the arctic tundra. They lurk beneath stones, logs, compost piles, fallen leaves, and flood derbis of river and seashore. In arid regions, the roots of plants

may harbor a multitude. Burrowing species make their homes in humus, sand, packed clay, or the sodden mud of river banks and marshes. In the dry dust under porches, or in the shelter of cliffs and the mouths of caves, Ant-lions make their little sand traps. In the depths of caves, perpetual darkness hides a curious insect fauna of its own, a limited but specialized population which should be investigated whenever opportunity arises.

Most adult insects fly, and when the air is warm enough it swarms with them, especially in the vicinity of flowers. In our northern Spring, the inconspicuous blossoms of shade trees are well attended. All summer long garden and meadow bustle with bees, flies, wasps, and butterflies from dawn till dusk; and, with twilight, the crepuscular and nocturnal forms begin their night's activity. Large numbers of these are attracted to lights, and can be trapped, netted under street lamps, or picked off of window screens. Adults of species which are aquatic when immature may often be taken on the wing above ponds and streams, while predaceous species are frequently found "hawking" along hedgerows, roadsides, and forest paths and clearings. Barnyards, too, are worthy of attention, yielding, especially, biting and parasitic flies, and such species as may feed or breed in filth.

Lake, and mud puddles, rivers and ditches, fresh water in any quantity is well provided with aquatic insects. So is the salt water of the tidal zone. Some of the creatures skate upon the surface without wetting their feet. Some dive when alarmed. Some are skillful swimmers, while others creep upon the bottom, burrow in mud, bore in aquatic plants, or cling tenaciously to the polished stones of swift-running mountain streams. There are insects in arctic waters which are frozen solid a great part of the year, and in thermal springs so hot that few forms of life can endure them. Rainwater caught in footprints, tin cans, hollow trees, and eaves troughs soon swarms with insect larvae. Even a neglected bowl of flowers in your parlor can harbor a generation of mosquitoes.

Plants of every size and condition, from the little green algae on the tree trunk to the great tree itself, afford room and board to countless six-legged "guests." Seed, seedling, growing plant, mature, dying, dead, dry, decaying, rotten, and reverted to the earth, plants in all stages support insects of all stages, wherever plants and insects grow. Leaves, flowers, and fruits may be devoured entire or delicately mined from within. Sap and nectar may be sucked, twigs pierced, stems hollowed, pith excavated, bark gnawed, trunks and branches riddled, and roots bored. Most of these activities leave traces by which the astute collector may discover the actors. While looking for them, you will also come across a variety of casual visitors, nocturnal creatures passing the day in a convenient crevice, fleet-winged species resting in the sun, as well as predators and parasites deliberately seeking the more permanent residents.

Plant galls amply repay investigation, producing not only the original causative insect, but also parasites and the uninvited guests called inquelines. Since all such creatures are small, and most of them minute, it is necessary to take the galls home and rear their inhabitants in captivity to be perfectly certain of their association.

Animals, too, have their hexapodous associates. Mammals, birds, reptiles, and even fish, are subject to the attack of parasites, external and internal. Many of these are specific to a particular host, and a systematic examination of all available animals will reveal a considerable assortment. Insects themselves are almost all parasitized by other insects, and there is a great deal of interesting work to be done in establishing their relationships.

Dead animals, and even their dry bones, attract a different set of insects seldom to be found elsewhere; flesh flies and carrion beetles among others. And, if you are not too fastidious to look, dung also yields its own unique and numerous inhabitants.

Not even Man himself escapes the attention of insects. Some of them simply come for dinner, others take up permanent residence and cannot be evicted without violence. Buildings erected by Man for his own accomodation appeal to insects looking for a good warm place to spend the winter, and some of them like it so well that they stay the year round. All the food gathered and stored by Man for his future sustenance sustains, as well, a numerous hexapodous company. His rugs and clothing, his books and furniture, the very roof over his head and the floor beneath his feet may look like lunch and lodging to one insect or another.

In short, there is, for practical purposes, no place a collector can look in which an insect may not occur. Some localities are richer than others, and a habitat which is thronged this week may be deserted next, but until you have searched a place thoroughly you cannot be sure whether or not insects are hidden there. When you have collected in any area a long time, you will learn what hours, spots, and atmospheric conditions are likely to be most productive. But do not let this knowledge limit your activities. The species aboard in less favorable circumstances may differ from those of the rush-hour crowd. On the other hand, do not ignore a species simply because it is extremely abundant. It may be a strongly seasonal form, available in the adult state for a few days or a few hours only, out of the entire year; or perhaps it is one with a long life-cycle, maturing only at intervals of several years. It could be a very long time before you see the animal again.

LOOKING FOR SPIDERS

All spiders are carnivorous, feeding almost wholly upon insects. They can not fly, and although some of them are expert divers, none of them is truly aquatic; but, within these limits, they follow their insect victims everywhere. Some of them spend the day in silk-lined burrows, underground. Others hide in caves, in cracks, and under all kinds of debris. The herbaceous plants of marsh and meadow shelter a large population as do the trees and bushes of forest and wayside. Almost any flower may contain a camouflaged spider lying in ambush for the unwary fly. The conspicuous silken nets, funnels, and egg sacs of many species will lead you to their inconspicuous owners, and a search of barns, attics, and cellars will produce semi-domestic varieties.

Any person making a general collection of insects is certain to turn up a great many spiders in the process. Since these have been less studied than insects, the chance of finding new species is considerably greater, while even less is known about their habits than about those of insects. If you are not interested in spiders yourself, you can do a service to Science by catching them anyhow, and donating them to some learned institution; or you might profitably establish a trading agreement with an arachnologist in some other part of the world. An advertisement in a scientific journal or popular magazine of natural history would probably uncover a number of people eager to "swap" insects for spiders, the creatures of one area for those of another, or an assortment of species for those of a particular family or genus. Acquaintances formed in this manner may improve with years, and add both to the scope of your collection and to the interest of your hobby.

COLLECTING PROCEDURES

Every serious collector takes pride in the perfection of his specimens. With a collection of insects or spiders, the achievement of this perfection begins in the field. The creatures must be caught carefully, killed quickly, and packed securely, if they are to reach the laboratory in good condition.

The great variety of collecting techniques employed by expert collectors are individually derived from the few basic methods here described. These are dictated by the physical nature of the specimens, their habits, the places from which they must be extracted, and the tools and materials most readily available to the collector. In making a general collection, you will probably, sooner or later, use all of them, but it is not recommended that you try to do so all at once. You would be so hampered by the weight and bulk of your equipment that a maggot could escape you. Much better try them in succession, carrying a minimum of impedimenta, until you have learned the possibilities and limitations of each and which are most suited to your own needs and abilities. As you become proficient, you will devise improvements of your own, and evolve a collecting kit adapted to your personal requirements.

HAND PICKING

This is the original collecting technique, and it is still satisfactory for many insects and spiders. The necessary equipment is equally fundamental, consisting of good eyes, nimble fingers and the following simple articles.

FOR WET COLLECTING

1. Several small bottles with tight stoppers.
2. A supply of preserving fluid.
3. A small water-color paint brush.

FOR DRY COLLECTING

1. Several killing jars, ethyl acetate or cyanide type.
2. Storage boxes with packing material.
3. Some paradichlorobenzene moth crystals.

GENERALLY USEFUL

1. Notebook and dark pencil.
2. Small slips of paper, for locality labels.
3. Small metal boxes, for transporting live specimens.
4. A small, wide-mouthed bottle and a card large enough to cover it. This is used to catch dangerous specimens.
5. A pair of forceps, slender and pointed.

Hand picking is applicable to a great variety of insects and spiders at some stage of development or under some conditions. Many species are naturally sluggish, or even immobile; and few of the wingless varieties are fast enough to escape, when alarmed, if you can manage to keep them in view. Even the swiftest of the winged kinds are easily taken when sleeping, preoccupied, or numb with cold.

Most species large enough to be grasped without injury may be simply picked up with the fingers and dropped into the collecting jar. Wasps and bees, true bugs, Black Widow spiders, and other creatures convicted or suspected of biting or stinging, should be handled with more care. If such a specimen is found in a suitable location, you may be able to catch it between the mouth of the killing jar and its cover. In other places the bottle and card may be more practical. Put the mouth of the bottle over the specimen, slide the card under it, uncover the killing jar, place the two bottles mouth-to-mouth, withdraw the card from between them, jolt the specimen into the

killing jar, and clap on the lid. If you are dexterous with the forceps, you may prefer to use it for handling dangerous species, as well as those too small or too inaccessible to be seized between the finger and thumb.

Creatures too soft-boiled to dry without distortion must be collected and preserved in liquid. These include all spiders, the eggs, larvae and pupae of most insects, and the adults of some. A few hard-bodied insects that are black or dark brown in color, such as dung and water beetles, can stand wetting and may be collected in liquid and subsequently removed, pinned, and dried in the usual manner. Hairy, scaley, or delicate-winged species are collected in liquid only when wanted for dissection, as their appearance is irreparably ruined by such treatment. All species, hard or soft, which are so small that they must be mounted on microscope slides are properly collected wet. Caterpillars which are to be inflated can be collected in liquid, but the color will be better if they are brought into the laboratory alive and dropped into boiling water, or gasses in the dry killing jar, like a hard-bodied insect, and blown immediately thereafter.

A very large number of preserving fluids have been concocted by learned collectors, each claiming some particular advantage. Their formulae are available in technical publications. This museum, however, uses nothing but 95% pure ethyl alcohol, somewhat diluted with water for most purposes. Unfortunately for the amateur entomologist, pure ethyl alcohol, 190 proof grain neutral spirits, is subject to a federal liquor tax which makes its price prohibitively high. Its sale is further restricted by State regulations. In New York State it cannot be purchased without a Doctor's perscription or a permit from the State Liquor Authority. Many scientific institutions, such as university laboratories, hospitals, and museums, have permits, and are also tax exempt, but they may be called to account for every pint they use. If you can arrange to obtain your alcohol from such a source, you are in luck. If you cannot, go to the nearest drug store and find a rubbing-alcohol compound containing 70% of ethyl alcohol. This will be a satisfactory killing fluid for all but the most delicate species. As a preservative, it is just barely strong enough. When a small bottle-full is diluted with the body fluids of several large specimens, it ceases to be effective, and must be replaced. Change the alcohol on even a few small specimens at least once, that on a large lot two or three times, within a few days of capture. Thereafter, renew the liquid whenever it becomes discolored.

For very tiny thin-skinned species, such as aphids and thrips, use a killing fluid containing, by volume, one part of water to three of 70% alcohol, replacing it with straight 70% alcohol the following day. This "stepping up" minimizes the shrinkage caused by sudden removal of water from the tissues.

"Completely denatured alcohol" contains 95% of ethyl alcohol, rendered impotable by the addition of a little wood alcohol and gasoline. You can buy it at many large drug stores, or order it from a chemical supply house, and dilute it as you would pure alcohol to serve your several purposes. To make a killing fluid for delicate specimens, add 6 parts of water to 7 of alcohol. For general collecting, and to preserve very small species, use 2½ parts water to 7 of alcohol; and for preserving those of large or moderate size, 2 to 11. Always replace the killing fluid by the more concentrated preserving fluid within a day or two. The stronger the alcohol, the less frequently must it be changed because of dilution by the natural moisture of the specimens, but too strong a mixture will make the creatures brittle. Laboratory procedures for dealing with soft-bodied arthropods are discussed in Leaflet Number 6.

To look well, a collection of alcoholic specimens should be stored in bottles of uniform design and a limited number of sizes. Those used as standard in this Museum are lipped vials with corks, 2 dram size for small and medium sized species, 4 dram for large ones. Such vials are obtainable at drug stores and scientific supply houses. When purchased in quantity, the price is surprisingly low. Doubling as collecting bottles, a pocketfull of these little storage vials have several advantages over a single large collecting jar. For one thing, you cannot accidentally spill your whole day's supply of alcohol at one time. For another, each species, colony, or associated group of creatures can have a bottle and label to itself. Do not forget the label, date, locality and observations, written in soft pencil on a small slip of paper and placed inside the bottle with the specimens. Color notes will be particularly valuable, as vivid or delicate hues are bleached by alcohol, while creatures which are pale or colorless gradually turn dark brown.

Both the discoloration and the distortion of liquid preservation will be less if you bring back your specimens alive, and kill them by stewing in water heated to just below the boiling point. Let them simmer for five to fifteen minutes, according to size. Then, if they are large enough to handle, puncture each with a needle, to relieve internal pressure, before transferring them to alcohol. Stewing is highly recommended by specialists in the study of larvae, particularly for the preparation of grubs and other wax-white animals. When the beauty of the specimens is more important than economy of time, it certainly repays the extra effort.

If a tight-corked bottle is more than three quarters full of liquid, the air pressure caused by the insertion of the stopper may be great enough to force it out

again, especially if the stopper is wet. Fill your collecting vials about two-thirds full, to allow plenty of room for both specimens and air space.

If, through a shortage of bottles or the unavailability of small ones, you should find it necessary to put more than one group of specimens in a container, be careful to keep them well separated from each other, and inseparable from their proper label. When using a wide mouthed jar, tie up each lot, with its label, in a small twist of cheese cloth. Partition a tall narrow bottle with plugs of cotton or soft paper. To facilitate subsequent unpacking, put two distinct wads between each two successive layers of specimens, so that, should the claws of the creatures become entangled in the fibers, you will not have members of two lots clinging to opposite sides of the same bit of packing.

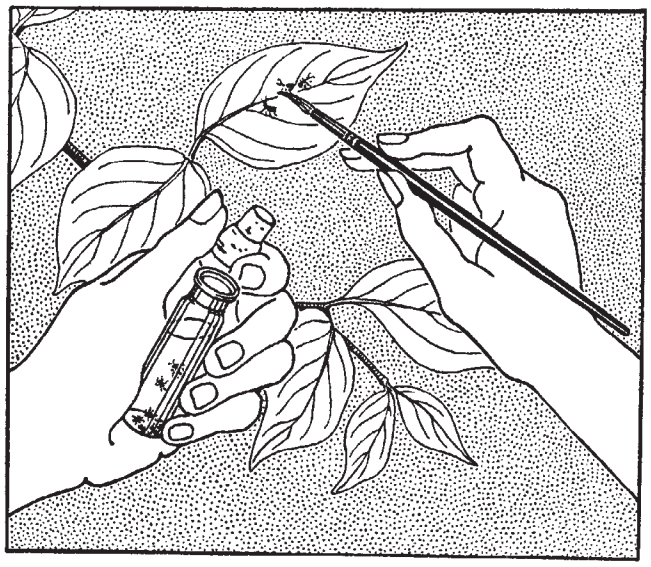

Fig. 1. Using the wet brush to handle minute insects.

Many of the insects and spiders collected into alcohol are too small to be grasped with the fingers, and too delicate to be seized with forceps without danger of crushing. These may most easily be captured by use of a camel's hair brush. A number one or two round water-color brush is perfect. Moisten the brush with killing fluid and sweep up the specimen with its tip, using a sideways prying motion if the creature is tenacious. Once it has released its grip, the specimen will adhere to the wet bristles until it is washed off in the collecting vial. In a pinch the tip of the forceps or the end of a twig can be employed in the same manner.

Although small bottles of alcohol can be carried loose in the pocket with comparative safety, those who specialize in this kind of collecting sometimes use a hunter's vest, carrying one vial in each of the cartridge pockets with which the front of the garment is covered. In buying a vest for this purpose, insist on complete pockets, closed at the bottom, and be sure to use vials that fit them precisely, so as not to fall out when you bend over.

Insects sufficiently hard-bodied to be mounted upon pins are usually killed in a dry killing bottle, and all hairy or scaley ones, moths, butterflies, and true flies especially, must be so collected unless intended for dissection. The construction and use of the Ethyl-acetate or Ether type of killing jar is discussed in Leaflet Number 1; the traditional cyanide jar in Number 7. Although such bottles anesthetize an insect quickly, resistant species may revive if removed less than half an hour after capture. It is unwise to overcrowd a jar, both because the creatures may damage each other while still squirming and because the accumulated moisture from a large lot may condense on the inside of the bottle and stain the specimens. Consequently, on a collecting trip of any duration, it becomes necessary to carry several killing jars to be used in rotation. It will also be advantageous to provide jars of various sizes, so that small and delicate species need not be lost or damaged among the large and durable specimens in a common jar. For a day's collecting you might use one half-pint bottle, for very large specimens; two four-ounce bottles, for those of average size; and several four-dram vials for the very small. Moths and butterflies, being prone to shed their scales, must have a special bottle of their own which is not used for other insects. Since you should never touch them with your fingers, you are not likely to take many Lepidoptera by hand-collecting, although it is possible to knock a sleeping moth into the killing jar without picking it up, or to capture an occasional butterfly by the bottle-and-card technique. Similar precautions should be observed with flies, especially the very hairy ones, the handling of which is described below under "Aerial Collecting."

Specimens should be left in the killing jar no longer than necessary, since prolonged exposure to the lethal fumes may cause discoloration, and the constant agitation to which the bottle is subjected in the field may so batter the catch that it cannot be identified. Only experience can teach you how many specimens a killing jar can safely accommodate, and for how long, but from time to time you should stop adding insects to a bottle, and about half an hour later transfer its contents to a storage box for safer transportation.

The simplest effective field storage box is a strong, tight, pocketsize container filled snugly with layers of thin glazed cotton or cellulose packing material cut to fit exactly. Fill this box from the bottom up, placing the specimens, one deep, between the layers of cotton, and always replacing all the packing before closing the lid, so that the specimens cannot bounce around

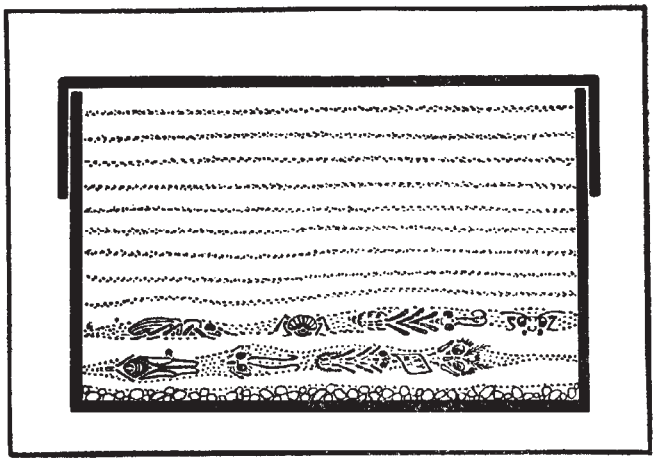

Fig. 2. Diagrammatic vertical section of a field storage box, showing the insects packed between layers of cotton.

in the box. If you put a spoonful of paradichlorobenzene under the bottom layer at the beginning of your trip, its fumes will serve to dispatch any specimen which may not be quite dead when packed. Remember the label, which should be part of every layer, or at least of the top layer of every lot.

An alternate method of packing, preferred by many experienced collectors, is to wrap the specimens in paper envelopes or tubes. The large-winged species requiring envelopes are commonly taken with a net, and their treatment will be described under "Aerial Collecting." Thick bodied and small-winged species, beetles, bugs, hoppers, bees, and many others, may be stored in cylinders made by wrapping a slip of paper about three inches square around a pencil, stick, or any convenient object, and crimping the ends shut, as shown in fig. 3. Before rolling the cylinder, write the data relative to its contents on what will be the outside edge, so that it can be read without unrolling. Fill each cylinder so tightly that the specimens cannot rattle, and keep the tubes themselves from banging around in the storage box by wedging them in with a wad of cotton or crushed tissue paper. When there are enough papered specimens to fill the box entirely, no other packing need be used.

Unless the specimens are to be mounted immediately, the storage boxes should, upon return from the field, be left open in a warm place until the insects have dried most thoroughly. In the moderately dry summer weather of the eastern United States, this may take only a day or two, but very large species may require from one to two weeks. In the humid tropics, forced drying is frequently necessary. When using an oven to dry insects in a hurry, keep the temperature low, about 100 to 120 degrees F. You do not want to cook your catch before it dries.

When the insects are dry, put a teaspoonful of "Para" into each box before closing, to keep out mold and insect-eating beetles and ants. If the lid is not very snug, it will be safer to keep the small storage boxes in a large metal can or cabinet which is tight enough to keep out entomophagous pests as well as mice. So stored, the specimens will keep indefinitely

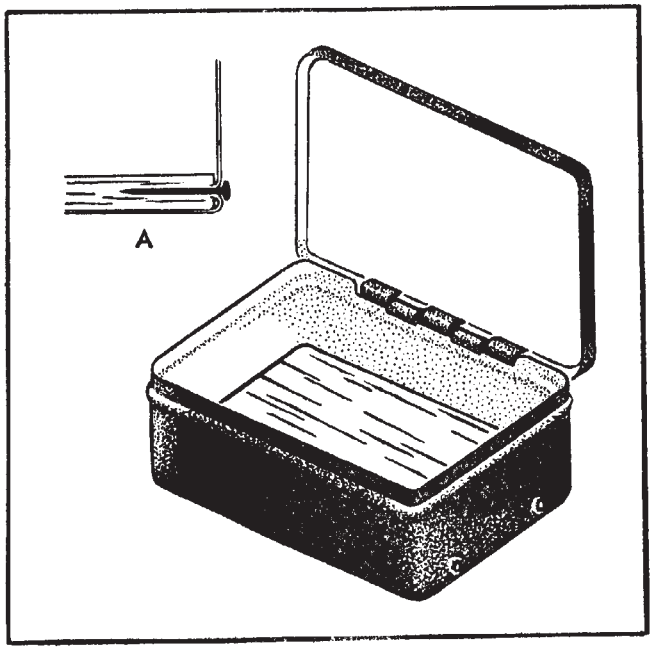

Fig. 4. A pocket relaxing box.
A. Detail of an easy method of securing the absorbent lining.

and need only be relaxed to be mounted. This process is described in Leaflet Number 4.

If the specimens are to be mounted on the day of capture, you can keep them soft and workable until wanted by the use of a pocket relaxing box. Make this of a thin metal box with a tight hinged lid, such as is used for packing ginger, nuts, and some kinds of cigarettes. Obtain a piece of balsa wood or cork about a quarter of an inch thick, and as large as the inside of the box. Fasten it into the bottom of the box by means of a few slender brads driven into the edges from outside, as shown in fig. 4. At the beginning of a collecting trip, moisten this lining, wipe off any excess water, and fill the box with layers of cotton or with papered specimens in the ordinary way. When

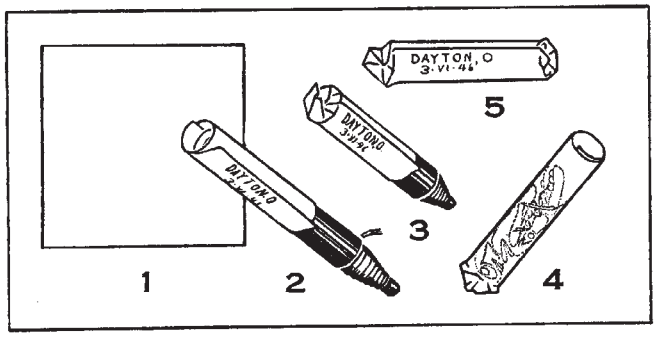

Fig. 3. Steps in making paper cylinders for wrapping large, hard-bodied insects.

you return to your base in the evening the morning's catch will still be pliable and ready for mounting.

Many of the immature insects discovered in the field will be unidentifiable unless reared to maturity in the laboratory. It is easy to get them there alive and well if you have small metal boxes in which to carry them. Baking powder tins, cocoa cans, and salve boxes serve admirably. For convenience in carrying, select them to nest one inside the other when not in use. To prevent injury by jolting, give each creature something immovable to which it can cling, a bunch of leaves, a piece of bark, or whatever the tastes of the species may indicate. A crumpled piece of paper toweling, slightly damp, will also do. Subterranean insects can be packed in their native earth. Whatever material is used should fit the box so tightly that it cannot shift.

Unless otherwise specified, insects and spiders secured by more complicated methods should be killed and packed in the same ways as those which were taken by hand.

is particularly suitable. A killing jar which has contained Lepidoptera should not subsequently contain any other kind of insect as the loose scales cling to oily or hairy specimens so thickly as to obscure their characters and spoil their appearance. Although they can be packed between layers of cotton, moths and butterflies will rub less if each is stored in an individual envelope. Cellophane and waxed paper envelopes of convenient sizes are sold by wholesale stationers. The triangular paper envelope, traditional among Lepidopterists, is shown in fig. 5. Whichever you use, write the data on the outside before putting the insect inside, with the wings folded together over the back.

The very small moths called Microlepidoptera are largely nocturnal, and are commonly taken in light traps. However, when collecting by day, especially in the late afternoon or early evening, you are certain to flush a number of them. If you are prepared to handle them properly, these make the more perfect specimens. Since the insects are tiny and very fragile,

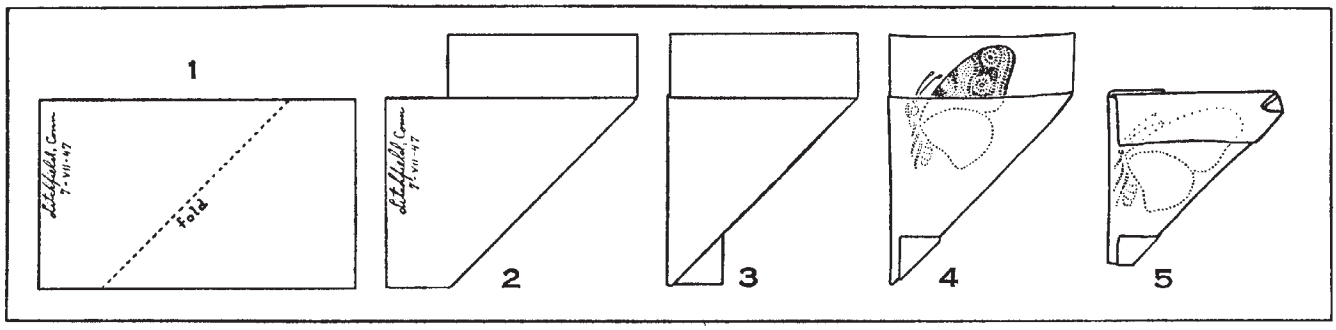

Fig. 5. Steps in making triangular envelopes for packing large-winged insects.

AERIAL COLLECTING

The most conspicuous and characteristic tool of the Entomologist is the insect net, used to capture insects on the wing. The construction and operation of such nets is discussed in Leaflet Number 2.

The size and delicacy of the aerial net confines its use to fairly open country, fields, gardens, roadsides, clearings, deserts, beaches, and the like. Fortunately, it is in just such places that flying insects are most commonly observed. Although beetles, grasshoppers, true bugs, and others are not infrequently taken in flight, the majority of specimens so captured will be moths and butterflies, true flies, dragon and damselflies, wasps and bees, and members of some minor orders.

Of these, moths and butterflies require the greatest care. If the tiny scales with which these insects are clothed become lost, the color pattern goes with them. They rub off very easily and may be detached if touched with an even slightly oily finger, or jostled together in the killing jar. Leidoptera should, therefore, be handled with forceps. A broad smooth stamp-forceps special tools for collecting them are correspondingly small and fine. The best net is of silk gauze, and need be no more than six inches across, with an eighteen inch handle. A killing bottle should contain, at most, three or four moths at once, so several very little vials should be provided. Carry a cork-lined storage box and a supply of "minute nadeln," insect pins about half an inch long and scarcely thicker than a hair. Some collectors prefer pins of standard length, number 000, but these bend so easily that they are a nuisance to handle ever after. Pin the specimens as soon as they are removed from the vial, separating the wings and fluffing up the fringes by blowing on them gently. If possible, spread "micros" on the day of capture. If it is too inconvenient to pin the insects in the field, leave them in the killing vial, which should be very slightly damp, until your return, and then pin immediately. Even with the best of care, it is probable that only about half your catch will be fit to keep by the time it is mounted.

True flies also require special attention in the field. Not only are they often delicate in structure, but

many of them are covered with fragile hairs and spines which are necessary for identification. No heavy or vigorous insect should be put into a killing jar with flies. For the best specimens, use several small killing vials, reserved for Diptera only. With husky species, such as Horse-flies and some Flower-flies, it is safe to fill the vial to capacity and leave it so all day. If it is as much as half full, the natural moisture of the specimens will keep the catch pliable until you return to your base, where you can empty the bottles and mount the specimens in one operation. The less often you handle Diptera, the more perfect they will be. In some groups of flies the male genitalia are used in making an identification and should be pulled out into plain sight at the time of pinning. If the catch consists of frail, pilose, or spiney species, not more than a dozen specimens should be put into a bottle at one time, and these should be removed within two or three hours at the most. Very particular dipterists may carry pins and cork-lined storage boxes with them, pinning their specimens in the field. Others pack theirs between layers of cotton in pill boxes.

May-flies and some other ethereal creatures are on the borderline between the hard-bodied and the soft-bodied, and may be treated as either. Some students keep them in alcohol. Others pin them while fresh, or dry them unmounted and subsequently glue them to the sides of the pins without relaxing.

Grasshoppers and katy-dids, dragon-flies and other thin skinned, bright colored, but heavy bodied insects present a problem. Due to their bulk they dry so slowly that the abdominal contents decay and stain the specimens. Methods of preventing this are varied. Forced drying is one. Evisceration and stuffing is another. Dragon-flies are sometimes placed alive in envelopes and starved to death, a process perhaps not so barbarous as it sounds, since it requires a few hours only. Alternatively, they can be collected into concentrated alcohol. After two weeks in this bath they will be almost entirely de-hydrated and, when pinned, will dry immediately. Green pigmented species, mantises, katy-dids and others, keep their color best if killed and kept for several weeks in a 2% solution of formaldehyde before pinning.

Stone-flies, lace-wings, and other large-winged, slight-bodied insects fit most readily into envelopes; bees and wasps, bugs, and other compact creatures, into cylinders or between layers of packing in a box. Directions for mounting large-winged species are given in Leaflet Number 5.

SWEEPING

The exceedingly rich but largely invisible fauna of thick foliage can be captured wholesale by swinging a net back and forth through herbage, or dragging it quickly through bushes and the leaves of trees. In order to withstand this violent treatment, a sweeping net is made of strong muslin with a heavy rim and short, thick handle.

The catch obtained by this non-selective method consists of assorted botanical fragments, spiders young and old, beetles, leaf-hoppers, true-bugs, grasshoppers and oddments of other orders. In all probability, only a portion of this conglomeration will be of interest to any one collector, and you may have some trouble in selecting from the seething mass the specimens you want. You can, of course, just open the net and peer inside, trusting to luck and your own dexterity to sieze the valuable specimens while allowing the others to escape. You can dump the whole lot into the killing jar and cart it home to sort at leisure, thus needlessly slaying a great many harmless creatures. Or, you can shake the entire catch into the bottom of the net, secure it with a twist, and put net and all into a large killing bottle just long enough to anesthetize the animals. Then empty the net onto a cloth, or any clean surface, pick out the specimens you need, and drop them back into the killing jar or alcohol bottle as their sturcture may indicate. The rejected remainder will soon revive, little the worse for the experience.

Collectors who do a great deal of sweeping sometimes use a separator to facilitate the sorting process. This separator is a box, large enough to contain several handfuls of leaves and having, near the top of one side, an opening at which a glass bottle may be attached. The top of the box is removable, so that it can be emptied easily. In the center of the lid is a hole, with stopper, through which the contents of the sweeping net are introduced. Most of the creatures inhabiting foliage are positively phototropic; that is, they seek the light. They have, moreover, a tendency to climb upward. When enclosed in a dark box they will crawl up toward the light which is admitted only through the glass bottle. When the bottle becomes at all crowded, it is replaced by an empty one. The vegetable debris which remains in the box is removed frequently, before it becomes so tightly packed that the creatures have difficulty in squeezing through it.

Separators are not sold by the scientific supply houses, and if you want one you will have to make it yourself. Remembering the principle by which it works, you can use whatever materials are most convenient to you. The separator shown in fig. 6 is made of a large metal cracker box, such as some grocers use. The glass bottle is a pint canning jar, the kind with a flat glass lid held down by a threaded metal rim. This rim is soldered to the box, and surrounds an opening almost as large as the mouth of the jar, which can thus be screwed onto the box in a moment, and just as readily replaced by a similar jar. The receiving hole in the lid is equipped with a wide-mouthed

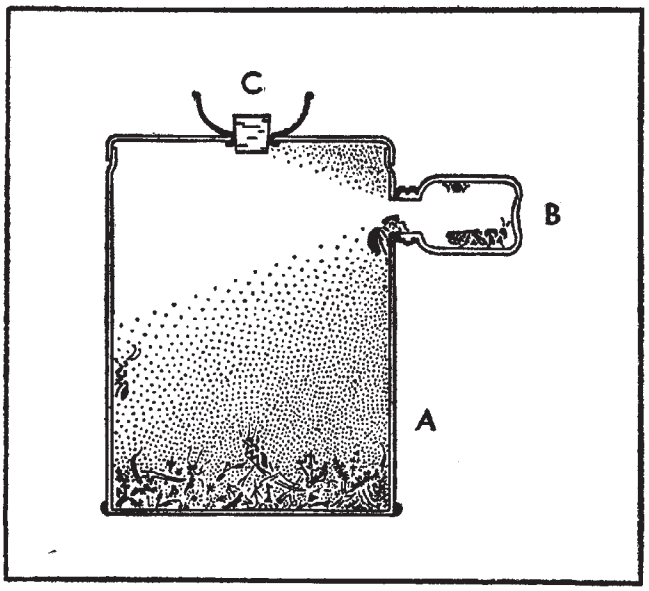

Fig. 6. Diagram of a separator for collecting positively phototropic insects and spiders.
A. Metal box containing sweepings.
B. Replaceable glass jar.
C. Receiving hole with funnel and cork.

funnel, made for filling canning jars, and is closed by a large cork.

Sweeping is most successful in neglected fields, abandoned meadows, marshes and the edges of woodlands. In the deep forest, or in grazed and cultivated areas, it is less productive. More insects are taken by this means in the early morning and late afternoon than in the middle of the day.

BEATING

Many insects not otherwise obtainable can be jolted out of trees and large bushes by thumping the branches vigorously with a club. The specimens dislodged will inevitably be lost unless provision is made to receive them. The larger the receptacle provided, the greater the proportion that will be captured. If a party of collectors work together, they may appoint one member to do the beating while the others station themselves around a bed-sheet spread upon the ground, ready to sieze whatever may fall onto it. An individual collector will probably prefer something less cumbersome, a square yard of muslin or a bridge-table cover, for instance. So small a beating sheet is more efficient if it can be spread upon a light collapsible framework and held immediately under the branch which is being beaten. A very simple frame is shown in fig. 7. It consists of two strips of wood crossed at right angles and feastened at the intersection with a small bolt and wing-nut. Such an arrangement can be improvised in the field with a couple of saplings and a piece of twine. The cloth is fastened to the frame by means of tapes or loops of strong elastic sewed fast to the corners, and can be as large as you care to manage. An ordinary big black umbrella with a crooked handle makes a serviceable beating cloth, if held bottom up; while the crook is handy for pulling down branches too high to reach unaided. The black color may be an advantage, as it is said that, although they are harder to see, the specimens are not in so great a hurry to leave a black cloth as a white one. A sweeping net will also serve and, though rather small, it is so deep that few of the specimens which drop into it are able to climb out before you can sieze them. The beating net, wide, shallow, heavy, and very strong, serves as both cloth and club. It is operated by ramming its rim against branches and the trunks of slender trees, but it is so exhausting to handle that few collectors find it worth the effort. Beating is most productive when applied to solitary trees, or to those in hedge-rows and at the edges of woods. Dead and ailing trees should be beaten, as well as flourishing ones, since they attract a different fauna. Blooming trees are particularly rich.

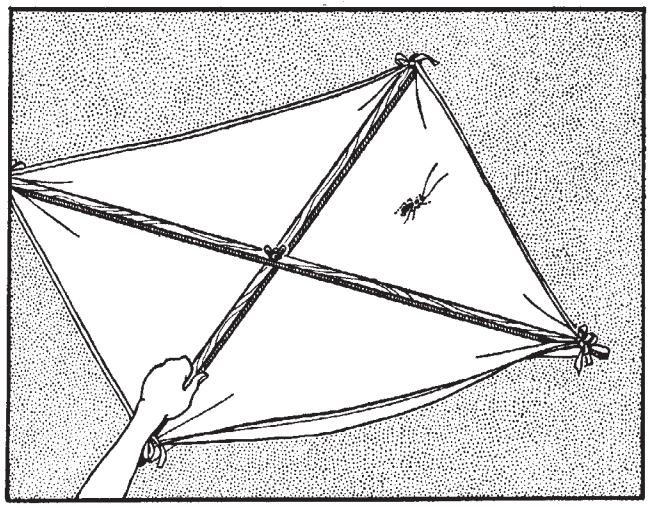

Fig. 7. A simple collapsible beating cloth.

AQUATIC COLLECTING

The insects which cling to rocks, pebbles, logs, and plants beneath the surface of water can easily be caught with forceps, once seen and brought within reach. Half-submerged tree trunks and rocks too large to lift must be inspected as well as may be possible where they lie, but stones, sticks, and vegetation small enough to handle can be picked up and examined thoroughly. When exposed to air, the specimens will soon betray themselves by their activity. Approach the swimming species suddenly, from below, using a dip-net, or a kitchen sieve lashed to the end of a pole. Drag this net through aquatic vegetation to secure the beetles and bugs which lurk in such places. In still water, the bottom-dwelling forms may most readily be taken by dredging with a scrape-net, which is flat

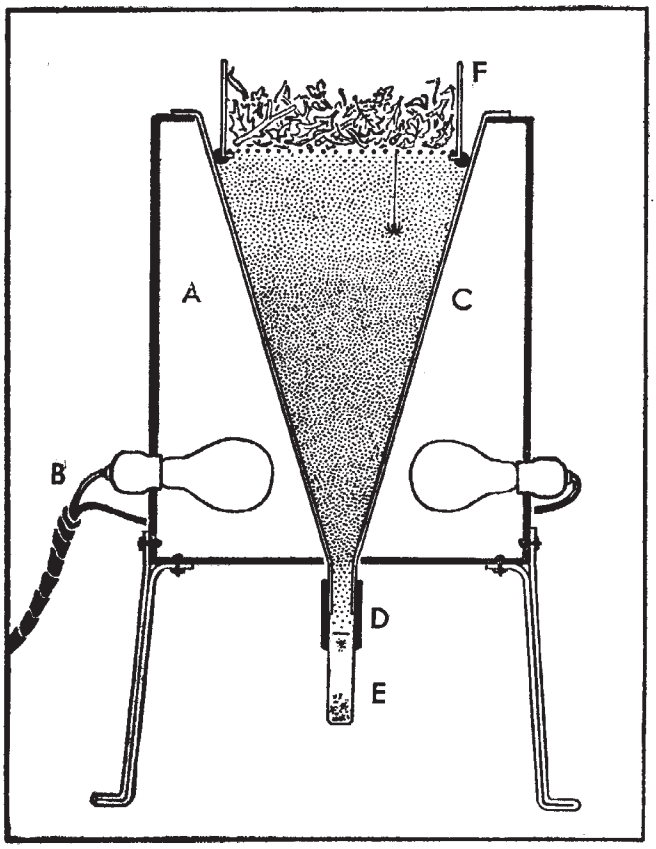

Fig. 8. Diagram of a separator for negatively phototropic insects and spiders.

- **A. Tight box.**
- **B. Lamps to heat the separator.**
- **C. Funnel, made of thin polished metal. It is separate from the box and is lifted out when it is necessary to reach lamp bulbs.**
- **D. Section of rubber tubing.**
- **E. Glass shell vial full of alcohol.**
- **F. Mesh-bottomed container for debris. You will want several, with mesh of various sizes for debris different fineness.**

on the bottom edge. Both these nets are described and illustrated in Leaflet Number 2. In shallow running water, hold the net in one hand, with the lower edge of the rim pressed against the bottom and the mouth of the bag facing upstream. Just above the net, stir the mud and agitate the stones with the other hand. The creatures so disturbed will be carried into the net by the current; the mud and smaller vegetable fragments will wash through the mesh.

Debris left on the shore by a recent flood, freshet, or spring tide, may be simply swarming with insects washed out of their inundated homes. So also may the flotsam caught in a whirlpool or eddy. If an inspection convinces you that such is the case, it will repay you to shovel the debris into a burlap bag, drain it, and put it into a separator to extract the creatures, most of which, unlike those taken in sweeping, are likely to be negatively phototrophic. That is, they will seek darkness, and crawl downward in the search. Accordingly, the separator required must work on opposite principles from the light separator described above. One such device is called, after its inventor, the Berlese Funnel. As the name indicates, it is a funnel, very large. At the top is a wire mesh basket to contain the debris; at the bottom, a bottle of alcohol to receive the specimens. The insects, distressed by the light from above and the drying of the debris, try to bury themselves further. They fall through the wire mesh, and being unable to keep a foothold on the polished interior of the funnel, drop into the bottle and are automatically collected. This process is hastened by warming the funnel. Berlese used a water-bath heated by a Bunsen burner for this purpose, but a box full of lamps, or some other electrical contrivance, would be just as effective, and easier to make. This separator is shown in fig. 8. It works as well for leaves and leaf mold, moss, lichens, bark and fungi as it does for flood debris or soil samples.

When working in the vicinity of water, do not neglect to look inside culverts and on the undersides of bridges, as well as among leaves in shady places, for the adult forms of species whose larvae inhabit the adjoining streams and ponds.

SIFTING

The many insects and spiders living among fallen leaves, rotten wood, fungi, and other moist, rich, fragmentary matter are, on the whole, so small and inconspicuously colored as to escape attention in their natural surroundings. As described above, they can be efficiently extracted by use of the Berlese separator. Less comprehensive but more immediate is the process called "sifting," whereby the creatures are shaken out of their hiding places on the spot. The necessary tools are a deep large-mesh sieve and a cloth onto which the specimens may fall. If you have a beating cloth, that will do. If not, get a somewhat

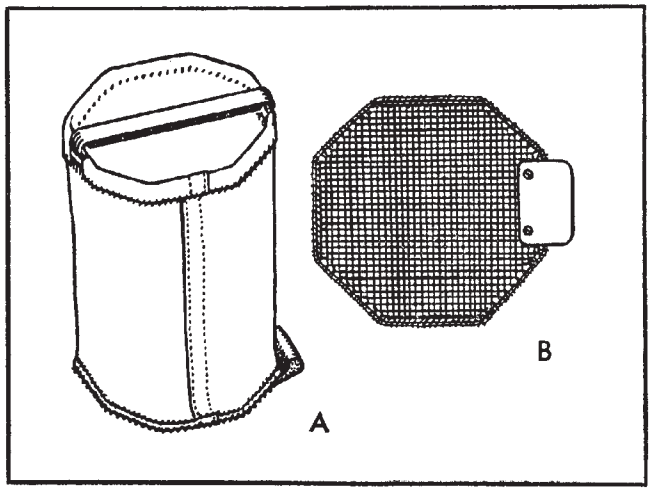

Fig. 9. A collecting sieve. The shape and size are optional.

- **A. The sieve showing handle.**
- **B. Bottom, showing wooden grip.**

smaller one. A piece of white oil cloth about two feet square is excellent, being easy to clean and handy to sit on in damp places when not needed for its proper purpose. The sieve can be a wire basket, such as is used in making french-fried potatoes, or a specially constructed one designed for collecting. Such a sieve is shown in fig. 9. It is a canvas sleeve about 14 inches deep and 12 inches across, having in the bottom an octagonal piece of ¼ inch galvanized iron wire mesh, and at the top a galvanized iron wire hoop crossed by a convenient handle. Although not strictly necessary, a small wooden grip bolted to the edge of the mesh at the bottom of the bag is a great comfort to the hands of the collector. Precise directions for making this sieve are given in Leaflet Number 7, together with those for separators, traps, and other special equipment.

When using the sieve, fill it to a depth of about four inches with debris. Holding it over the middle of the sifting cloth, shake the screen violently from side to side a few times. A sprinkling of dark fragments will fall through. Put the sieve down on a corner of the cloth, take up the alcohol bottle and brush, and concentrate upon the specks. When one of them moves, grab it. Do not be impatient. It will be several minutes before all of the creatures stop "playing possum," and begin to leave. When you think you have them all, pick up the sieve, dust off the cloth, and shake again. Four shakings usually suffice to exhaust a lot of debris. Then empty the sieve and start over.

Sifting is most productive if the sifted material is gathered in a shady place which is always moist, but not wet. In the autumn, fungi of various kinds are especially populous. These can be shaken in the sieve, or held over the cloth and thumped.

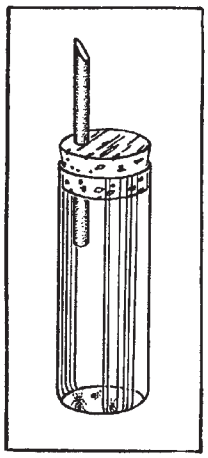

Fig. 10. A quill bottle.

Fig. 10 shows the quill bottle, a device alternative to the wet brush for picking up minute hard-bodied species. It is a vial with a shallow cork through which a hole has been bored near one side. A piece of the quill of a large feather, or its equivalent in thin plastic tubing, passes through this hole, fitting snugly. The outer end of the quill is cut off diagonally, making a small scoop with which the insects can be shoveled up. The inner end of the quill projects beyond the cork far enough to prevent the captives from falling out through it when the bottle is inverted. The quill bottle must be emptied into a vial of alcohol from time to time.

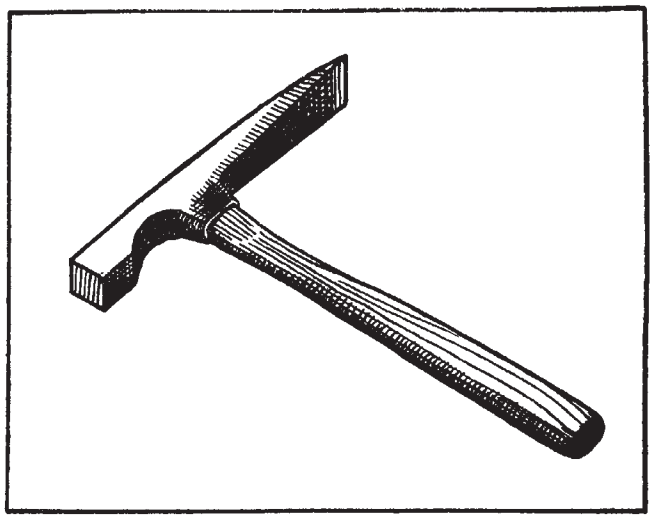

Fig. 11. A Mason's hammer.

COLLECTING BURROWERS AND BORERS

Insects and spiders which burrow in the ground, or in the stems, branches and roots of plants, are discovered largely by hard work and a sound knowledge of the habits of the beasts. Sometimes you are lucky enough to sight one abroad and follow it home, but usually you just have to guess where you would be at this time of day if you were a digging wasp or a roundheaded borer, and then go there and look. This entails the expenditure of elbow grease and the use of some sort of digging tool. For soft earth and sand a garden trowel is satisfactory. A mason's hammer or small geologist's pick is invaluable for breaking hard soil, prying up rocks, splitting wood, and tearing the bark from dead trees. It is shown in fig. 11. A strong sharp knife is necessary for digging borers out of wood, and for splitting twigs and the stems of herbaceous plants.

The sides of streambanks and road cuttings, ditches, gullies, or any other place where a considerable vertical expanse of earth is exposed is likely to attract digging wasps, bees, spiders and other creatures which nest underground. Even when there are no external openings, it may repay you to slice off the face of such a bank with a shovel. If there are any inhabitants, their tunnels will then be visible, and you

can follow them up with a trowel or a knife. When excavating nests, especially those of ants or termites, be on the watch for parasites and inquelines.

Species which live at the edges of ponds and streams can be flooded out of their burrows by dipping water over them till the earth is saturated. Those which live in mud already sodden, or even slightly submerged, are to be routed out by the messy but practical process known as "bog trotting." This consists of tramping through the vegetation, muck, and shallow water of marshes, and at the edges of sluggish streams and stagnant ponds, creating as much disturbance as possible. The insects, mostly ground-beetles, thus rudely aroused, will shortly appear on the surface of the mire, headed for solid ground, or climbing up the stems of plants or the legs of the collector. Since the creatures are swift, you will be more likely to see them in time if you walk backward, watching your wake, and inviting a mud bath. Wear your oldest clothes, and sneakers or hip-boots. Carry a minimum of equipment. The true, or quaking, bog is a dense mat of small living plants, growing on top of water from the shore outward, and sometimes completely covering a lake or pond. Although far from rigid, it is often thick enough to bear the weight of a man. If so, it is easy to drive out its numerous and largely coleopterous inhabitants by standing still. As the mat of vegetation sinks under your weight, the water, seeping through it, forces the beetles upward until you find yourself ankle deep in a puddle upon the surface of which your victims are haplessly floating. Experts who are addicted to marsh and bog collecting claim that it is so richly rewarding as to justify the personal discomfort which may attend it.

In the season when night-flying beetles are abroad, great numbers can sometimes be unearthed by digging under an illuminated sign board, where the creatures, attracted to the light at night, have dug themselves in to pass the day. This is especially fruitful if the lights are blue, and far removed from other brilliant illumination.

When spading a garden in the spring, you are certain to unearth insects which lived upon the plants grown there during the preceeding summer. A great many of these will be in the pupal state, but if kept in damp soil will soon mature and yield perfect specimens. Digging at the foot of a large tree will probably reveal the pupae of species which, as larvae, fed upon its leaves. Plants observed to be ailing without apparent reason may be suspected of having borers or other insects at the roots.

The earth under a carcass is likely to harbor insects feeding upon seepage from the carrion. These may be tidily extracted by shoveling the soil into a pail of water. As the clods melt the insects rise to the surface, whence they can be harvested with forceps. The same procedure can be employed with cow-chips and the excrement of other animals, with the soil under an accumulation of dung, or with compost or earth of any kind which is likely to contain desirable specimens.

In arid regions the insects and spiders, like other animals, seek shelter from the mid-day heat by hiding in the coolest, dampest, and darkest place they can find. For many of them, this means among the roots of plants. If the plants of the desert are pulled up, and the roots shaken, a surprising number of creatures may be uncovered. The hollow stems of dead weeds also afford temporary shelter to nocturnal species.

Square-heads, long-horns, and other boring insects, beetles, moths, and saw-flies, when young may inhabit solid wood. They are especially difficult to get at without doing damage to the specimens, and unless you have strong evidence of a heavy infestation, or are particularly interested in the larval stages of these creatures, you will be wasting your time to try. If you get them, you will probably have to rear them before they can be identified exactly. The adults are often taken by beating dead and dying branches.

TRAPPING

Trapping is the easy way of catching many elusive kinds of insects, most of them nocturnal. The traps range from an artful multiplication of natural hiding places to elaborate contraptions comprehensible only to their inventors. You can, for instance, "plant" flat stones, sheets of bark, and pieces of board in likely spots and wait in the hope that species normally found in such places may take up residence. In such favorable locations as deserts and the barren tops of mountains they may do so overnight. In verdant areas, where there is plenty of other shelter, it may be weeks or months before conditions under the "plants"

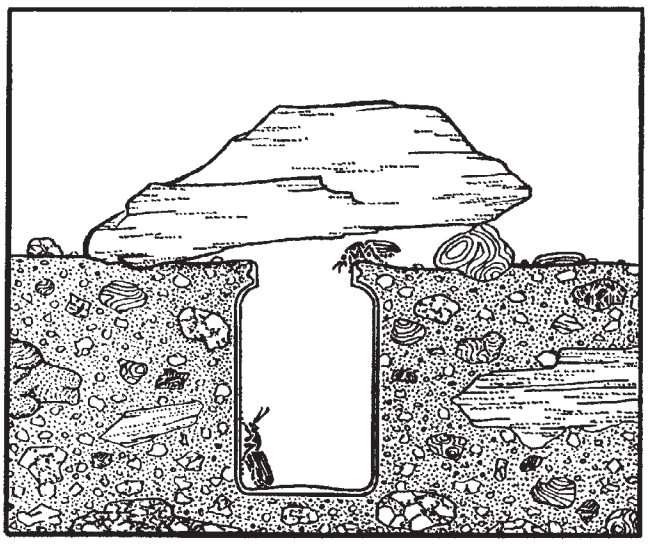

Fig. 12. Diagram of a simple trap, made by burying an empty jar.

become sufficiently attractive. In the autumn, when the insects are looking for places in which to hibernate, exceptionally fine catches are to be expected. At this season, a band of cloth wrapped around a tree trunk will also shortly be inhabited. If you are interested in ant guests, put a slab of wood over every ant-hill you can find. In a few weeks the ants will have formed, under some of them, galleries which are open to inspection every time you care to lift the lid. Bark beetles and borers which infest dying and dead trees can be attracted by cutting branches of appropriate trees and hanging them up in some place convenient to the collector. As the sap ferments and the wood dries, there will be a succession of visitors which you may capture by beating the branches at intervals.

Assorted small carcasses, or bits of larger ones, if exposed in remote places, will summon carrion-beetles, rove-beetles and many other insects to the feast. If you leave them where the civic sanitation committee can find them, however, they will never get ripe enough to reach maximum efficiency.

Insects which are pedestrian by habit are often taken in an empty wide-mouthed bottle or tin can, buried to the lip in the earth, and shielded from rain and light by a stone or piece of wood sufficiently elevated to allow the insects access to the trap. Once in, they cannot climb out, and so remain until you call for them. The efficiency of this arrangement is increased by baiting the jar with a bit of rotten meat, or with a sweet fermenting syrup such as is described below for use in "sugaring" for moths. Specimens which drown in syrup have to be washed with water before mounting. Traps of this kind must be inspected every two or three days, if the specimens are to be found in good condition.

The Rummel trap, devised by a skilled professional collector, is effective for the capture of some flying species which do not come to lights; and it is relatively easy to construct. As shown in the picture, fig. 13, it consists chiefly of a cylinder of wire screen covered by a solid lid. It stands upon three or four feet which elevate it about three-quarters of an inch inside of the cylinder, and fitting it at the bottom edge, is a cone of wire screen with an opening three quarters of an inch across at its apex. Under the cone is a saucer filled with fruit stewed in sugar and allowed to ferment, a process which may be hastened by the addition of a little yeast. The insects, attracted by the smell, crawl under the edge of the cylinder, between the feet. When they have fed to repletion, they fly upward. Striking the screen, they crawl through the central aperture into the covered cage, where most of them go to sleep. It is convenient to build this trap to fit inside a five gallon covered paint pail, made into an anesthetising chamber on the principle of the ethyl acetate killing jar. Before opening the trap, place it in the pail for a few minutes, to quiet the specimens, then dump them onto a sifting-cloth for sorting. The pail also serves as a carrying case for the trap, and as a stand upon which to set it while in use.

Success in using this trap depends upon selection of an advantageous station, usually one on a stump or rock in open woods. Forest paths and clearings are especially appropriate. The season and atmospheric conditions also influence the catch profoundly, warm, still, humid weather being most satisfactory. More specimens enter the trap during the twilight hours of dawn and dusk than at other times, least during the heat of the day. Most of the creatures attracted to the trap are moths and butterflies, although there will be some beetles, bugs, and a few other kinds of insects among them. For perfect, unrubbed specimens, inspect the trap daily. A trap line of ten or a dozen traps may be profitably maintained from early spring to late fall.

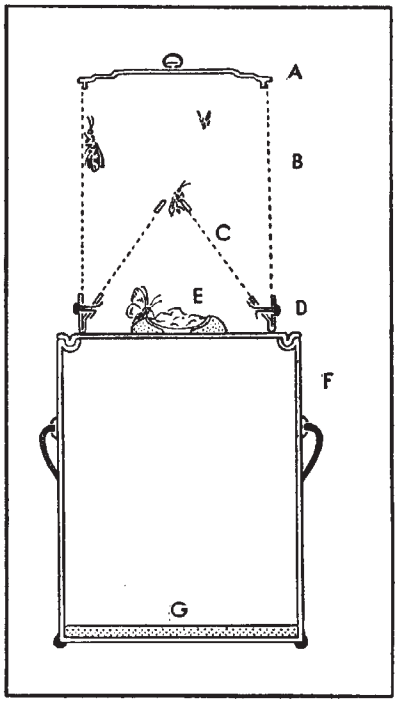

Fig. 13. Diagram of the Rummel Trap.

A. Tin pot lid.
B. Wire screen cylinder, soldered to rim of lid.
C. Wire screen cone, to which are soldered the feet made by bending a strip of thin metal into an appropriate shape.
D. Cotter pins passing through holes in the feet and fastening the cylinder and the cone together. Trap is opened by removing these pins.
E. Saucer set in plaster of paris and containing bait.
F. Five gallon paint pail.
G. Layer of plaster to absorb the anasthetic used to quiet the specimens for sorting.

NIGHT COLLECTING

Although some nocturnal insects are taken in traps, or found asleep or in hiding during the day, night collecting amply repays the extra effort which it may demand.

The principal difference between diurnal and nocturnal collecting is that, at night, the collector must provide his own light. For some purposes, a strong flashlight is adequate. The gasoline-burning Coleman Lantern is exceedingly efficient in shedding a brilliant illumination over a larger area. An electric headlamp, with focussing beam, is much esteemed by some experienced collectors. It has the double advantage of freeing both lands, and concentrating its beam, and the wearer's attention, on a comparatively small area. It is especially valuable for locating spiders, as their eyes, like those of some insects, are chatoyant; that is, they reflect the light which falls upon them as points of vivid color. In the concentrated brilliance of the headlamp, every spider within range, if looking in your direction, springs to your attention instantly.

Nocturnal collectors will find it both pleasant and convenient to work in pairs or trios, one to carry the light, one to hold the killing bottles, and possibly one to swing the net. Other equipment can be distributed among them, and the party will thus be prepared to perform effectively any collecting operation which may be required.

Any collecting technique which is effective by day can be practised at night with equal or superior results. Active diurnal species, particularly grasshoppers, will be found clinging to the stems of tall grasses, quietly asleep. Leaves, flowers, and crevices also shelter a slumbering multitude, flies, beetles, dragonflies, and others, all of which can be had for the trouble of picking. On the other hand, nocturnal species will be awake and busy. Adult beetles, which as larvae bored in wood, will be found walking over the bark of dead or dying trees. Beating and sweeping are both especially productive in the twilight, at which time the nectar-drinking moths also appear.

The irrisistible fascination of the flame for the moth is proverbial, and although not all the insects so attracted are moths, nor are all moths affected, it is the basis of the most familiar nocturnal collecting technique. Even in cities, street lamps, porch lights, and illuminated windows attract a surprising number and variety of insects. In the country, remote from other sources of illumination, a single lantern may bring in thousands in a single night. As a collector, you can use this fact in several ways. You can simply hang up your lantern in a tree and stand beneath it, net in hand, awaiting what may appear. You will get a good many moths by this method, but you will lose most of the beetles and other insects which drop to the ground when they reach light of a certain intensity, instead of flying right into the flame as a moth will. If interested in such creatures, you will do much better to spread a sheet or canvas on the ground and set your lantern in the middle of it. The white cloth intensifies the effect of the illumination; and the dark specimens, falling upon it, are easy to see and seize. You will find a flashlight useful for recovering specimens which drop beyond the edges of the sheet.

If you have a car you might try this. Hang up a sheet over a high wall, or tie it to a horizontal branch. With pins, turn up the bottom edge to form a gaping

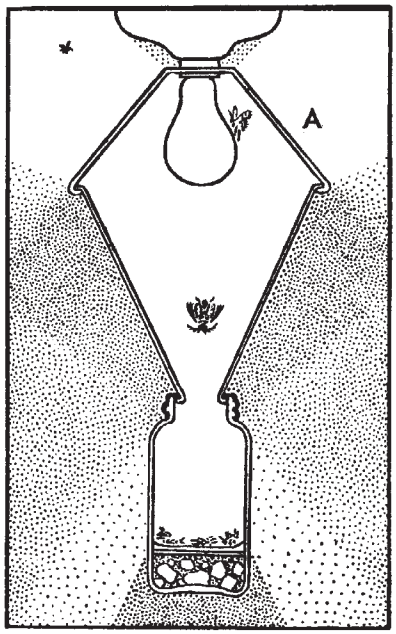

Fig. 14. Diagram of a simple light trap.
A. Wire lamp-shade frame to support funnel.

pocket about a foot deep. Train the headlights of the car upon the sheet. The reflected light will attract numerous insects, most of which, when they strike the cloth, will drop into the pocket, whence you can remove them before they have a chance to climb out.

Automatic light traps, which kill indiscriminately every insect which falls into them, are almost as numerous as collectors. Many kinds are described in technical literature. A very simple one is shown in fig. 14. It consists of a quart-size cyanide jar with a large metal funnel at the top. This is suspended immediately under a lamp, which may be one provided for the purpose or a porch, garage, or other outdoor light to which the trap is an incidental appendage. For the construction of this trap, see Leaflet Number 7.

In addition to the lack of selectivity, automatic light traps have another drawback. They are too efficient. Under favorable circumstances they attract so many insects that, even if the jars are emptied

frequently, the specimens are almost sure to rend, rub, and crush one another before they are removed.

"Sugaring" is another traditional method of nocturnal collecting. It is employed chiefly for moths, although a few other insects do come to the bait. The idea is to distribute a sweet odorous syrup in likely places, and wait for the specimens to come to supper. In practice, it goes like this:

Obtain a quart of molasses and, if need be, thicken it with brown sugar until it is distinctly "slow." To improve the allure, spike it with a little rum, stale beer, spoiled fruit juice, or asafoetida. It is difficult to understand how any creature could enjoy asafoetida, but the insects appear to do so! Put this mixture into a paint pail or other readily portable container and, armed with a paint brush about two inches wide, set out late in the afternoon to lay your trail. This trail should be a circuit around which you can walk in half an hour or thereabouts, leading through forest paths, along the edge of marshland or in any place where trees are plentiful but not dense, and the footing is sure. Remember that you will be making the rounds after dark, and will not be thinking of avoiding pitfalls. At intervals of 15 to 50 feet around the course, select accessible trees, not too rough of bark, and at the most convenient height paint upon each trunk a patch of syrup about as big as your hand. If the trees are so thick that you anticipate trouble in finding the right ones in the dark, mark them with strips of white adhesive tape, or with slips of paper fastened with thumb tacks. When the circuit is completed, return to your base and provide yourself with several moth-killing bottles, large and small, one jar for other insects, packing boxes, labels and pencil, forceps and aerial net, and a good strong flashlight or lantern. If possible, secure the services of an accomplice to carry the lamp and net. If you use cyanide bottles, fortify each by pouring a teaspoonful of ether or ethyl acetate onto the porous bottom filling, for quicker action.

As soon as dusk has fallen, begin to walk around the trail, inspecting each baited tree with the flashlight as you go. You will find the insects sitting on the bark, their probosces extended into the syrup like straws into a soda. Some of them will start away as soon as a bright light falls on them. These you must take with the net if you can. Some of them will be, at least to all appearances, quite drunk. These you may knock into the jar with a flick of the finger. If the collecting is good you will be strongly tempted to overcrowd the killing bottle. Don't! Take the time to pack the insects properly. If you cannot leave them in the killing bottle long enough to be sure they are dead, put a little killing fluid on the packing of the storage boxes to finish them off. Continue making the rounds until your feet give out, the moths go back to sleep, or the packing boxes are all full. Like other nocturnal collecting, sugaring is most successful on nights when it is hot, humid, dark and still. Cool, windy, or brightly moonlit nights produce few insects.

WINTER COLLECTING

Many amateur collectors seem to think that, with the first frost, all the insects and spiders de-materialize. This is not true. Adults of some species do die in the autumn, but their eggs survive, and can be found by the observant and interested collector. They are often very beautiful and worthy of attention. Other species pass the winter in the mature form, or as larvae, nymphs, or pupae, hidden in snug underground chambers, beneath debris, under bark, in caves and hollow trees, under stones, in attics, cellars, and outbuildings, or in almost any nook or cranny into which they can contrive to wedge themselves. All of these you can find if you care to take the trouble. Do not, however, make the attempt in really cold weather. The colder it is, the deeper the creatures bury themselves. Wait until a sunny day when the temperature is a little above freezing or, better yet, one after a succession of such mild days. The insects will then be astir, albeit sluggishly. You will find a few hardy species sunning themselves in the open. Many more will have come almost to the surface, and can be taken by sifting, digging, turning over stones, and stripping loose bark from dead logs. There are a few kinds of insects which are commonly seen only in the winter or very early spring. One, a springtail, is a minute species which you may see in great numbers hopping over the snow. Another is a stone-fly which matures while there is still a film of ice at the edges of the swift streams where its larvae live.

Truly domestic insects, which live in heated houses, and parasites infesting warm blooded animals, naturally are active the year round. Immature insects found in the winter can be brought into the laboratory for rearing if their food is such as is obtainable out of its proper season. And, when there is no collecting to be done, the serious student can spend his winter hours happily in mounting, sorting and, identifying his summer's catch.

PACKING INSECTS FOR SHIPMENT

Sooner or later every collector of insects and spiders will have to pack some, if not all, of his collection for shipment through the mail or by express. This is an hazardous undertaking, unless approached with extreme precautions, which differ according to the nature of the material.

Alcoholic specimens in vials may be treated in two ways. You can wedge them into the vials with wads of cotton to prevent violent agitation, fill the vials, cork them tightly, and pack them between layers of

cotton in a box; or, having secured the specimens with cotton plugs, you can pack the corkless vials, upright, into pint preserving jars, like asparagus spears in a can, fill the jar with alcohol, and seal it with a rubber ring. In either case, the container must itself be packed in a strong wooden or corrugated cardboard

Fig. 15. Diagram of a jar of alcoholic specimens packed for shipping.

box large enough to permit of its being completely surrounded by a layer of excelsior or crushed paper several inches thick, as shown in fig. 15. If it is necessary to ship more than one jar in a box, separate them by a layer of packing. Do not make the boxes too heavy for easy handling.

Insects packed in paper envelopes and cylinders travel well, if housed in a crush-proof container. Of the thousands of shipments unpacked in the Department of Insects and Spiders, the most consistently satisfactory have come from South America in boxes scarcely larger than cigar boxes, but made of planking half an inch thick carefully screwed together. The papered specimens filled the boxes, with no more packing than was needed to keep them from shifting. If you find it necessary to use containers of questionable strength, ship them in larger cartons, surrounded with packing, as described above for alcoholic specimens.

Dried insects upon pins can be safely shipped in Schmidt boxes or other strong storage boxes of small or moderate size if steps are taken to prevent the pins from coming loose during the journey. With flies and other creatures light in weight it is only necessary to drive the pins into the cork bottom of the box securely. With Cicadas, large beetles, giant moths and other heavy species, further precautions may be necessary. A specimen of great weight may, if jolted violently, pull its pin free and go banging about among the rest of the collection working wholesale havoc. A simple method of preventing this is shown in fig. 16 Pin the specimens into a box, spacing them as evenly as possible. Drive the pins into the cork until they strike the bottom. Since the pins are of uniform height, their heads will then stand level. If an insect's body is long, brace it with an extra pin on either side to prevent it from swiveling about upon its pin, should it be shaken loose. Cut a piece of cardboard to fit the inside of the box exactly. If you like, you can equip it with a pair of adhesive tape tabs or a string loop handle, by which to lift it. Put this into the box, resting on the heads of the pins. Fill the space between the card and the top of the box with packing, and shut the lid. Now the pins simply cannot work free. An occasional leg or antenna which was loose when packed may come off in transit, but that should be the full extent of the damage. This method of packing is risky unless the pins are thick enough to be rigid. The force needed to drive the pins through the cork and the strain put upon them in pulling them out, to say nothing of the pressure of the packing upon any which might be slightly higher than the others, are sufficient to bend a fine pin like a bow. And, like a bow, when the tension is released the pin will straighten with a snap, breaking

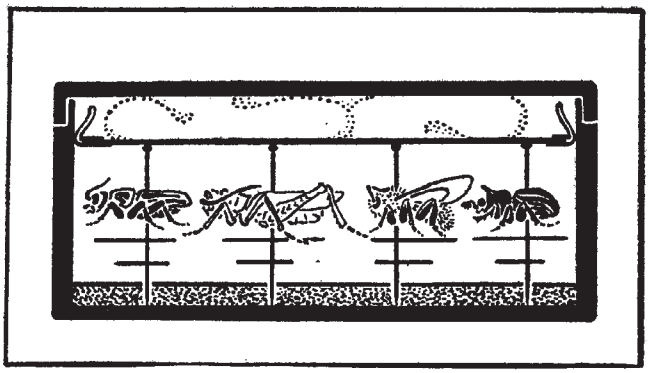

Fig. 16. Diagram showing a method of packing heavy pinned specimens for shipping.

the insect and flinging its fragments like missiles among the other specimens. To reduce jarring and the possibility of crushing, enclose a box of pinned insects in a larger box and cushion it well.

ETIQUETTE FOR THE ENTOMOLOGICAL COLLECTOR

It is unfortunate, but inevitable, that any person known to be a collector of insects or spiders is regarded by the lay public as somewhat demented. It is the manifest duty of every right-minded collector to

convince such of the uninitiate as he cannot avoid that the mania is at least an interesting one, more worthy of curiosity than of ridicule. It is impossible to traverse any public place with an insect net without becoming the butt of jests and the victim of innumerable questions, mostly silly. A little courtesy, when it comes hardest, will go far toward mitigating not only your own suffering at the tongues of the philistines, but also those of other collectors who may come after you. Indeed, with sufficient patience, you may even make a convert or two, especially among the young. Children, if they spot you in the field, are certain to follow you everywhere with leech-like persistence and a flood of conversation. This need not be wholly disastrous, for if you cannot shake them you can put them to work. Explain what you are doing and ask them, quite seriously, to help. The casually curious will soon weary of turning over stones, or chasing grasshoppers, and will depart peacefully of their own accord. The few who stick it out will be sincerely interested, and so worth teaching.

When collecting in strange territory which is not an absolute wilderness, it is only polite to ask the owner's permission and, having received it, to treat his property considerately. If you pull up his vegetables, mow down his flowers, strip his trees, overthrow his woodpile, and, in general, leave a swath of devastation behind you, not only you but all other collectors will be anathema to him forever after. There is another reason for disturbing things as little as possible, and that is to keep the insects content to remain in the vicinity. It is an article of faith among the instructed always to replace a stone or board which has been overturned, as it may take months for conditions under a newly moved stone to become acceptable to insects. Needless, to say, it is unethical to abstract specimens from another collector's trap, should you happen to find one. You might, however, leave a note in it, and so make the owner's acquaintance, to mutual benefit.

For the sake of others who may be working the same district, and out of personal liking for insects and spiders as animals, the considerate collector will not kill any harmless creature except for scientific purposes. The number of specimens of each kind which should be taken will depend upon the collector's interests and facilities. If your interests are general and your storage space limited, you may confine your catch to two pairs of adults of each species. If you are fascinated by the strange life cycles of insects, you will want to keep immature specimens of all ages. If you are making a distribution study, or working out a pattern of seasonal variation, you may want hundreds of specimens of the same species from different localities and of many dates. In any case, take all you really want, but let the others go. Like any other natural resource, the insect population, especially of large and conspicuous species and in well collected areas, is likely to suffer from abuse.

Direction Leaflet Number Four

HOW TO MOUNT AND LABEL HARD-BODIED INSECTS

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Department of Insects and Spiders
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The value of a collection of insects depends largely upon the care with which it has been mounted and labeled. A successful system of mounting must preserve the insects in such a way that they can be handled and viewed from all sides without breaking, and must keep associated with each specimen all the information which the collector may have about it. Indeed, without data, any collection of insects, however perfectly mounted, is valueless for scientific purposes. Any orderly method of keeping a collection which satisfies the basic requirements is acceptable. The one here described is that now used by most advanced amateur and professional entomologists for dealing with hard-bodied forms.

TOOLS AND MATERIALS

The tools and materials which you will need for mounting your collection are few but essential. They include:

1. Insect Pins.

Since most hard-bodied insects are preserved simply by drying and, when dry, are extremely brittle, they are usually impaled upon special insect pins, as shown in fig. 1. The pins serve both as convenient

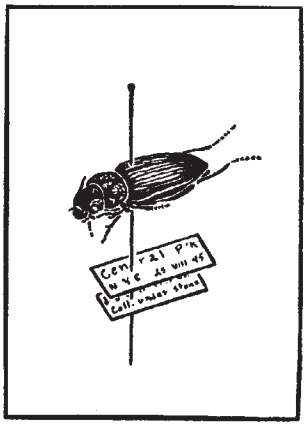


Fig. 1 The accepted scientific method of mounting hard-bodied insects.

handles and as a means of securing the specimens in the storage boxes. They are made of steel, an inch and a half long and of various thicknesses. The diameter is designated by a number, the higher the number the thicker the pin. Most insects commonly taken by beginners can be pinned on number threes. Number fives are good for the largest species, while a specimen too small for a number one is too small for simple pinning and must have special treatment. Insect pins are sold, in lots of one-or five hundred, by scientific supply houses, which can be found in the classified telephone books of most large cities. If there are none closer to you, you will find the following firms good sources of entomological equipment: Wards Natural Science Est., P. O. Box 24, Beechwood Station, Rochester, New York; General Scientific Supply House, Inc., 761 East 69th Place, Chicago, Illinois.

2. Forceps.

Many insects are too small to handle without the aid of tweezers or forceps. You will have to have at least one pair, slender, pointed, and straight or curved at the tip, according to preference. For butterflies and moths you may want a broad-ended, smooth-faced stamp forceps and, though not absolutely necessary, a heavy, curved, rough-faced pin forceps will be very useful. All may be obtained at the same place that you get your pins.

3. Scissors. Small and sharp.

4. Paper.

Stiff, hard surfaced, white, and about as thick as a visiting card. This will be used to make pin labels and points for mounting very small insects.

5. Pen and Ink.

The pen should have the finest available point. The kind called "Crowquill" is very good. Black waterproof India ink will make the clearest and most durable labels.

6. Glue.

This is used to fasten small insects to points, and to repair broken specimens. True glue, water soluble and slow setting, can be used at need; but it will not stick to oily specimens and in hot and humid weather tends to soften and "come unstuck." White shellac diluted with alcohol was, for a long time, the best available adhesive. It sets in a moderately short time

and clings tenaciously even to waxy species. Duco, or some similar clear plastic cement, is now preferred by many collectors, as it sets rapidly and is almost invisible. It must, however, be thinned with acetone or a thinner provided by the maker. The minute quantity of cement needed for entomological mending would, otherwise, become dry at the surface before the pieces to be joined could be brought into position. Plastic cements will not hold if the specimen is wet or oily, and in difficult cases shellac may be the only alternative. Whatever adhesive you prefer, keep it always at hand in a non-tip bottle with a tight stopper and needle applicator. A drawing ink bottle is readily adaptable to this purpose. One so used is shown in fig. 2.

7. A small camel's hair brush.

If you have to buy this new, get a number-one round water-color brush. You will find it very useful for picking up pieces too delicate to handle even with forceps. It is only necessary to moisten the brush with water or alcohol and touch it to the fragment. A small drop of adhesive is applied at the proper spot on the insect, the detached piece placed against it and held for a few seconds, and the brush withdrawn. In stubborn cases it may help to put a little glue on the fragment as well as on the specimen before joining them.

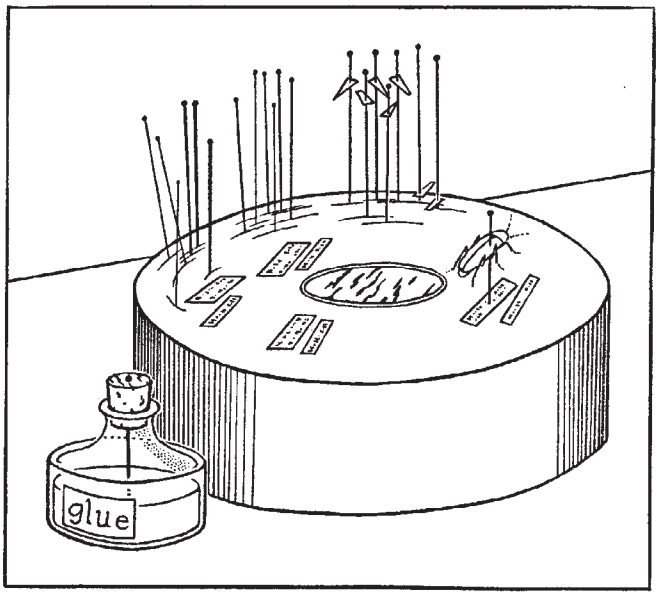


Fig. 2. A pinning block and glue bottle.

8. A pinning block.

This is a piece of some penetrable substance upon which the specimen or label may be placed while the pin is driven through it. A piece of balsa wood, cut across the grain, does very well. An inch thick slice sawed from a roll of toilet paper, bound around the outside with adhesive tape or gummed paper, and plugged in the middle with a tight cork to keep it firm, will also give good service. Fig. 2 illustrates this kind of block. If the upper surface of the pinning block is not flat and smooth, sandpapering will soon make it so. When mounting a large lot of insects, particularly if many of them require individual setting to arrange the appendages, you may have need of several pinning blocks at one time. A sheet of cork or thin balsa wood plank about the size of a sheet of letter paper is also useful, especially when point-mounting some kinds of small insects as described below.

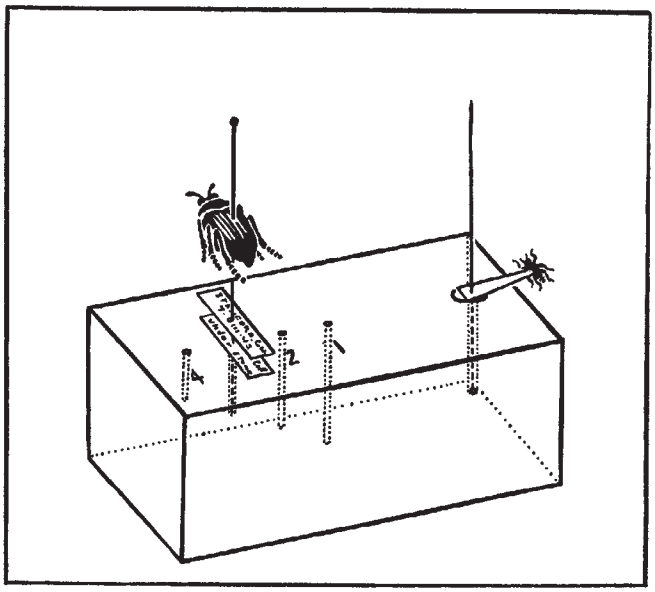


Fig. 3. A pin gage in use.

9. A pin gage.

This is used to measure the height of specimens and labels upon pins. A handy kind of pin gage is shown in fig. 3. It is a small block of hard wood, metal, or plastic, having in its upper surface holes of various depths. At the right, distinguished by the surrounding circle, is a hole half an inch deep and big enough to admit the head of a number five pin. When a specimen has been pinned, its position is adjusted by putting the head of the pin in the bottom of this hole and pushing the insect's back down close against the surface of the block. Note that the hole is so close to the edge of the block that a point-mounted specimen projects beyond it and is not dislodged when the position of the point is determined. At the left of the block is a row of holes, ⅝", ½", ⅜" and ¼" in depth. These may be of the same diameter as the first hole, or somewhat smaller, large enough to accommodate the shaft of a number five pin. They are numbered in the order in which the labels are placed upon the pin, the highest first. As soon as the point of the pin has passed through the label it is inserted into the appropriate hole and pushed to the bottom. The label will then stand at the proper height upon the pin. Of course, you will not have to use all of these holes all

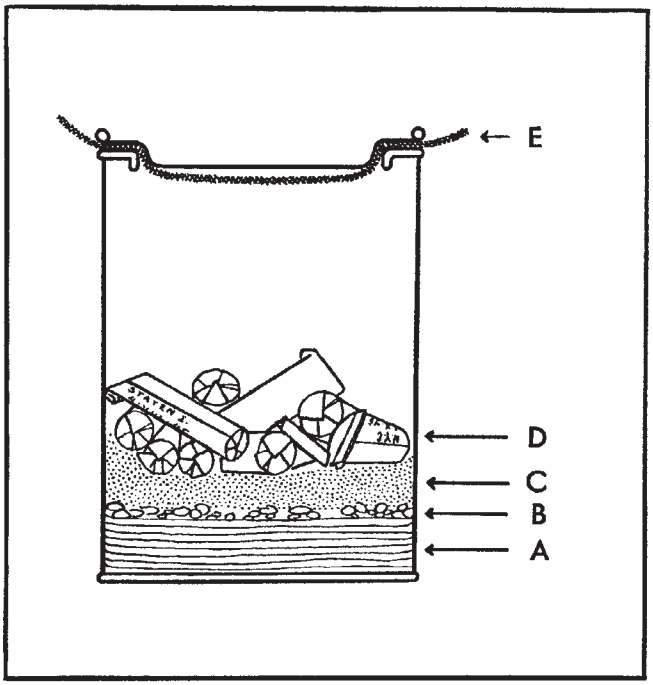


Fig. 4. Diagrammatic vertical section of a relaxing box made of a tobacco tin.

A. Soaking-wet blotting paper.
B. Paradichlorobenzene moth crystals.
C. Dry cotton.
D. Insects wrapped in paper tubes.
E. Paper towel.

of the time. When less than four labels are required, your choice of holes will be influenced by the number and nature of the labels, and by the thickness of the specimen.

10. A relaxing box.

This is a humidor used to soften specimens which have been dried for storage or to keep fresh specimens in workable condition until wanted. It is a large-mouthed, moderately shallow, watertight vessel with a close lid, large enough to contain a considerable number of insects in their storage packing if necessary. The museum relaxing boxes were made of sheet copper by a tinsmith, and measure 14" x 8" x 5". However, a tobacco tin, one pound or larger, is equally satisfactory while it lasts, and when rusted through can be easily replaced. An ice box storage jar or a small acquarium covered with a pane of glass will also do the job. In the bottom of the vessel should be about an inch and a half of some porous material capable of absorbing a great deal of water; sand, soft paper, balsa wood, plaster of paris, or a synthetic sponge, for instance. This is kept soaking wet while the box is in use. A layer of dry cotton batting about an inch thick on top of this blotter will preserve the specimens from damage through direct contact with the liquid. A tablespoonful of paradichlorobenzene moth crystals under the cotton will discourage the development of mold. Since the atmosphere inside the relaxing box is saturated, a sudden decrease in temperature will result in the condensation of water. To prevent the drops which form on the underside of the lid from falling on the specimens, upholster the lid with cloth, or place a paper towel across the mouth of the vessel before putting on the cover. Fig. 4 is a diagram of a relaxing box.

When softening specimens which have been stored between layers of cotton or wrapped in paper envelopes or tubes, do not attempt to unwrap them. Put them into the box packing and all. The relaxing box should not be filled to the top, since the moisture penetrates so great a mass slowly, and the outer specimens might fall apart before the inner ones are relaxed. However, several loose layers of wrapped specimens can safely be placed in the relaxing box at one time.

The time required to relax the specimens varies with their size, the amount and nature of the packing, and the temperature. In general, for very small or delicate species overnight will be long enough. Twenty-four hours is sufficient for most insects, but a few very large kinds may take longer, especially if the wings are to be spread as described in leaflet number 5. If it is not possible to finish mounting a box full of insects at a sitting, the remainder may usually be left over till the next day without damage, but over-long exposure will result in discoloration of some species and eventually in disintegration of the specimens.

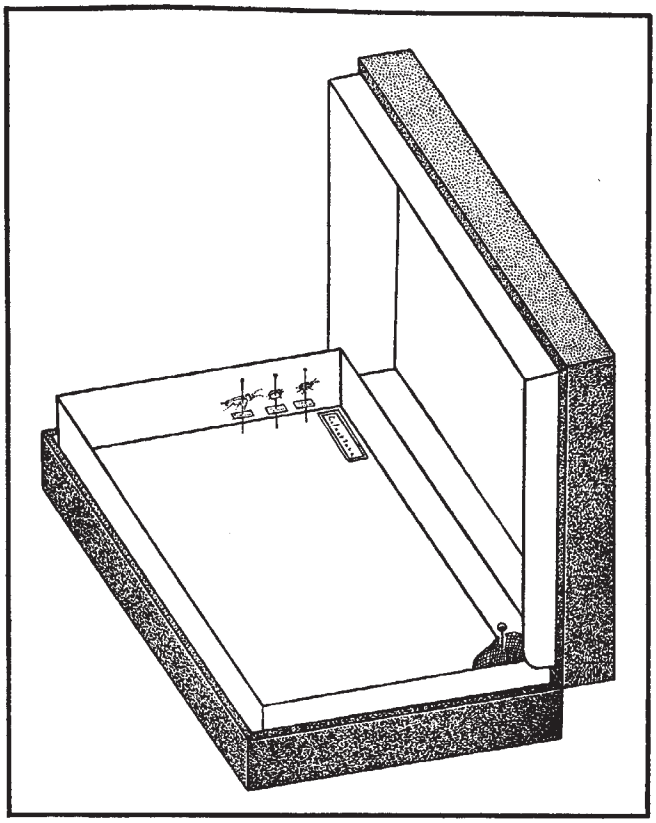


Fig. 5. A Cardboard storage box for insects.

11. Storage boxes.

Before pinning a lot of insects you must also provide storage boxes in which to place them as soon as they are mounted. Any kind of close-covered box will do, if the bottom is lined with a material soft and deep enough to receive insect pins and hold them. Museums, and a few private collectors, use large, glass-topped, cork-bottomed drawers which are kept in stacks. Wooden Schmitt boxes or cardboard storage boxes sold by supply houses are small enough to file in large library shelves. One of these appears in fig. 5. Very satisfactory, though somewhat small for Lepidoptera, are wooden cigar boxes, the kind having the top rabbeted to insure a tight closure. These may be lined with sheet cork, balsa wood, or two layers of corrugated cardboard placed at right angles to each other. The lining should be snug, and secured with glue to prevent it from being dislodged. A large number of these boxes, set on edge, can be accommodated in an ordinary bookshelf.

LABELING

Every properly pinned insect carries with it on the same pin one or more labels bearing the data relating to it. Whenever possible, these labels should be prepared in advance and placed on the pin at the same time as the specimen, thus reducing the chances of losing the information and the number of times each specimen must be handled. You might try counting or estimating the number of specimens of each date and locality when filling the relaxing box, and making the pin labels while the insects are softening.

Pin labels are best made of a good quality of light card or stiff white paper cut into strips not over three quarters of an inch wide. They should be lettered in black ink with a fine pen and in the smallest space consistent with neatness and legibility. If they are written uniformly, one below the other, close to the left hand side of the strip, with a narrow space between them, the right hand edge of the whole strip can be trimmed in one operation and the labels separated by a minimum of snips.

If your collecting has been very successful and you have hundreds of specimens with a single set of data, you might do as museums do and have the labels printed. If you collect in one place the year round, have the locality printed but leave on each label a space for the insertion of the date by hand. Four and one-half point type is of a size convenient to both collector and printer.

The information carried by the pin label must always include the locality and date of capture, and, if known, the name of the collector. In learned institutions, whose collections are built up of many private collections, labels may also bear the name of the donor. Observations on the habits and habitats of the creatures, such as "altitude 1000 meters" or "feeding on leaves of *Quercus alba*" add greatly to the value of a collection and may also be written on pin labels. The technical name of a plant host should be used, if known, but the common name is much better than none.

In order to conserve space in the storage boxes, pin labels are made as small as possible and should not project much beyond the specimen if it can be prevented. To this end, the data are abbreviated whenever this can be done without obscuring the meaning. Dates are often written as a series of numbers with dots between. The month is indicated by an unmistakable Roman numeral, to prevent confusion, since some collectors place the month first and some the day. Special care must be taken to distinguish between the Roman and Arabic "one," and between the Roman "two" and the Arabic "eleven." Thus, 1-II-'42 is the first of February, nineteen forty-two, while I-11-'42 is the eleventh of January. You may, of course, write out the date in full, if you prefer. When the identity of a specimen has been determined, its scientific name, or as much thereof as is known with certainty, may also be written on a label and placed upon the pin below the others. Several strips of pin labels appear in fig. 6.

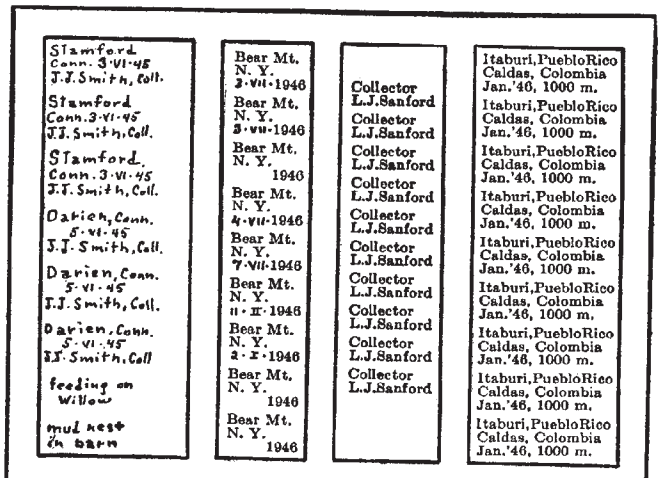


Fig. 6. Pin labels for insects, hand lettered and printed.

PINNING

With the insects properly relaxed, the labels and storage box ready, and the tools at hand, the mounting can begin. The specimens are removed from the relaxing box, not more than a few at a time, and the box closed immediately. A specimen is either held in the fingers or placed upon the pinning block, as its shape may indicate, and a pin of suitable size is passed through it from top to bottom at right angles to the length of the body. About half an inch of the pin should be left protruding above the back. In order to preserve the structure and pattern of at least half of the creature undamaged, the pin is inserted a little to the right of the middle line; and since most collectors are right handed, this facilitates all subsequent handling.

The precise point of insertion varies among the different orders, the most common being shown in fig. 7. Beetles are pinned through the right wing cover, well forward and far enough from the inner edge to prevent splitting of the elytron. Similarly, grasshoppers, cockroaches, and some other leathery-winged forms should be pinned through the right forewing, as the insect will then balance upon the pin

tropical beetles are so thick that a pin will scarcely reach through them. Extra long pins are available for these, if needed; but since these insects are very durable they can usually be pushed up almost to the top of a standard pin, which will then protrude far enough at the bottom to fasten the creature into its box. All the data for such a giant should be written on one large label, pinned upside down and close against the under-

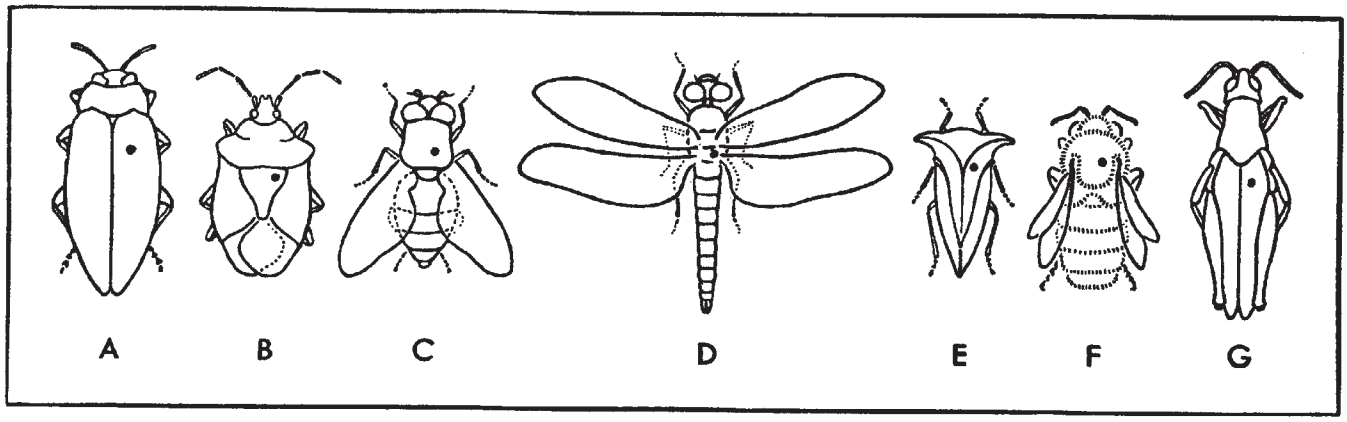


Fig. 7. Hard-bodied insects of several orders, showing where the pin should be inserted.
A. Beetle B. True Bug C. True Fly D. Dragon-fly E. Tree-hopper F. Bee G. Grasshopper

much better than it would had the traditional pro-thoracic position been used. In true bugs the pin is passed through the right corner of the scutellum, the triangular sclerite between the bases of the wings. Two-winged flies, tree-hoppers and cicadas, bees, and most wasps require a pin between the front wings, a little to the right. Butterflies and moths, the wings of which are commonly spread at the time of mounting, are pinned through the middle of the thorax, between the wing bases. Dragon and Damsel-flies, Stone flies, and similar forms which are frequently spread, should be pinned between the fore or hind wings as space and balance indicate. The wing-spreading operation is discussed at length in leaflet 5. If, however, through lack of time or storage space, such insects are to be mounted without spreading, they may be side-pinned. That is, the pin may be passed through the body from right to left, just below the wings. Butterflies, Damsel-flies, long-legged and large-winged wasps, and other insects having wings which project above the back sufficently to interfere with handling, are often dealt with in this fashion. Side-pinned specimens can later be relaxed, re-pinned and spread should it prove desirable. A side-pinned butterfly is shown in fig. 8.

It is important to the appearance of a collection that all the specimens stand at the same height on their pins, whenever practical. For this reason the use of a gage is recommended. The few insects which have wings or other projections rising so far above the back as to interfere with handling, if not side-pinned, may be placed low upon the pin, the top of the projection coming half an inch below the head. Some

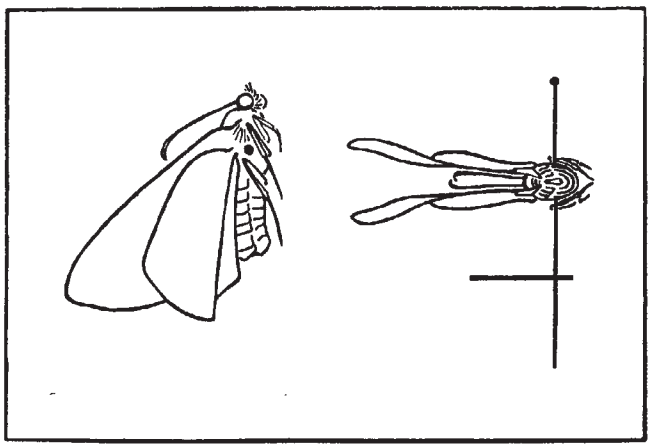


Fig. 8. A side-pinned butterfly, top and rear views.

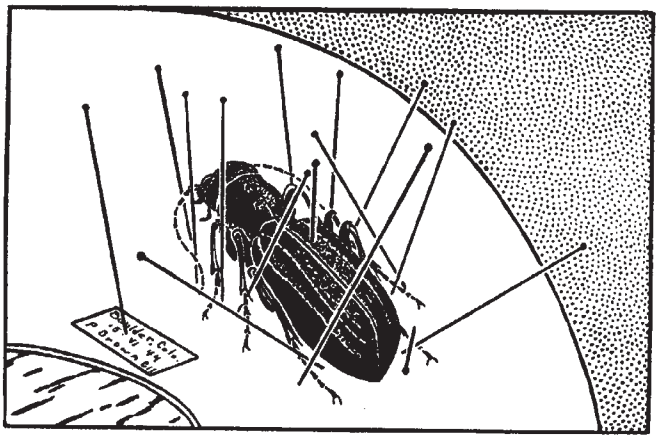


Fig. 9. Setting a beetle on the pinning block.

side of the specimen. It is read by turning the insect over.

The legs and antennae of a mounted insect should be neatly arranged, as close to the body as you can get them without hiding their characters, which are often used in making a determination. If the appendages refuse to remain in the attitude which you wish them to assume, drive the pin into the pinning block until the insect's body almost rests upon it. Then bring the appendages into position and fasten them with pins, as shown in fig. 9. If one pin does not suffice to secure a member, a pair crossed above or below it will often do so. Sagging abdomens may also be corrected by this method. The exceedingly attenuated abdomens of Dragon-flies will be more durable if each is reinforced with a fine broom straw or piece of wire. This should reach from the end of the abdomen well into the thorax. It will show least if you remove the abdomen from the body, insert the support from the thoracic end, and join the pieces by means of a little glue and the projecting end of the reinforcement thrust into the thorax. The practise of pinning Odonata is giving way, among serious students, to that of storing the specimens in individual cellophane envelopes.

Specimens which have been arranged on a pinning block should be allowed to set before they are removed. This may require several hours or several days and can be determined only by experiment.

As soon as a specimen has been pinned or, if it has been set, as soon as it is dry enough to remove from the pinning block, the pin label or labels should be attached. To do this, lay the label on the pinning block and drive the pin through it for the proper distance. The first label should be about half an inch above the point of the pin, a second label far enough below the first to be read without difficulty. Unformity in the height of the labels adds to the appearance of a collection, and may be assured by means of a pin gage. When using such a gage, as shown in fig. 3, the specimen being a small one requiring four labels, the locality label will be placed by hole 1, the collectors label by hole 2, the observations label by hole 3 and the identity label by hole 4. With thicker specimens or those requiring fewer labels, the locality label will most often stand in position 2. In choosing the exact spot on a label through which to thrust a pin, consider the size and shape of the specimen. If it is smaller than the label, let the label extend beyond it as evenly as possible in all directions. If the specimen is larger, place the label as nearly centered under it as you are able. Insects which have been mounted with wings extended at the sides require the label to be pinned in the middle with its top edge toward the head of the creature, so that the label is read from behind. Long, thin species call for a label parallel to the body's length with the top to the insect's right, the label being read from the left. If the left wings only have been spread, as they often are in grasshoppers and some other kinds of insects, the label must be pinned near the right side and extend under the wings at the left. Small insects mounted on points as described below also require a label pinned at the right end. The objects of all this are to save space and to make the collection look neat.

POINT MOUNTING

Of the several methods devised for mounting hard-bodied species too small for pinning, the most satisfactory is to glue them onto points. These are small, narrow slips of stiff paper with an insect pin through one end and an insect at the other. To make them, use a straight strip of paper ⅜" wide, cutting it into triangles or quadrangles by a series of diagonal snips as shown in the diagram at the top of fig. 10. At the base these should not exceed ⅛" in width; at the tip they may vary from nothing to the full width of the base. A broad attachment is more secure than a narrow one and some species are roomier than others. If your catches include many small insects, make up a supply of these points in advance.

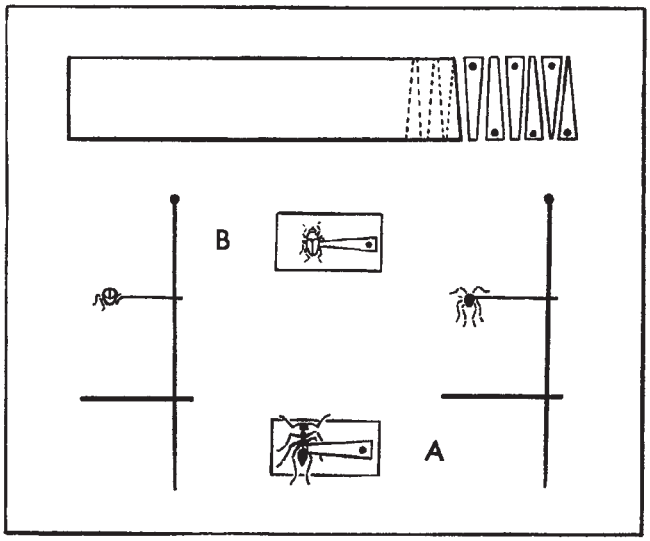


Fig. 10. The cut and use of points for mounting small insects.
A. An ant, top and rear views.
B. A beetle, top and rear views.

The point is attached to the right side of the specimen so that when the creature is headed away from you the point extends to the left of the pin. The precise manner in which the point is applied will vary with the shape of the specimen, as illustrated in fig. 11. Most beetles, like "A," are rather flat on the bottom. To mount one of these, place the relaxed specimen, bottom up and head away from you, on a pinning block or sheet of cork. Separate the second and third legs of the right side, which will be at your left, so as to leave as broad a space as possible for the attachment of the point. If the point is glued to the legs, it is likely

to come off, legs and all. Push about a quarter of an inch of the pin through the base of the point, enough to hold the pin firm in the block when the point stands level with the spot of attachment. Holding the pin in the left hand, put a very small quantity of glue on the underside of the tip of the point. With this tip directly above the spot of attachment, push the pin into the block beside the insect until the point touches it, as shown in the picture. Be sure that the specimen

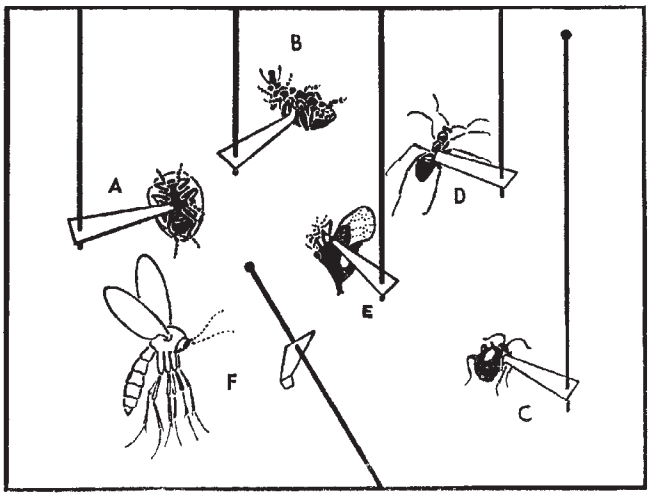


Fig. 11. Methods of applying points to insects of various shapes.

is level, with its long axis at right angles to the length of the point, and that neither the tip of the point nor the drop of adhesive extends beyond the midline of the insect. Leave pin and specimen in this position until the glue has set. Then withdraw the pin from the point, and insert it from the other side. The point should stand half an inch below the head of the pin at the end of this operation.

If a specimen is cylindrical, and offers no flat surface on the bottom for the attachment of the point, it may be treated like the weevil "B." The tip of the point is bent upwards and applied to the side of the creature between the bases of the legs. If, in mounting specimens upside down, you find the left-handed procedure inconvenient, turn the creature around with the head toward you. Its right and yours will then correspond.

A specimen so constructed that it cannot lie on its back but can stand on its feet may be handled, like the globular beetle "C," by bending the tip of the point downward and applying it to the right side of the creature above the bases of the legs. If it will make the point fit better, the bending may be done diagonally as shown.

Ants like "D" require a very broad point attached to both thorax and abdomen, bridging the weak place at the waist. Since the abdomen is broader than the thorax, the specimen will stand at right angles to the point with less trouble if the tip of the point is clipped off or bent under a little at the back. This also appears in the picture.

"E" is a Membracid or Tree-hopper. Members of this family are compressed laterally, and have important characters on the ventral surface. It is therefore convenient to mount them as shown. When inverted the specimen will lie horizontally on top of the point with the feet stretched out to the left. It is equally acceptable, but more troublesome, to mount Membracids in the same way as illustrated for the fly, "F," the method used for most laterally compressed species. The specimen is shown lying on its left side. The point, with the tip bent down, is already in its final position near the top of the pin. The tip, which has a little glue on the outer surface, will be pressed against the right side of the insect just under the wing. The disadvantage of this method is that the pin must be held in the fingers until the glue has set sufficiently to keep the specimen in place. It is, however, the only practical method for insects which will neither lie on their backs nor stand on their feet. "F," when mounted, will be in a vertical position, wings up, feet down.

When mounting insects on points, remember the label, pinned near the middle of the right hand edge and read from behind. Completed point-mounted specimens should look like those shown at the bottom of fig. 10.

STORAGE

As soon as an insect is mounted, pin it into a storage box to keep it safe from dust and damage. If you are making a large general collection, you may want to sort your specimens as you go and use a separate box for each group. When the boxes are full, or the day's work finished, leave the open boxes in a warm, dry, mouse-proof place for several days so that the specimens may dry rapidly. Slow drying causes discoloration of some specimens. A few very heavy-bodied creatures, notably large grasshoppers, are so difficult in this respect that they may have to be eviscerated through a ventral incision while fresh, and stuffed with cotton, if the color is to be preserved.

When the specimens are dry, put into each box, before storing it away, a teaspoonful of paradichlorobenzene, as a precaution against mould and the attack of Dermestids and other entomophagous beetles. If the boxes are to be filed on edge, tie up the crystals in a piece of loose-woven cloth and pin it into a corner of the box. This will prevent the crystals from breaking the specimens as they shift position every time the box is moved.

Direction Leaflet Number Five

HOW TO MAKE AND USE SPREADING BOARDS FOR INSECTS

By ALICE GRAY

Department of Insects and Spiders
The American Museum of Natural History

The wings of an insect are often its most characteristic feature and should, in well mounted specimens, be clearly visible. Since many kinds of insects die with their wings so closed or folded as to obscure their characters, it is necessary to spread them artificially. This is particularly true of moths and butterflies, but damsel-flies, stone-flies, and members of some other orders may be handled in a similar manner. Such creatures as beetles, grasshoppers, and true bugs, whose hind wings are covered by the forewings save when in flight, if spread at all, may be spread on the left side only. The other pair of wings remains in the normal resting position. Properly pinned and spread insects of several orders are shown in fig. 1.

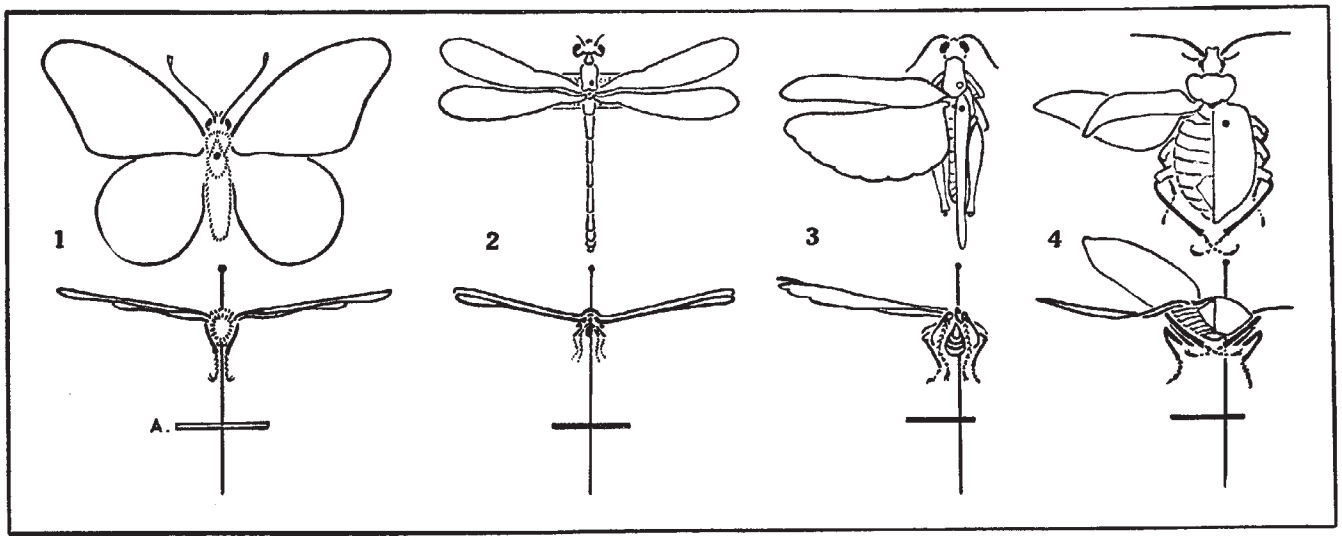
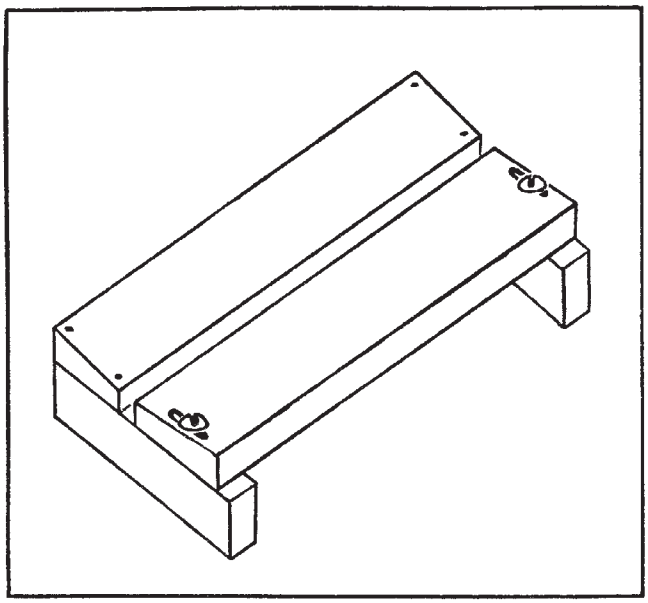


Fig. 1. Insects which have been mounted by the use of spreading boards, top and rear views, showing the position of the pin in the specimen and of the locality label on the pin.

1. Butterfly. A. is the label.
2. Damsel-fly.
3. Grasshopper, showing the traditional thoracic position of the pin, as well as the preferred position in the right forewing.
4. Beetle.



←Fig. 2. An adjustable spreading board.

Although it is possible, with patience and ingenuity, to spread insects without special equipment, the process is made quicker and easier by the use of a spreading board, upon which the wings may be extended. This is actually two boards mounted with enough space between them to contain the body and legs of the insect. Fig. 2 shows a commercially made spreading board with groove of adjustable width. If you have not many specimens to mount, you would do well to buy one of these from a scientific supply house; but if you are planning a large general collection, it would be better to make for yourself a number of spreading boards of assorted sizes.

The dimensions of spreading boards may vary. Those given here are large enough to contain our biggest local insects, and small enough to handle easily. For very little species, they could be much

narrower; for tropical giants, they might have to be wider. It is desirable to base the measurements upon the largest board that you will need, and to have the pieces of all the boards cut to those measurements by the lumber yard or wood-working shop where you buy the materials. The minor alterations necessary in the smaller boards can be made with a hand saw after they are assembled.

The two principal pieces of each spreading board should be of very soft wood. California redwood and eastern white pine are excellent, but western white pine is too hard. It does not matter what wood is used for the smaller pieces.

MATERIALS FOR ONE SPREADING BOARD

Two pieces of soft wood, 12" x 3" x ⅝" at one edge and ⅜" at the other, as shown in fig. 3. This slope of

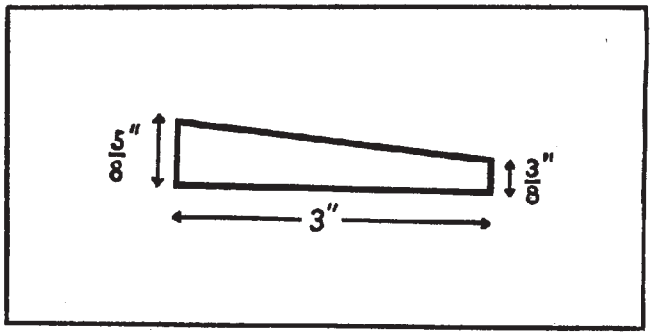


Fig. 3. End of one of the two principal pieces of a spreading board.

the top surface of the boards gives the wings of the mounted insects an upward tilt which tends to offset a natural tendency of the wings of pinned specimens to droop.

Two pieces of wood, 7" x ¾" x ½". The thickness of these pieces combines with that of the narrower edge of the principal boards to determine the height of the specimens upon their mounting pins, and is therefore important. The other dimensions may vary a little, if desired, although their length should at least equal the total width of the completed article, and their width must be great enough to receive several small nails without splitting.

Three pieces of wood, 12" x ¾" x ½". The length of these pieces is their only significant measurement, but the cabinet maker who cuts the pieces would probably like to make all the small ones from the same strip of material.

One piece of cork or balsa wood, 10½" x 1" x ⅛" approximately. Balsa wood strip of suitable size is carried by many hobby-craft stores, and it is sometimes possible to obtain sheet cork from a concern dealing in linoleum and similar floor coverings.

TOOLS AND SUPPLIES

Small-headed wire brads, some one inch and some three-quarters of an inch in length.

Carpet tacks, about a quarter of an inch long.
A little glue.
A hammer.
A small saw.

ASSEMBLING THE SPREADING BOARD

Place the two seven-inch strips, one broad surface down, parallel to each other and a foot apart. On top of these, and at right angles to them, put one of the two wide boards. Match the corners at the thick edge of the board, and nail the pieces together as shown at the top of fig. 4. Use the one-inch brads at the outer corners, the three-quarter inch elsewhere.

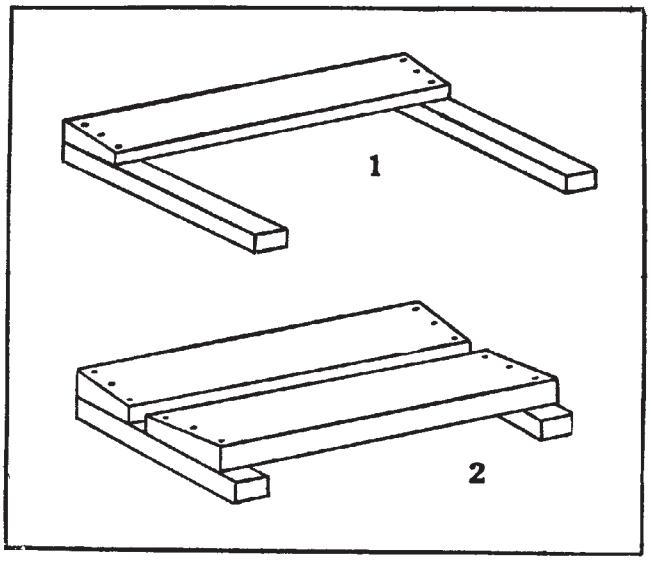


Fig. 4. First steps in assembling a spreading board.

Lay the second board parallel to the first, with the thin edges facing each other and enough space between them to accommodate the body and legs of an insect. Fasten with brads, as shown at the bottom of fig. 4. Grooves ¼", ⅜" and ½" in width will probably be most useful.

Turn the assembly over. For a quarter of an inch on either side of the central space, spread the bottoms of the boards with glue. Cover the gap with a strip of balsa wood or cork. Since, in use, this strip must bear considerable strain, it should also be secured with a number of large-headed tacks, as shown in fig. 5.

Still working on the underside, place the three long wooden bars on top of the short ones, and at right angles to them, parallel to the large boards. The outer pair should match the boards at the corners, while the middle one must lie directly above the space between them, over the cork or balsa wood strip. Nail all three in place with one inch brads as shown in fig. 6.

Unless the groove has been made extremely wide, the ends of the short cross-pieces will be protruding at one side of the spreading board. Cut these off

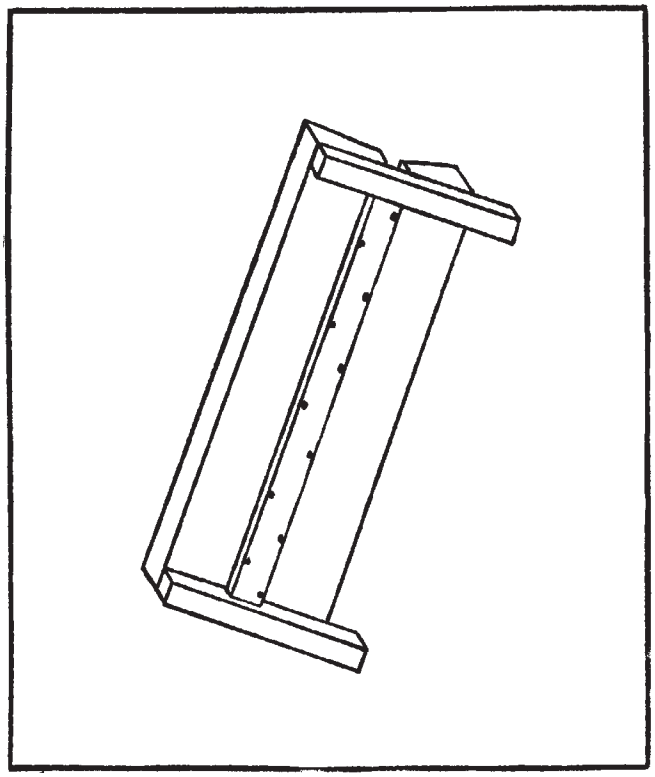


Fig. 5. Position of the balsa wood strip on the under side of a spreading board.

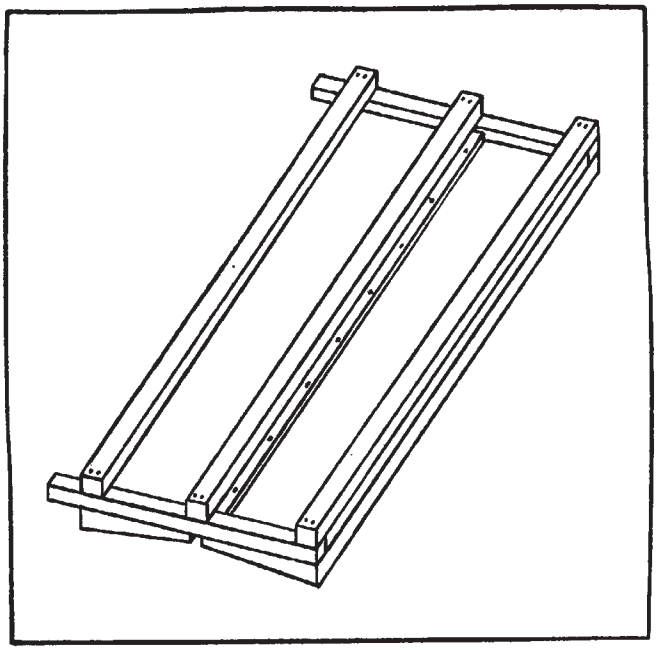


Fig. 6. Last step in assembling a spreading board.

as close as possible, with a small hand saw, and the board is finished.

USING THE SPREADING BOARD

Every experienced spreader of insects develops individual variations upon the basic idea, which is to extend the wings of the specimen flat upon the board, and keep them there until dry. The method here described is the one in use at this Museum. It produces specimens of good quality more quickly and with less equipment than any other system with which we are acquainted. The necessary tools are illustrated in fig. 7. They are:

1. Glass headed furriers' pins, sometimes sold as veil pins. You will need about ten for each of the specimens to be mounted at one time. They can be bought by the pound from dealers in commercial sewing equipment. Ordinary dressmaker's straight pins will serve the same purpose, but are harder on the hands of the user.

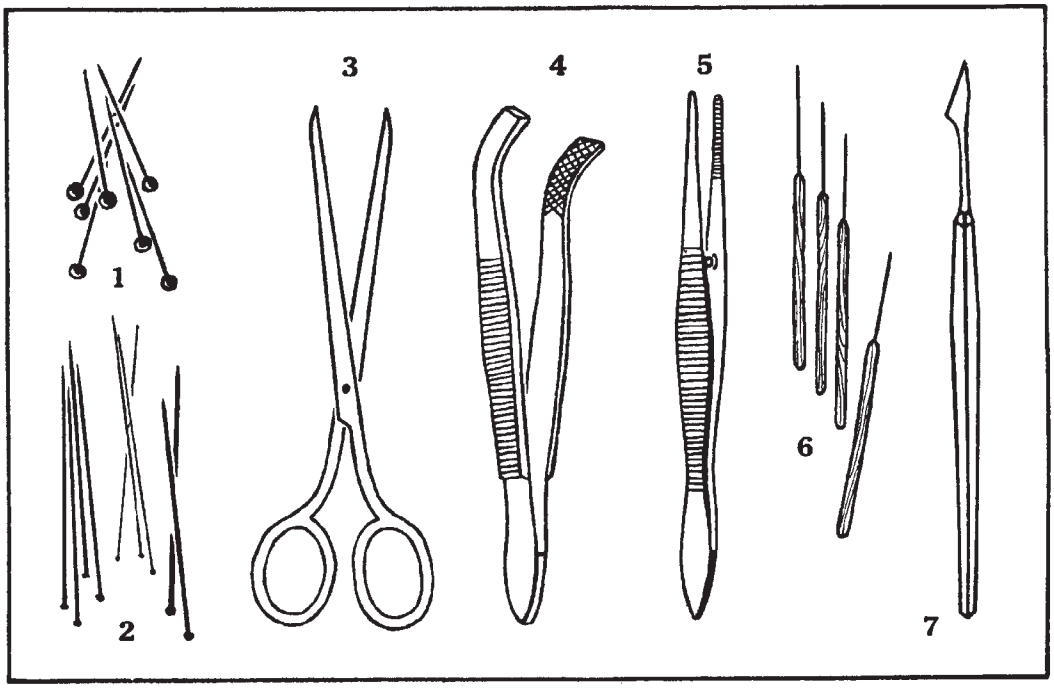


Fig. 7. Tools used in spreading insects.

1. Glass-headed pins.
2. Special steel insect pins.
3. Scissors.
4. Pin forceps.
5. Pointed forceps.
6. Spreading needles.
7. A lancet for Skippers.

2. Special steel insect pins. These usually come in packages of one-hundred or five-hundred, and are of uniform length. The variable thickness is designated by a number which increases with the diameter of the pin. Number three is probably the most generally useful size, but ones and fives are also valuable. Insects too small for size one pins must be dealt with by special methods, as very fine pins bend too readily to be practical.

3. A pair of scissors, for cutting strips of paper.

4. A pair of broad-ended, rough-faced forceps, for grasping insect pins.

5. A pair of slender, pointed forceps, straight or curved, with which to hold the specimens.

6. Spreading needles. Make these yourself, using number eleven or twelve sewing needles with match sticks for handles. The eye end of the needle should be thrust into the end of the match stick for about half the needle's length, by means of a pair of pliers. You may have to try several times before finding a match straight enough in the grain to endure this without splitting, but the resultant tool is better for its purpose than any you might buy. If you plan to mount one specimen at a time, you will need four of these needles, but when spreading a large number of insects at once, you may have to use four for each specimen on half of the board, or about a dozen, and in case of a series of stiff specimens, which require needles to remain in place until the insects have dried, four for each specimen in the lot.

7. A lancet, or broad bladed dissecting needle, for cutting the wing muscles of Skippers. Skippers are butterflies belonging to the family Hesperiidae which may be recognized by the hooks at the ends of the antennae. Their wings are small, but so strongly muscled that they often cannot be spread without tearing unless the muscles are cut, as shown in fig. 8, by a small but deep longitudinal incision just under each wing. This operation is performed after the specimen has been pinned in the usual manner, as described below.

In addition to these tools, you will require some strong, tough paper, typewriter bond will do, and some stiff heavy paper or light index card. The papers must be large enough to make strips about seven inches long.

Dissecting needle, forceps, and insect pins are obtainable from dealers in scientific supplies.

Entomological specimens must be mounted while damp and pliable. If this cannot be done when the insects are fresh-killed, they must be softened by exposure to the saturated atmosphere of a relaxing box. The construction and use of relaxing boxes is discussed in Leaflet Four, and one of them is shown in fig. 9. Twenty-four hours in such a humidor will usually bring the driest specimens to workable condition, and even when mounting fresh specimens it is advisable to keep them in a relaxing box until you are ready for them.

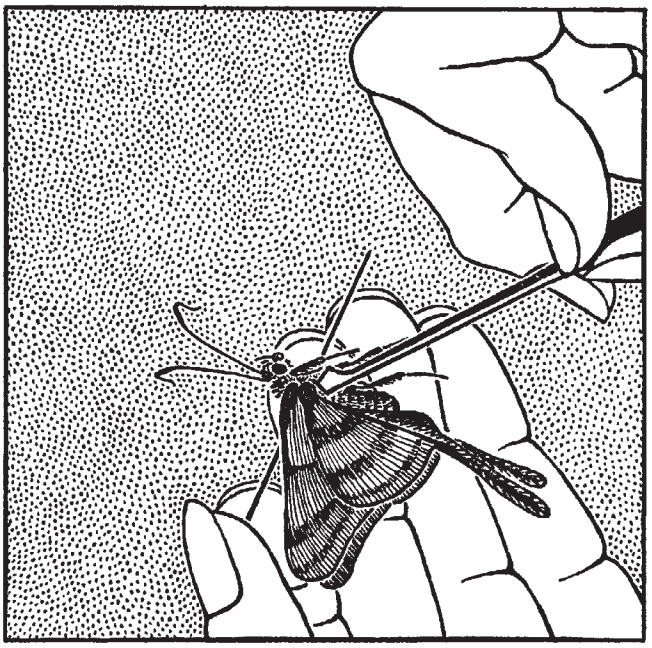


Fig. 8. Lancing a Skipper, showing method of holding the pinned specimen steadied by the middle finger, and position of incision to cut the hind wing muscles.

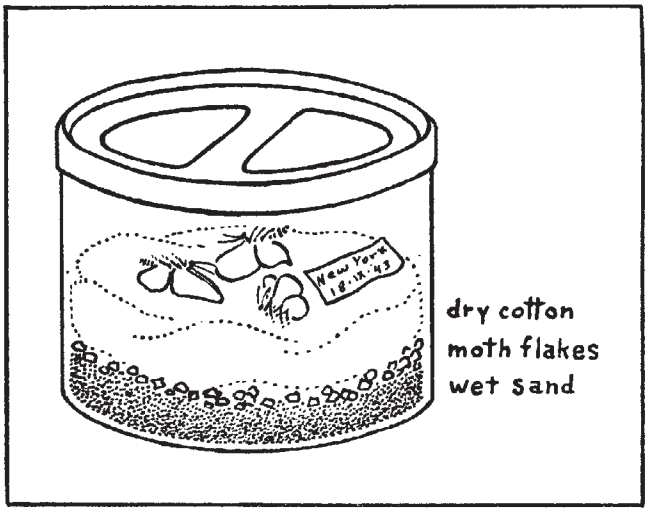


Fig. 9. Relaxing box made of an ice-box jar. In the bottom, an inch of soaking wet sand. Next, a tablespoonful of paradichlorobenzene to prevent mold. On top, a layer of dry cotton to protect specimens from contact with liquid.

For convenience in describing the spreading process, it will be assumed that the operator is right handed, and that the specimens are moths and butterflies of average size, to be mounted, in the usual scientific style, upon pins.

Select boards with grooves of widths suitable to the specimens to be mounted. For each board, if it is to be filled to capacity, make four strips of strong letter paper about seven inches long and three-sixteenths of an inch wide, called guide strips, and

four strips of light card of the same length but a quarter of an inch more than wide enough to cover the wings of one side of the largest specimen the board is to hold. When spreading a large mixed lot, it will save time if you make a quantity of strips of assorted sizes and keep them in readiness.

Lay out the pins, papers, and mounting tools where you can easily reach them, together with the relaxing box holding the insects. During the spreading operations, the board lies with one end toward the spreader, and the work progresses from the middle of the board toward that nearer end. When half of the board is filled, the position of the ends is reversed and the process repeated. Some workers raise the further end of the board by resting it on a book or shallow box.

Along each side of the central groove place two guide strips with their inner ends overlapping about three-eights of an inch and fastened at the middle of the board with a glass-headed pin. This overlap appears in fig. 10. The outer ends of these strips will extend for a short distance beyond the ends of the board.

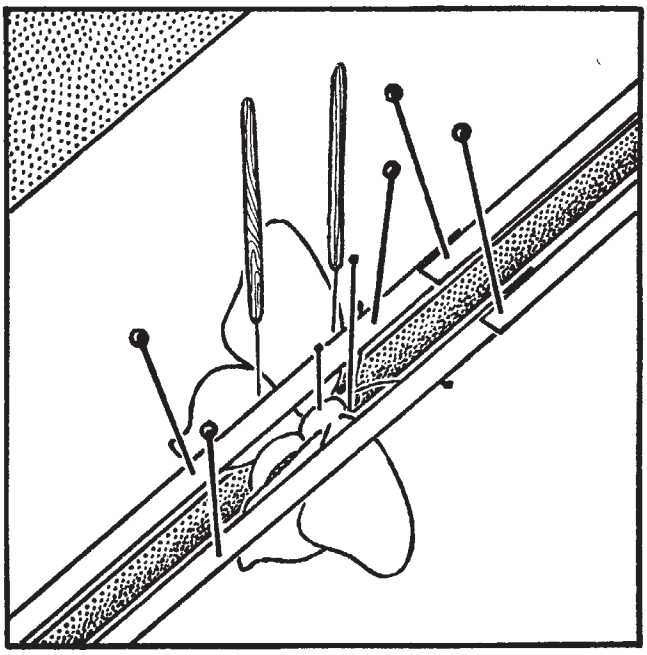


Fig. 10. Butterfly half spread.

With the pointed tweezers, remove a specimen from the relaxing box, holding it firmly by the thorax. Blow upon it gently from behind. If the wings flutter slightly, the specimen is soft enough to spread. Lay it upon the palm of your left hand, with the wings away from you and the head toward your right. With the points of the forceps parallel to the insect's body, seize it just under the bases of the wings, and pinch. This will cause the wings to open enough for you to see where to insert the pin. Use a steel insect pin as large in diameter as the specimen can accommodate without distortion. It will serve as a handle for the insect, which ought never to be touched with the fingers, and which, when dry, will be extremely brittle. Hold the pin in the left hand, and pass it directly through the thorax, between the wings, from top to bottom and at right angles to the length of the body. It should protrude about ⅝" above the back.

Holding the point of the pin in the left hand, take the pin forceps in the right and, sliding them between the wings, grasp the top of the pin. Holding the specimen in this manner, body parallel to the groove and head away from you, push the point of the pin straight down through the cork strip at the bottom of the groove until it strikes the wooden bar beneath. So that the spreading of the wings may not be obstructed by the pins holding the guide strips, insert the first insect pin about an inch away from them. The body of the insect, with the legs folded close against it, should lie neatly in the middle of the groove. If the upper edges of the boards do not strike just below the bases of the wings, move the specimen up or down upon its pin until they do.

Lifting the right guide strip by its free end, slide it between the wings and use it to pull the wings of the right side down against the board. Put a pin through the strip just back of the wings to hold them out of the way while you work on the other side. This also may be seen in fig. 10.

Depress the wings of the left side by means of the left guide strip, kept taut between the thumb and forefinger, and held down by the third finger of the left hand. Taking one of the spreading needles in the right hand, use it to pull the left forewing forward until its rear margin is at right angles to the length of the body. This can be done without tearing the wing membrane if the needle point is inserted just back of one of the heavy veins near the front margin of the wing close to the guide strip. When the wing is in position, drive the needle through the membrane and into the board, to keep the wing from slipping back during the following operations.

If the pull on the wing causes the body to pivot on its pin, a second insect pin placed close against the body just in front of the right forewing and driven securely into the bottom of the groove should overcome the difficulty. Fig. 10 shows this restraining pin in place. The position of the antennae under the guide strips may also be seen in fig. 10.

Using a second spreading needle behind a strong vein, pull the left hind wing forward and fasten it in place, securing it further by a pin through the guide strip just back of its rear edge. The exact relative position of the fore and hind wings is a matter of controversy. Tradition demands that the margins of the two form a smooth continuous outline, but as so great an overlap conceals the often interesting characters near the upper front margin of the hind wing, the

side of the specimen. It is read by turning the insect over.

The legs and antennae of a mounted insect should be neatly arranged, as close to the body as you can get them without hiding their characters, which are often used in making a determination. If the appendages refuse to remain in the attitude which you wish them to assume, drive the pin into the pinning block until the insect's body almost rests upon it. Then bring the appendages into position and fasten them with pins, as shown in fig. 9. If one pin does not suffice to secure a member, a pair crossed above or below it will often do so. Sagging abdomens may also be corrected by this method. The exceedingly attenuated abdomens of Dragon-flies will be more durable if each is reinforced with a fine broom straw or piece of wire. This should reach from the end of the abdomen well into the thorax. It will show least if you remove the abdomen from the body, insert the support from the thoracic end, and join the pieces by means of a little glue and the projecting end of the reinforcement thrust into the thorax. The practise of pinning Odonata is giving way, among serious students, to that of storing the specimens in individual cellophane envelopes.

Specimens which have been arranged on a pinning block should be allowed to set before they are removed. This may require several hours or several days and can be determined only by experiment.

As soon as a specimen has been pinned or, if it has been set, as soon as it is dry enough to remove from the pinning block, the pin label or labels should be attached. To do this, lay the label on the pinning block and drive the pin through it for the proper distance. The first label should be about half an inch above the point of the pin, a second label far enough below the first to be read without difficulty. Unformity in the height of the labels adds to the appearance of a collection, and may be assured by means of a pin gage. When using such a gage, as shown in fig. 3, the specimen being a small one requiring four labels, the locality label will be placed by hole 1, the collectors label by hole 2, the observations label by hole 3 and the identity label by hole 4. With thicker specimens or those requiring fewer labels, the locality label will most often stand in position 2. In choosing the exact spot on a label through which to thrust a pin, consider the size and shape of the specimen. If it is smaller than the label, let the label extend beyond it as evenly as possible in all directions. If the specimen is larger, place the label as nearly centered under it as you are able. Insects which have been mounted with wings extended at the sides require the label to be pinned in the middle with its top edge toward the head of the creature, so that the label is read from behind. Long, thin species call for a label parallel to the body's length with the top to the insect's right, the label being read from the left. If the left wings only have been spread, as they often are in grasshoppers and some other kinds of insects, the label must be pinned near the right side and extend under the wings at the left. Small insects mounted on points as described below also require a label pinned at the right end. The objects of all this are to save space and to make the collection look neat.

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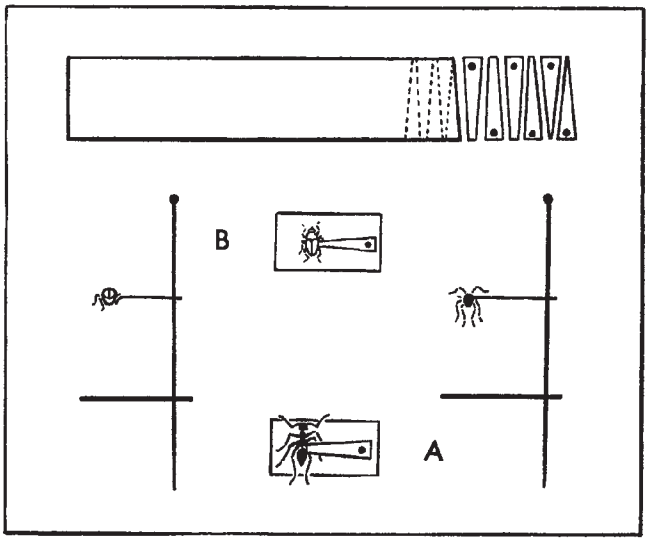

Fig. 10. The cut and use of points for mounting small insects.
A. An ant, top and rear views.
B. A beetle, top and rear views.

The point is attached to the right side of the specimen so that when the creature is headed away from you the point extends to the left of the pin. The precise manner in which the point is applied will vary with the shape of the specimen, as illustrated in fig. 11. Most beetles, like "A," are rather flat on the bottom. To mount one of these, place the relaxed specimen, bottom up and head away from you, on a pinning block or sheet of cork. Separate the second and third legs of the right side, which will be at your left, so as to leave as broad a space as possible for the attachment of the point. If the point is glued to the legs, it is likely

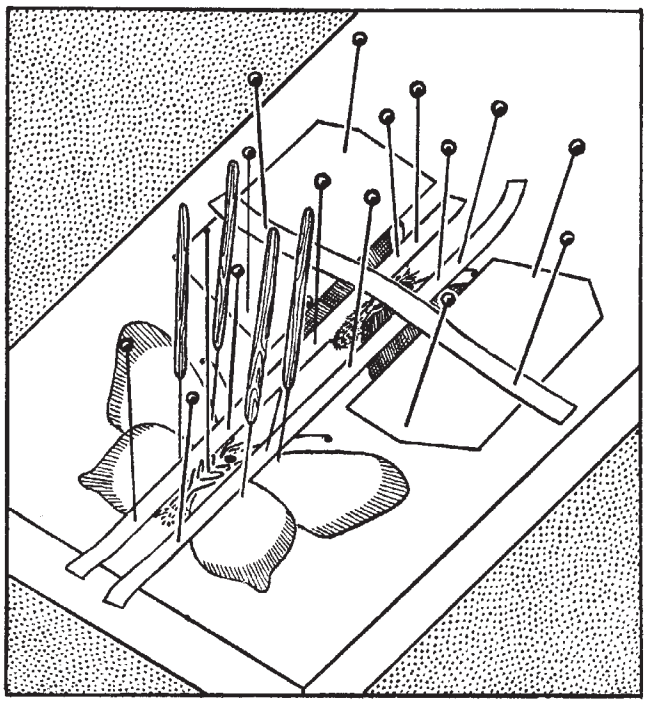

Fig. 12. Butterflies spread up-side-down on a flat board.

a strip of paper, as illustrated. Dragon-flies, even if they are to be pinned, may be mounted in the same fashion. The pin, however, should be left in position while the insect dries. When the specimen is removed from the board, the pin may be carefully twisted loose, withdrawn, and inserted from above through the same hole. A small drop of cement at the pin hole will prevent the specimen from turning on the pin, should the hole be a trifle too large for it.

Microlepidoptera, if too small to take number one pins, should be mounted upon "minuten nadeln." These extremely slender pins are too short and too delicate for easy handling, and must themselves be mounted upon a slip of cork or balsa wood which, in turn, is mounted upon an insect pin of standard size. A piece of blotting paper covered with strong onion-skin paper is equally satisfactory as a connective, and easier to produce in quantity. Cut a straight piece of white blotting paper half an inch wide and as long as is convenient. Cut a strip of strong, thin paper of the same length by an inch and a half in width. Cover one side of the paper with paste and wrap it snugly around the blotter. When the paste has dried, slice the strip crossways with a razor blade and metal-edged ruler into pieces about an eighth of an inch wide. When using one of these, pass the insect pin through the blotting paper from edge to edge at one end, and the nadel bearing the insect at the other. Fig. 13 illustrates this method of mounting.

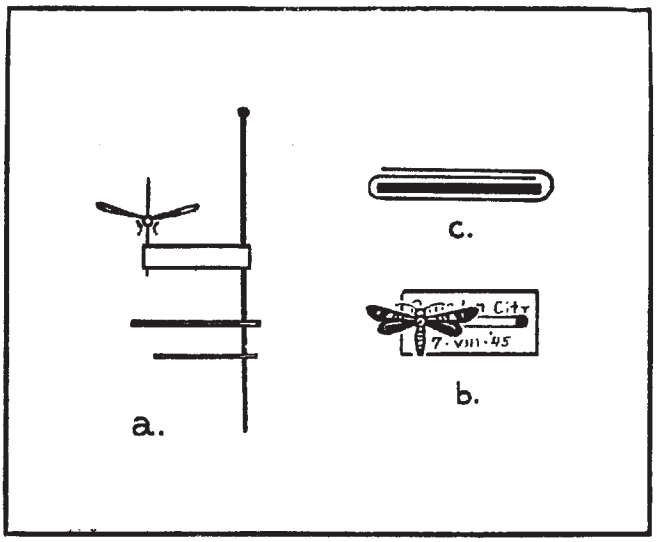

Fig. 13. A method of mounting Microlepidoptera upon minuten nadeln.

a. Rear view. Note collector's label below locality label.
b. Top view.
c. Diagram of cross section of connective, showing how the onionskin is wrapped around the blotting paper.

Insects of other orders are spread by processes essentially similar to those used for Lepidoptera. The small differences necessitated by the differing structure of the creatures will become obvious as you work. It is, for example, practically impossible to make the forewing of a beetle lie flat when extended at the side. It should, therefore, be lifted into flying position and held there by supporting pins, the guide and cover strips being passed beneath it. This results in the attitude illustrated in fig. 1. In this figure note also the positions of the pins in the various types of insects. The correct method of pinning hand-bodied insects of all kinds is discussed in Leaflet Number Four.

Direction Leaflet Number Six

HOW TO PRESERVE A COLLECTION OF SOFT-BODIED INSECTS AND SPIDERS

By ALICE GRAY

Department of Insects and Spiders
The American Museum of Natural History

Although most adult insects are preserved by air-drying only, the general collector will find, among his catch, many interesting creatures which cannot be so treated without intolerable distortion. Almost all spiders, ticks, and daddy-long-legs, for instance, are so thin-skinned and succulent that, if simply dried, they shrivel beyond easy recognition. So do the eggs, larvae, and pupae of most insects, and the adults of such diverse kinds as termites, silver-fish, aphids, and many others.

Soft-bodied arthropods can be dehydrated artificially, with comparatively little distortion, by methods outlined later in this paper. The processes are, however, uncertain, laborious, and exacting. Since small but important characters are sometimes obliterated by desiccation, only those specimens which are required for exhibition, rather than for study, should ordinarily be mounted dry.

LIQUID PRESERVATION

Study specimens, the majority of those taken by any serious collector, are usually killed and permanently preserved in ethyl alcohol somewhat diluted with water, as described in Leaflet Number Three. If you are interested in soft-bodied insects and spiders of all sizes, you will find it convenient to have at hand, in labeled bottles, stock solutions containing ethyl alcohol in various proportions. Assuming the available alcohol to be "completely denatured," and of the best quality, it will contain about 95% of ethyl alcohol and 5% of methyl alcohol and gasoline. The relative volumes of denatured alcohol and water in the most useful mixtures will then be these:

Approximate concentration of ethyl alcohol	Parts by volume denatured alcohol	Parts by volume water	Use
50%	10	9	For killing very delicate specimens.
60%	12	7	For "stepping-up" delicate specimens. Rarely needed.
70%	14	5	For preserving delicate specimens and killing tougher ones.
80%	16	3	For preserving specimens of average or large size.

If you have, or can borrow, a measuring graduate of 100 cubic centimeters capacity, you can easily prepare alcohol of any given concentration from that of any known greater concentration in this manner. Fill the graduate with alcohol to the mark corresponding to the desired percentage of the mixture. Then add water until the total volume reaches the mark corresponding to the known percentage of the original alcohol. Thus, to make a 70% mixture from a 95% solution, fill the graduate with alcohol to the 70c.c. mark and add 25c.c. of water, making 95c.c. in all. The proportions listed in the table above were derived in this way, and although only approximate, are accurate enough for practical purposes. If the water in your district is conspicuously "hard," you might use distilled water in mixing your reagents, though "soft" tap-water is usually all right.

Alcohol of full strength, 95% can be used as a preservative for the larger species, but it will probably make them so rigid that they must be soaked in water before they can be manipulated for examination.

If your collection must go for long periods unattended, so that it is in danger of drying out, add to the stock preservative solutions about two percent of

glycerine, or two tablespoonfuls to a quart. Glycerine will keep the specimens pliant long after the alcohol has disappeared. Do not use it, however, if you handle your collection frequently. You cannot avoid spilling a little of the liquid as you work; and when the alcohol evaporates, the residue of glycerine on tools and hands is unpleasantly sticky.

Whether killed with alcohol in the field or with hot water in the laboratory, fresh specimens are placed, at first, in a solution which is too weak to preserve them permanently. It will, however, begin the dehydration without distortion. When they are transferred to a stronger preservative a day or two later, the specimens will not shrink as much as they would have done if dropped directly into the concentrated solution. The more gradual this "stepping-up," the less the shape of the specimens will be affected. Some biological preparations require a long series of baths differing in concentration by as little as five percent, but for most insects and spiders, one step is probably enough. The smallest and juiciest species may be the better for two. The concentrations recommended for these purposes are listed in the dilution table above. If a bottle contains a large number of bulky specimens, change the final preserving fluid at least once, after an interval of several days, before storing the bottle away indefinitely. The body fluids of the animals may dilute the first alcohol bath below the 70% minimum effective for long term preservation. As often thereafter as the alcohol becomes discolored, replace it with a fresh supply.

When collecting in a remote area, far removed from your base of operation, and with a limited supply of alcohol, changing the fluid within a few days will be impractical. In this case, it is better to collect into straight 95% alcohol, risking the distortion, than to chance losing the specimens through dilution of the preservative by body fluids. Replace the killing fluid with fresh alcohol of appropriate concentration as soon as opportunity arises.

It is likely that each collecting bottle filled in the field will contain specimens of several species, and possibly of different dates or localities. Before these can be incorporated into a scientific collection, they must be sorted and separated, so that one bottle contains creatures of one species, date, and locality only. You can do this most conveniently while changing the alcohol for the last time. When sorting a collection, be sure that every bottle, whether containing a single specimen or a dozen, also contains a label giving the locality and date of capture and the name of the collector. Field notes relative to the animals may also be included, as well as the name of the species, if you know it. Write these labels with black waterproof India Ink, on hard but unglazed paper of good quality. Make them of such size and shape that they fit into the bottles easily, and can be read conveniently through the glass.

To assure the workmanlike neatness of your collection, use storage bottles of one shape and a few standard sizes. Two common kinds are shown in Fig. 1. The homeopathic vial, "A", is preferable for a large or little-worked collection, because the constricted neck grips the stopper tightly, retarding evaporation of the alcohol. The shell vial, "B", must be refilled more often, but its use in small much-handled collections is justified by the ease with which the specimens may be extracted from it. Your local

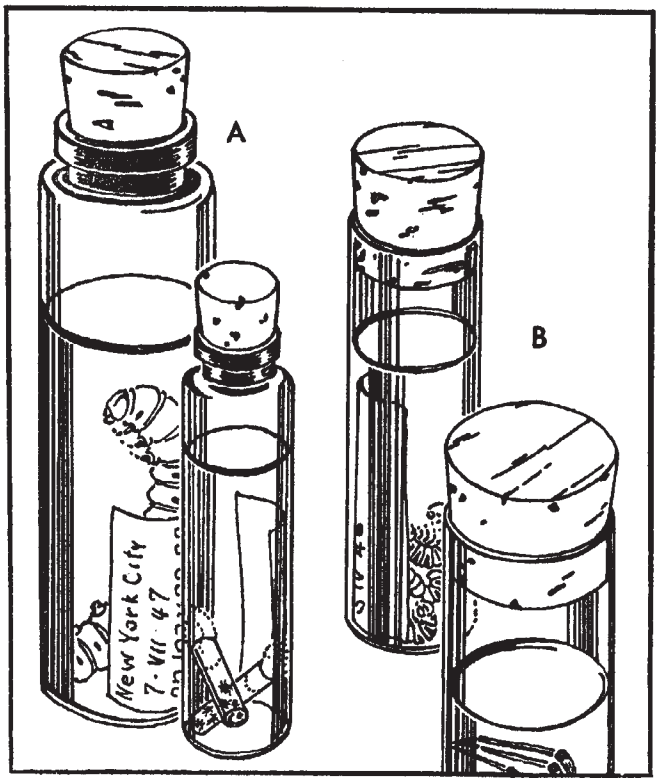

Fig. 1. Storage bottles for preserved specimens. A., homeopathic vials. Note tubes for minute specimens in the smaller. B., shell vials.

druggist probably carries vials of these or other suitable shapes. If not, you can buy them in quantity from any scientific supply house. Four drams is the most generally useful size, while eight drams will accommodate the largest species which you are apt to catch in this part of the world (New York). Vials smaller than two drams dry out so quickly that they are a nuisance. If you are afraid of overlooking extremely minute specimens in a large container, store them in tiny tubes stoppered with cotton, putting these tubes into the vials of alcohol. Such tubes are shown in the smaller vial at "A" in Fig. 1.

Rather than screw caps, bottles used for alcoholic specimens should have corks of the very finest quality. If the only available corks are coarse or faulty, use rubber stoppers. Store the bottles in an upright

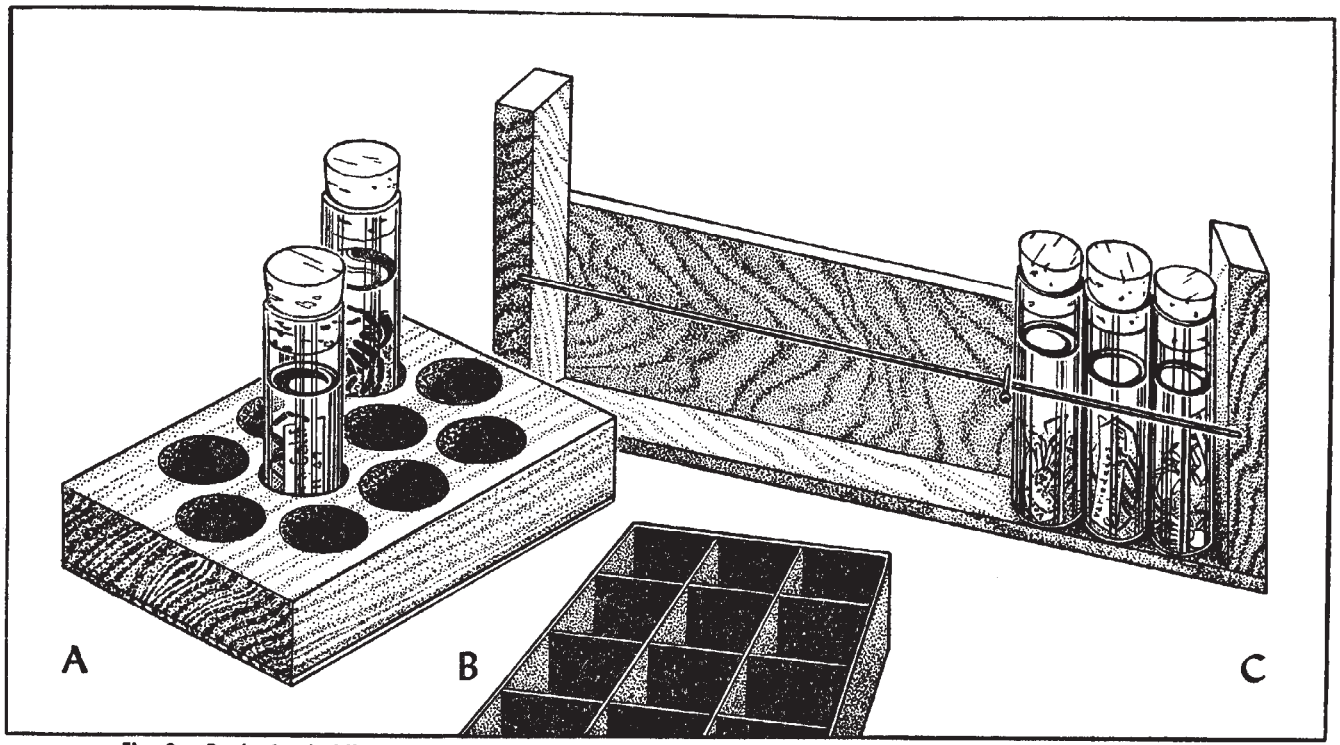

Fig. 2. Racks for holding storage vials. A., wooden block. B., cardboard "egg-box." C., "M.C.Z." rack

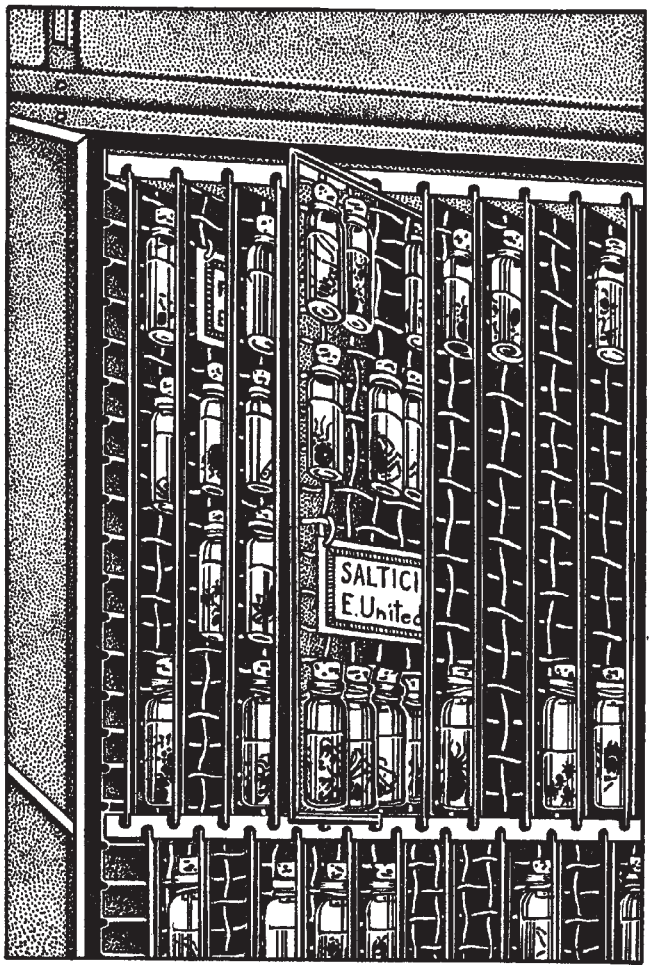

Fig. 3. American Museum method of storing an alcoholic collection.

position so that the liquid does not touch the stoppers constantly. Prolonged contact with alcohol hastens the deterioration of rubber and shrinks cork, allowing the liquid to escape.

Tall slender bottles readily become upset or disarranged. Avoid this by keeping them in racks or trays. Fig. 2. shows several kinds of racks which you can easily make for yourself. "A" is a piece of one-inch plank in which have been bored neat rows of holes a little larger in diameter than the largest bottle which they may be expected to receive. These holes are closed at the bottom by a thin piece of wood or a sheet of cardboard, fastened to the block with glue and tacks. "B" is a box divided into bottle-size compartments by cardboard partitions like those of an egg crate. The racks, like the bottles, should be of one design throughout the collection. In size they may vary, but they should all be made in multiples of a basic set of measurements, so that they will fit together without waste of space. Arrange the bottles in the trays, and the trays upon shelves, in some orderly manner; perhaps in the sequence followed by the author of the book which you use to identify the animals. You will then be able to find, without trouble, any species which is represented in your collection. By preference, the shelves should be enclosed in a closet or cabinet. It is no small chore to dust a collection of bottled arthropods.

"C" in Fig. 2. is an "M.C.Z." rack, used by the Museum of Comparative Zoology at Harvard. One side of the narrow box-like tray consists of a heavy

wire, exposing the contents of the vials to view. The ends of the tray are a little higher than the tops of the corked bottles, to protect the corks from being accidentally dislodged. They also serve as handles for lifting the tray out of the shallow drawer in which it is stored. Some "M.C.Z." racks are made double, with a wooden partition in the middle and wires on either side. These contain two rows of vials. There are no partitions between the individual bottles in the row. When the rack is not full, the bottles are held in position by a large pin driven into the wooden side horizontally, just above the wire, as the picture indicates.

Fig. 3. illustrates another and even more efficient way to store a large collection of alcoholic specimens.

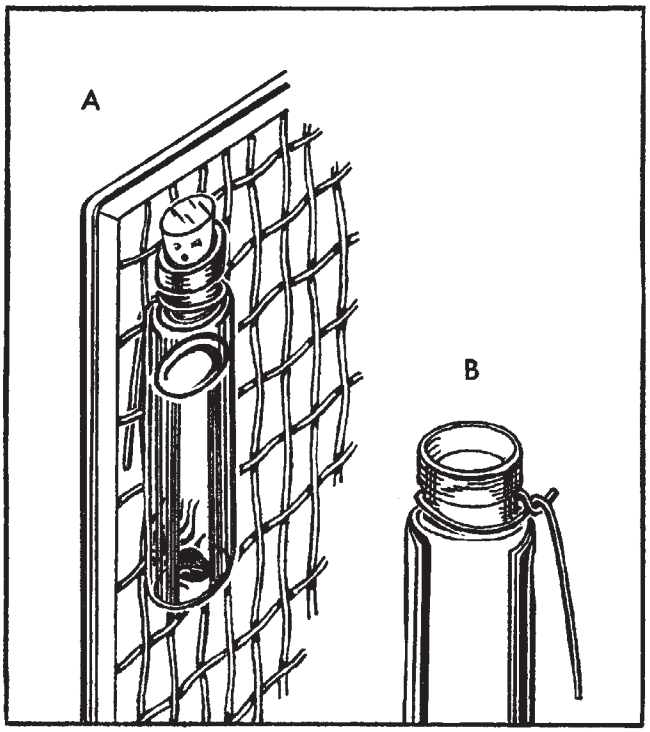

Fig. 4. A., corner of A.M.N.H. rack, showing metal binding. B., top of vial, showing how wire is twisted around the neck to form a hook.

It was invented and first used at the American Museum of Natural History. The creatures are kept in homeopathic vials. Around the neck of each vial is a collar of soft iron or copper wire prolonged into a hook, as you may see at "B" in Fig. 4. By means of these hooks, the vials are suspended in rows from vertical racks made of half-inch mesh galvanized wire screen. The rectangular mesh panels are bound around the edges with thin sheet metal. See "A" in Fig. 4. They are made to slide in grooves cut in the upper and under surfaces of the heavy wooden shelves with which the storage cabinets are provided. Since the slots need be no more than an inch and a half apart, and each panel will carry several rows of bottles, the capacity of such a cabinet is very great.

A bottled collection which must lie idle for long may very wisely be stored in pint canning jars as shown in Fig. 5. Remove the corks from the vials and replace them with cotton plugs. Cover the bottom of a pint canning jar with a thin cushion of cotton. Pack the vials into the jar, upright and as snugly as possible. Put on the rubber ring, fill the jar with alcohol, and clamp down the lid. Though years pass before you look at them again, specimens so stored will be moist and perfect when wanted.

Animals which have been preserved in alcohol should never be allowed to dry out. Unless your collection is "canned," inspect it at least once in six months, filling the bottles and replacing defective corks. When you want to study a specimen, remove it from its bottle with forceps and put it into a watch-glass or other small dish full of alcohol. Very little specimens can be transferred more easily by sucking them out of the container with a medicine dropper, fluid and all. A specimen which has accidentally dried can be relaxed by soaking in warm water, but it will never entirely regain its former appearance. A drop of some detergent or "wetting agent" such as Aerosol OT, applied directly to the specimen before covering it with water, will hasten the softening and frequently restores plumpness.

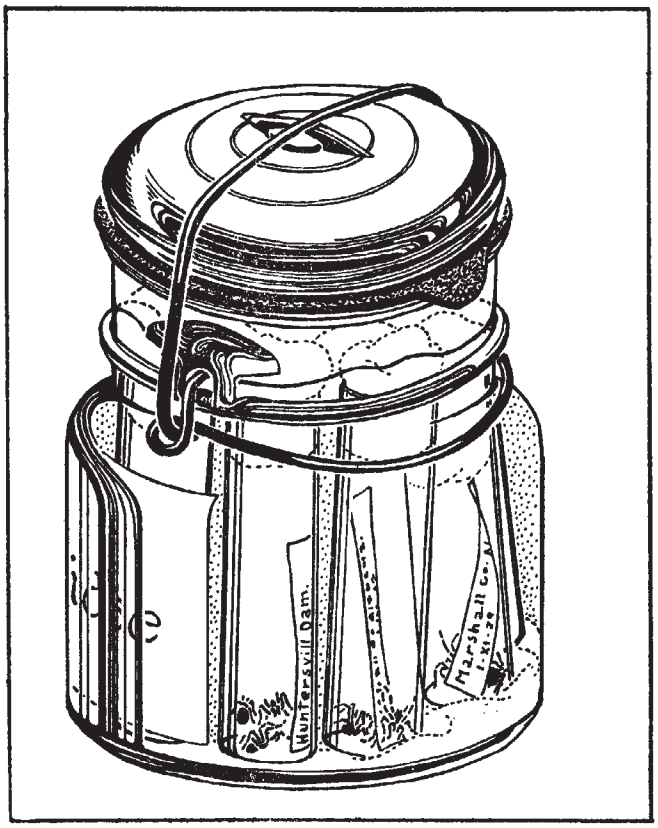

Fig. 5. Bottled arthropods stored in a pint canning jar, to prevent drying-out.

ARTIFICIAL DEHYDRATION

Although liquid preservation is more satisfactory for scientific purposes, it is sometimes desirable to mount spiders or soft-bodied insects dry. With the exception of Lepidopterists, students of insect development who like to keep together all the stages of a life cycle, hard and soft, are more likely to put the hard ones into liquid than to dry the soft ones. Show-specimens, however, should present as life-like an appearance as possible, and need not stand close expert scrutiny. These you will be justified in drying out by strategy.

Unhappily, no one stratagem will suffice for all occasions, and some specimens fail to respond properly to any process yet devised. Nevertheless, there are a few basic schemes by which more or less satisfactory dry preparations can be made from most soft-bodied arthropods. Once you have grasped the principles, you should be able to improve upon the skeleton directions here given, and with the experience of practice, to produce quite creditable results.

Specimens which have been preserved in liquid for a long time are sure to come out almost colorless when dried. Even the brightest of fresh specimens will dry slightly faded. If constantly exposed to a strong light, the remaining color soon bleaches to a neutral tan, only a ghost of the original pattern surviving. To preserve any semblance of their appearance during life, exhibition specimens will have to be painted. This should be done while you can still remember what they looked like, or better yet, while living specimens are available to serve as models. Ordinary oil paint is all right, but the transparent oil colors made for tinting photographs are particularly good for this purpose. They are so clear that a pattern of light and dark areas shows through, and can, therefore, be followed easily. Thin the paint with xylol for quicker drying, and put it on lightly with a small water-color brush. The more skill and patience you can bring to this operation, the more convincing the specimen will look.

DRY MOUNTING BY INFLATION

"Blowing" or "inflation" is the traditional and most widely practiced method for dry-mounting caterpillars. It can also be applied to grubs and to other creatures of suitable size and construction. The process consists of eviscerating the specimen, filling it with air like a balloon, and blowing continuously while it is drying in a small oven. For about six dollars you can buy from a scientific supply house a complete set of equipment for inflating caterpillars, together with instructions for its use. It is, however, perfectly practical and much cheaper to make your own "blowing" outfit from odds and ends, most of which you will already have around the house.

The principal item is the oven. A tin can of moderate size is readily converted to this use, as shown in Fig. 6. Open the can as neatly as possible, leaving the top attached to the body for about two inches. Empty and wash the can, removing the paper label. With tin shears, cut in the lid a wedge-shaped hole large enough to admit a big caterpillar. Then bend the lid back to its original position in the mouth of the can. At the other end, just under the opening, puncture the can with a beer-opener, to make a vent or flue.

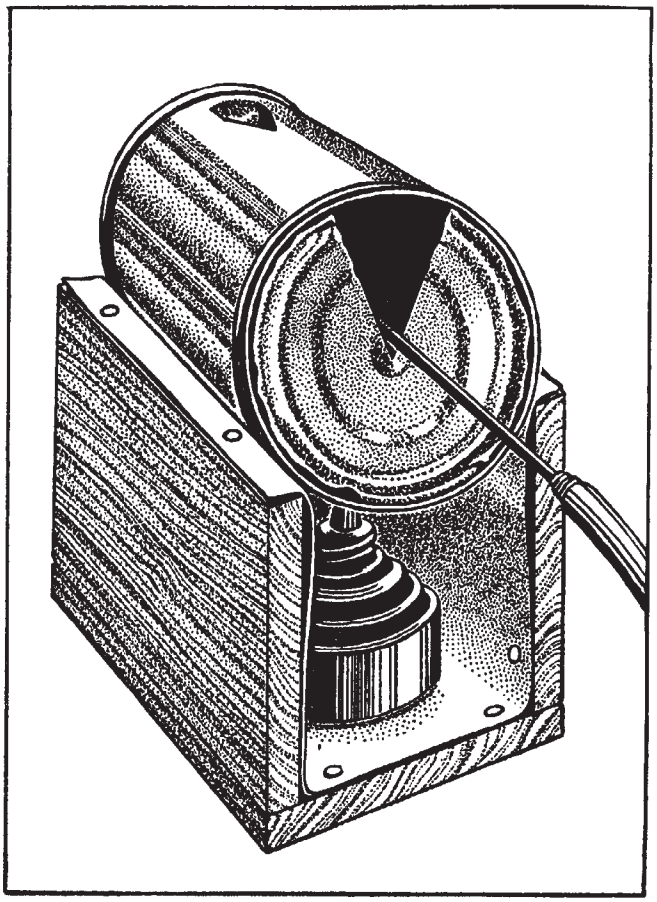

Fig. 6. Home made oven for drying inflated caterpillars.

The stand used to support the oven in the picture is made of scraps of wood, nailed together and lined with metal from another can. The source of heat is a spirit lamp, such as any druggist can supply. With a little ingenuity, you can adapt your oven to a gas ring or electric hot plate; but if you do, be sure to keep the fire turned low. Specimen, equipment, and operator alike may be damaged by excessive heat.

To "blow" an insect, air is forced into the skin through a fine tube or canula. In a purchased outfit, this tube will be of metal or of glass, tapering at one end and equipped with an adjustable clamp to hold

the specimen. See Fig. 7., "C". You can make one just as good from a fine-drawn medicine dropper and a pair of bobby pins. The pins, which are made of spring steel convenient in size, have only to be cut or broken at the bow. The hooked portions are bound to the dropper with heavy thread, as shown in Fig. 7., "B". The early entomologists never bothered with such pretty gadgets; they used straws, not the soda fountain variety, but real old-fashioned grass stems. You could do worse than follow their example, since the straw, becoming a permanent part of the specimen, simplifies both the process of inflation and the subsequent mounting of the dry skin. You can find suitable straws in any field or vacant lot, or if need be, in the kitchen broom. Select them of various diameters, and as long as possible, inspecting each to be sure that it is free of obstruction. Keep an assortment at hand, together with a spool of fine thread or a box of needle-points with which to attach the specimens.

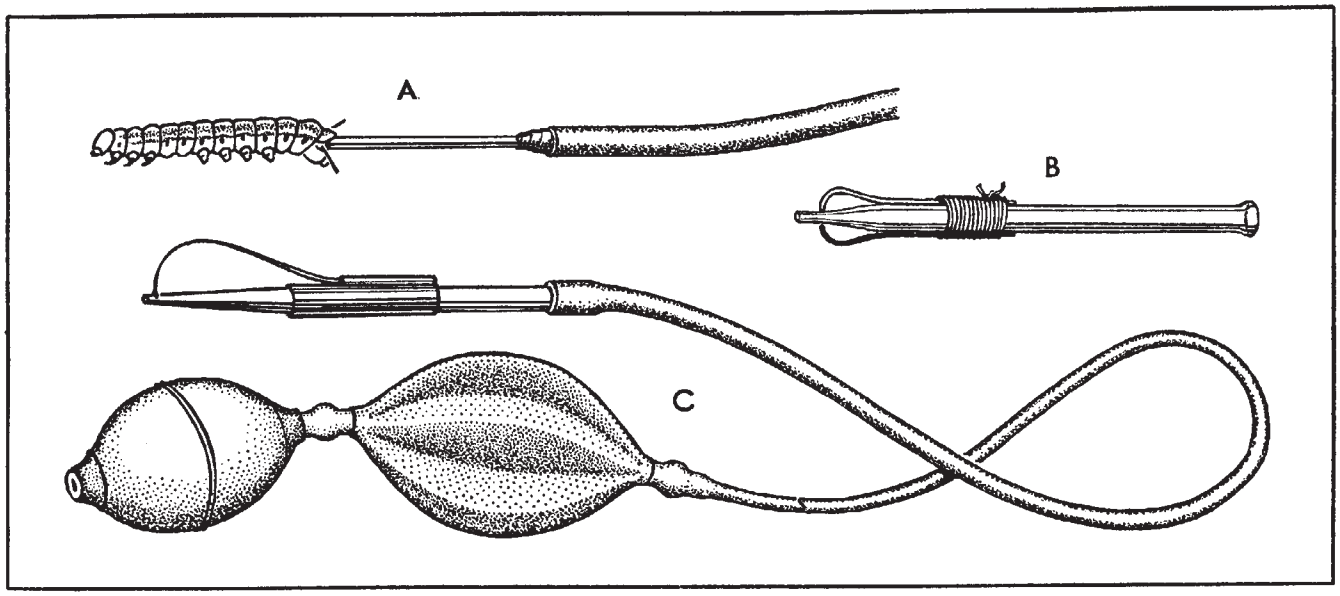

Fig. 7. Inflating apparatus for caterpillars. A., Specimen pinned to a natrual straw. B., Medicine-dropper canula with double boby-pin clamp. C., Commercially made outfit with constant-pressure bulb, and single clamp.

For best results, the flow of air through the specimen should be constant and steady all the while the skin is drying. This may be as much as half an hour. Even a glass blower might have trouble in maintaining a constant pressure for so long a time by lung-power, but the nearer you can come to it, the better. If you plan to "blow" many caterpillars, you would be well advised to buy a "constant pressure bulb" from a scientific supply house. It will cost two dollars, at the most. Made of rubber, and shown in Fig. 7, it is operated by squeezing the bulb furthest removed from the specimen. This pumps air into the second, or storage, bulb, whence it escapes in a steady stream regulated by a valve at the exit.

When inflating caterpillars by mouth, you will find it tiring and uncomfortably hot to keep your face constantly a bare straw's-length away from the stove. Eighteen inches of small rubber tubing attached to the straw will give you welcome freedom. If the straw is too small for the tubing, wrap the end with a strip of paper until it fits snugly. A glass mouthpiece made of a medicine dropper inserted at the other end of the hose is an added refinement. Incidentally, ask for pure natural rubber tubing when you order it. Regard all synthetic plastic compounds with suspicion. The flavor of the fumes given off by some of them, especially when hot, must be experienced to be believed!

In preparing a caterpillar for "blowing," you will need some absorbent paper, such as towelling, napkins or cleansing tissues; a pair of forceps; a pair of small scissors; and if the specimen is too large to cover with your finger tip, a roller, such as a pencil or a vial.

The animal selected for your first attempt at inflation should be a moderately large caterpillar, tough of hide and free of hairs and spines. It should also be of a common species, so that its loss, in case of failure, will not be too keenly felt. Delicate, small, and pilose specimens are more difficult to handle. These, together with the rare and precious, should be postponed until you have achieved a little skill.

If the specimen has not been preserved in liquid in the field, kill it with a poison bottle, or by dropping it into hot water. Lay it on a pad of absorbent paper. Then light the fire under the oven, so that it will be warm by the time you want it.

With the fingers of one hand, press the larva firmly against the paper, as though to flatten it. This will

cause the intestine to protrude at the anus, where it can be severed with the scissors. Working from head to tail, with a finger or the roller, squeeze out the body contents. The more fluid portions will be absorbed by the paper, and the whole operation is much quicker and less messy that you would expect.

When the skin is as empty as you can get it without bruising it, insert the air tube at the anal incision. If you use a straw, choose one to fit the opening. Run it into the specimen as far as the thorax so that it will act as a support to the limp hide. Fasten the specimen securely by means of a thread tied around it as close to the anus as possible, or by one or two needle points driven into the straw through the skin, as illustrated in Fig. 7., "A". A canula will be somewhat tapered. Insert it as far as necessary to make it fit closely, and

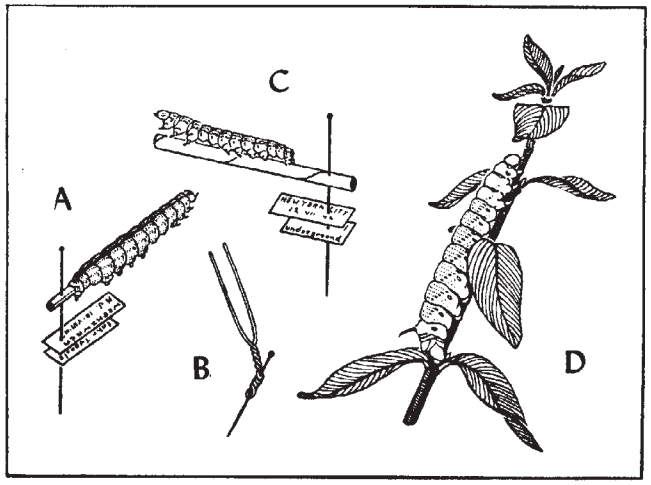

Fig. 8. Methods of mounting dried caterpillars. A, B, and C. Study-collection mountings. D. Exhibition mounting.

adjust the clamp to hold the specimen. Since this in no way supports the empty skin, a constant pressure bulb is almost necessary to prevent collapse whenever you stop blowing for a second. Of course, you can stand the oven on end and hang the specimen in it, head down; but this will call for a mechanical means of holding the tube in place, since the heat rising upward from the oven is too great to be endured for long by unprotected hands.

Inflate the larva by blowing gently on the other end of the tube, and insert it into the oven through the opening provided for the purpose. The air pressure should be maintained as steadily as possible, but it should not be great enough to distend the specimen further than it could expand in life. Rest the tube in the V of the opening as you blow. From time to time, remove the specimen to see how it is progressing. When done, it should be perfectly dry, hollow, and rigid, so that it can be held between the fingers without collapsing. Its color should be almost natural. The time required to achieve this desirable condition will vary with the size and density of the specimen, the temperature of the oven, and the humidity of the atmosphere. Do not leave the specimen in the oven longer than necessary, lest it burn.

If you have used a straw to inflate the creature, do not remove it, but cut it off about a quarter of an inch behind the specimen and pass an insect pin through the stub. Remove any needle points which you may have used, but leave a thread, after clipping off the ends. If you have used a canula, remove the clip and loosen the insect with a needle. Withdraw the tube with a cautious, twisting motion.

Several methods of mounting "blown" caterpillars are shown in Fig. 8, "A" being the pinned straw mounting already described. "B" is a device for holding a strawless specimen. It consists of a piece of fine silk-insulated copper wire about twice as long as the insect, bent double, with the part nearest the bend wrapped several times around an insect pin. The free ends of the wires are twisted together for a short distance, close to the pin, before being spread apart to produce a long Y a little wider than the insect. To use, cover the ends of the wires with glue, shellac or plastic cement; pinch the wires together at the base of the fork; and insert both ends into the opening left by the canula. The further they project into the specimen, the more support they will give it. When the pressure is released, the wires will spread apart, and be stuck to the sides of the insect by the adhesive with which they are covered. Wire which is too stiff and strong may burst the specimen.

At "C" is shown a caterpillar mounted by gluing its feet to a straw, natural or soda-fountain variety, which is impaled upon a pin. Note that any caterpillar mounted as part of a scientific collection is provided with pin labels giving the locality and date of capture, the captor's name, food plant when known and other pertinent details, before being pinned into the cork-lined box beside the adult of the same species. Pin labels and storage boxes are discussed in Leaflet Four.

"D" shows how method "C" may be adapted for an exhibition specimen, a real twig with artifical leaves replacing the less artistic straw. If the plant copied be appropriate to the species of caterpillar, the mounting will be instructive as well as attractive. It would be adviseable to paint the specimen, since exposure to light will soon bleach it. To minimize the rigidity of the inflated larva, mount it on a spot where its linear posture will seem natural.

If you are interested in exhibition mounting, you will learn a great deal about the making of artificial foliage, fruits and flowers from the Museum's Science Guide No. 82, "Building the Museum Group." This you may have for the sum of eighteen cents, including postage, by writing to the Division of Popular Publi-

cations, The American Museum of Natural History, Central Park West at 79th Street, New York City.

MICROSCOPE SLIDES

Of the million or more known species of arthropods, a great many are too small to be appreciated by the naked human eye. Of the hypothetical ten million yet to be described, the majority are probably minute. Adequate study of such creatures is impossible without the aid of some sort of magnifier, and if you are an enthusiastic student, you will want the best that you can find. The best is not necessarily the strongest. With increasing magnification, the size of the field and the depth of focus decrease, so that less of the specimen is visable at a time. For most insects and spiders, a four- or six-power hand-lens is more satisfactory than one with a magnification of twenty diameters. Take a few specimens with you to the opticians's, and try a variety of lenses critically before making your choice.

For laboratory work, a low-power binocular "dissecting" microscope is better than any hand-lens; but since it costs over a hundred dollars, few amateurs can hope to possess their own. Most high-school and college biology laboratories do have such instruments. Perhaps you can arrange to use one of these, when the class is not in session. Have someone who thoroughly understands it demonstrate its operation. You will be amply repaid for any trouble you may take in learning to use the microscope properly.

Specimens which are so small that they must be examined through lenses are likely to be correspondingly fragile. They should be handled as seldom as possible. Hard-bodied ones may be mounted dry, on cardboard "points," as described in Leaflet Four. Soft-bodied ones may be preserved in liquid, as discussed above. Either may be mounted upon slides.

The standard microscope slide is a slip of clear glass, one inch wide by three inches long. The specimen, suspended in a transparent medium, is sandwiched in between this slide and a smaller and much thinner cover-glass. So mounted, it is relatively safe from damage, easy to handle, and convenient to store. There is, however, this serious disadvantage; the position of the specimen is fixed, and one, or at most, two sides only are exposed to view. For this reason, it is desirable, when practical, to mount several identical animals in different positions upon the same slide, so that what is concealed in one may be displayed in another. The distortion apparent in some slide-mounted specimens is largely the result of faulty preparation and can be avoided.

Slide making for the medical sciences is a fine art about which many scholarly volumes have been written. Entomological slide making is, fortunately, easier. To an histologist or a bacteriologist, the smallest whole insect or spider is a gross object which can be treated adequately by processes simple to the point of crudeness. This does not mean that you can afford to be careless. It does mean that, working with a minimum of equipment and with such materials as are readily available and relatively harmless, you can expect to produce a satisfactory product most of the time.

The method of slide preparation here described, though not quite the simplest possible, is yet frankly a beginner's method. It requires no expensive tools, and no chemicals which are extravagant, explosive, deadly in small quantities, or proscribed by law. Nevertheless, it is a workable method of mounting most kinds of small insects and spiders, and a sound foundation upon which to build more elaborate procedures.

Many of the necessary materials you have already; a large drugstore may be able to provide the rest. If not, you can order them from a scientific supply house. Here is a list of the things that you will need.

1. "Completely denatured" alcohol of graduated concentrations, including full strength, as described above under "Liquid Preservation."

2. Xylol (xylene). Although a liquid, this is sold by the pound. One pound is about a pint and a half, and should last a long time.

3. Carbol-ylene. Four ounces will be plenty. This is a saturated solution of phenol (carbolic acid) in xylene. Phenol is very corrosive, and can "burn" you badly. If you spill any of this mixture on your skin, wash it off at once with strong alcohol.

4. Canada balsam, the transparent medium in which the specimens are to be suspended. A resin soluble in xylene, balsam is usually sold as a viscous liquid, packed in a bottle or a tube. It is almost colorless when new, but turns yellow with age.

5. "Duco" or other clear plastic cement.

6. Containers for the specimens during processing. The number and kind will depend upon the scale and frequency of your operations. If you wish to make a few slides only, at long intervals, you may leave each lot of specimens in its own labeled vial throughout the process, changing the fluids with a medicine dropper. If, on the other hand, you expect to be working steadily for a season, you may prefer to keep each liquid in a marked and covered dish, and to transfer the specimens from one to another. In this case you will need:

7. Some gelatine capsules, such as druggists use for powdered medicines. You can buy an assortment of sizes at any pharmacy. When each end is punctured several times with a strong needle, such a capsule becomes a miniature strainer in which one or several specimens can travel safely through a whole series of baths. To prevent confusion, mark both the capsule and the data label of the insect which it contains with

a letter or number by which the two may be identified. The symbol may be scratched on the capsule with a pin, or written with India ink.

8. Slides. These come by the dozen or half gross. The price per slide falls as the quantity rises.

9. Cover glasses, available in several sizes, and in two shapes, round and rectangular. They are sold by the ounce. Half an ounce will be plenty to begin with.

10. Some supports to hold up the cover glasses and prevent the specimens from being squashed as the balsam dries and shrinks. Supply houses offer, for this purpose, cover-glass size plastic rings of various thicknesses called "cells." These are tidy to use, and look well, but they retard the drying of the balsam by excluding the air. It is just as practical, and cheaper, to support your covers with fragments of broken

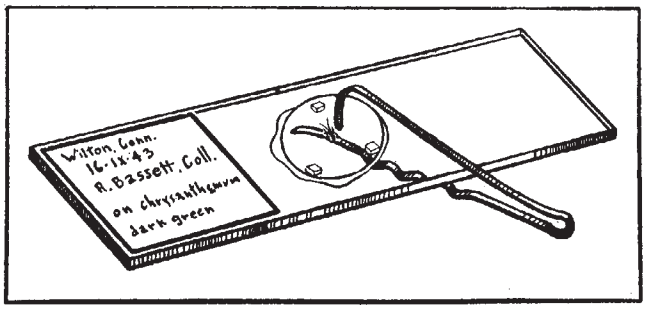

Fig. 9. Newly assembled microscope slide. Note label, cover-glass stilts, and bobby pin clamp.

cover-glass, if the specimens are thin, and with bits of transparent plastic sheeting of appropriate thickness, if they are bulky. These stilts will scarcely show in the finished slide, and since they do not entirely surround the balsam, they permit it to dry more rapidly.

11. Tools for handling the specimens, including fine forceps, mounted needles and medicine dropper.

12. Absorbent paper, such as blotters, towelling, or facial tissues.

13. Bobby-pins, bent into clamps for holding

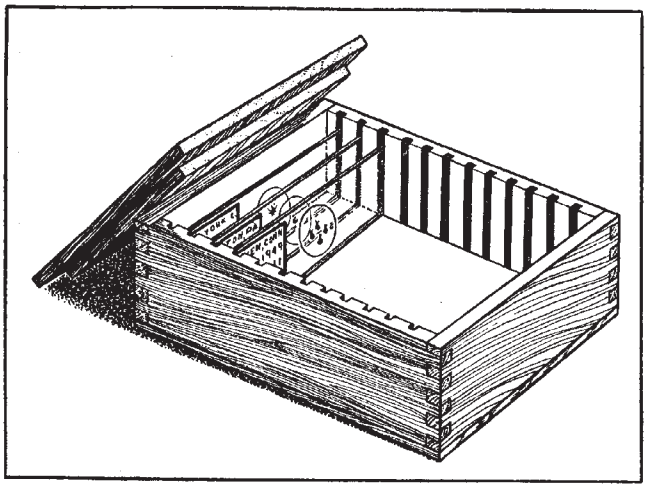

Fig. 10. A small storage box for microscope slides.

cover glasses as shown in Fig. 9. If the steel snaps when bent, grasp the bow of the pin with pliers and heat the ends red hot over a gas flame. Allow the pin to cool slowly, without quenching. This will remove the temper, so that you can bend the metal easily.

14. Gummed paper labels a little less than an inch square, fine pen, and India ink, for marking the slides.

15. Slide boxes in which to store the finished product. One of these is shown in Fig. 10.

16. A jig or pattern by which to center the specimens on the slides. Although not strictly necessary

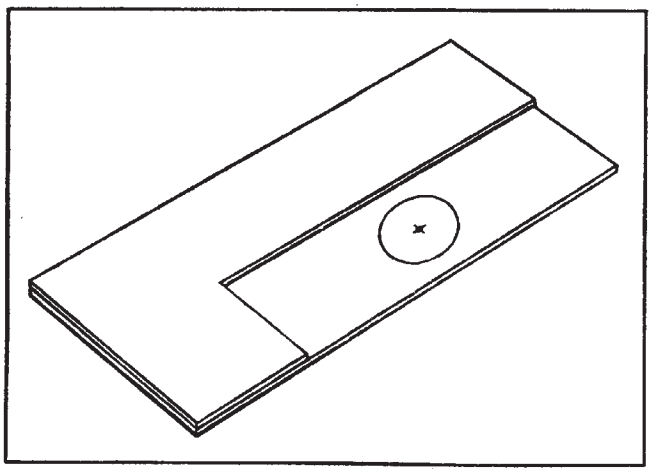

Fig. 11. A jig for centering specimens on microscope slides.

this is a useful gadget which will save you more time than its construction will require. Fig. 11 is a picture of a jig. To make it, you need two rectangular pieces of cardboard, about four inches by two. Lay a glass slide on the lower right-hand corner of one of the pieces, matching the edges, and draw a line around it. Cut out the corner of the cardboard, following the outline carefully. Glue the two pieces of card together, matching the three remaining corners, and put them to press under a heavy book until dry. You will now have a thin block of cardboard with a slide-size depression in one corner. With a ruler, locate the mid point of this depression. Mark it. With this point as center, draw a circle or rectangle the size of a cover glass. This locates the area which the cover-glass will occupy on the finished slide.

A biological specimen imbedded for scientific study must be not only covered but completely filled with resin to make it clearly visible. A trace of water in the specimen will fog the balsam. An air bubble inside the animal deflects the light and obscures the image. To replace the natural liquids and gasses of the body with a transparent, and ultimately solid, substance is the purpose of slide preparation processes.

The body fluids of animals are largely water. Balsam is soluble only in oils. The incompatability of

oil and water is proverbial. Fortunately, both water and xylol, the highly volatile oil used to dissolve the balsam, are miscible with alcohol. Thus alcohol can be used as an intermediate step between the two. In preparing a specimen for slide-mounting, the water in the tissues is wholly replaced by alcohol. During the process any air which may be trapped in the body cavities is, incidentally, dissolved. Then the alcohol is replaced by xylol and the xylol by a solution of balsam in xylol. When the oil evaporates, the solid resin remains, filling and covering the specimen completely and permanently.

In taking a specimen through the slide-mounting processes, the sequence of operations will be as follows:

1. Catch your specimen and kill it by dropping into hot water. This extends the appendages. Specimens killed in alcohol, although otherwise suitable, are likely to be difficult to arrange on a slide because the contracted position in which they are fixed. Prick the abdomen with a fine needle to admit fluids more readily.

2. Dehydrate the specimen by "stepping up" through a graduated series of alcohols. For most eggs and adult insects or spiders, however small, 50%, 70%, and 95% or full strength will be enough. For extremely minute or delicate immature forms, baths of 60% and 80% may be included. Leave the specimen in each bath for about an hour. Change the liquid on the specimen or the specimen in the liquid, as you prefer; but in either case, drain the creature thoroughly at each change. A bit of absorbent paper grasped with forceps is convenient for mopping up the last drop in the bottom of a vial. If you are using a capsule, press one end of it against a blotter. It will drain at once. When lowering a capsule into a bath, hold it vertically, so that the air may escape at the top as the liquid rises from the bottom.

One bath can be employed to process many specimens, if you are careful to avoid unnecessary dilution. Once used, however, the fluid should never be returned to the stock bottle. Keep it in a special bottle marked "used." The 95% alcohol is the most critical step of the de-hydration, and should be renewed frequently. Save the old alcohol to feed the spirit lamp for the caterpillar oven.

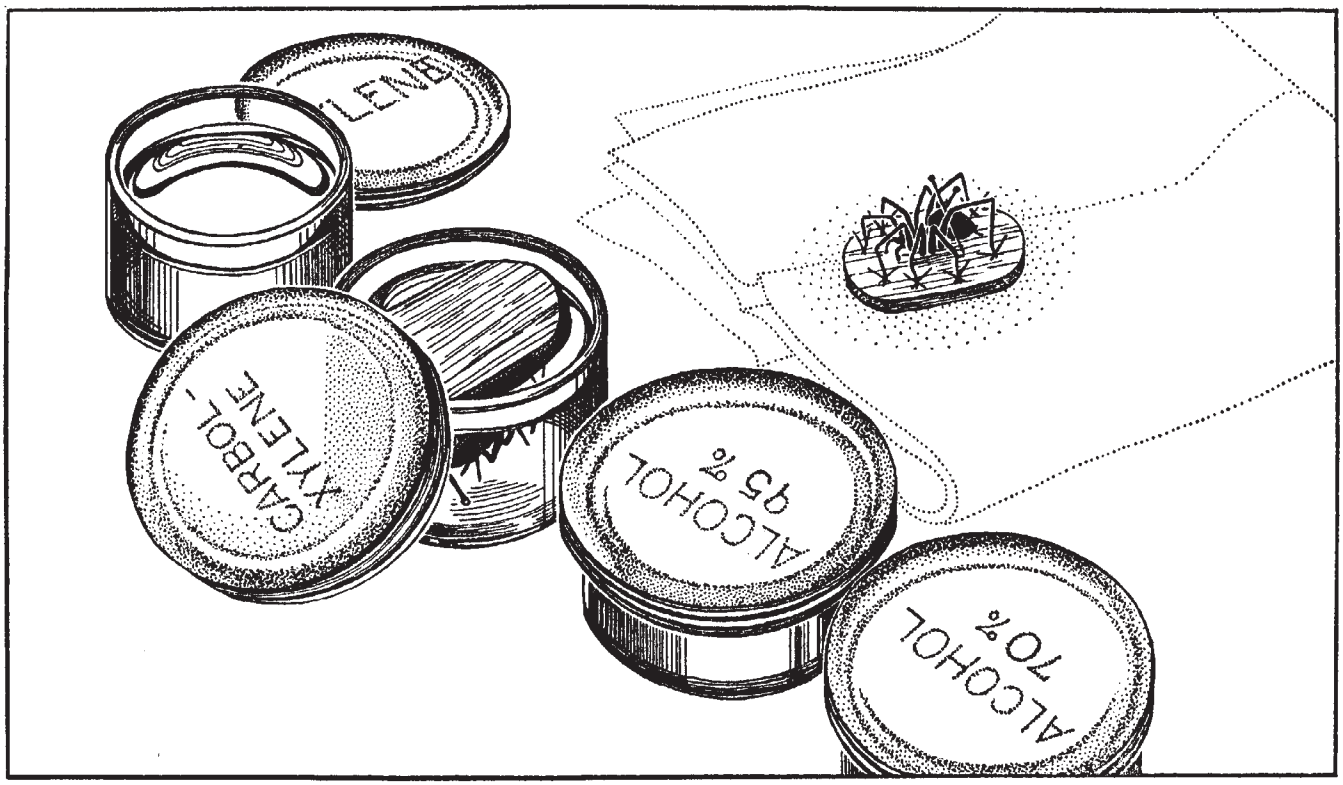

Fig. 12. Series of dehydrating baths for the preparation of spiders and soft bodied insects. The specimen, pinned to a chip of balsa wood, floats up-side-down in the dish.

3. From 95% alcohol, transfer the specimen to carbol-xylene. This serves two purposes. The phenol, which has a great affinity for water, will remove the last traces of moisture from the specimen. The xylol replaces the alcohol and dissolves the natural fats and oils of the body, making it transparent. This is called "clearing." If clearing fails to occur after a few hours, you may reasonably suppose that the carbolic acid is exhausted, and the solution should be changed. Carbol xylene turns brown with prolonged

exposure to light, but this does not seem to impair its efficiency. It is rather viscous, and if you are using a capsule, you may have to open it to let this liquid in.

4. When the specimen is perfectly clear, rinse it in two baths of xylol to remove the phenol. Allow for each the same length of time as was required for the clearing.

5. Clean and polish a slide and cover glass. Use soap and water. Handle the polished glass by the edges only, to avoid finger prints. Beware of dust and lint. Select the cell, glass fragments, or bits of plastic sheeting to support the cover. Be sure that the tools, balsam, and "duco" cement are ready at hand.

6. With pen and india ink, copy the data relative to the specimen onto one of the gummed paper labels, and stick it to the extreme left-hand end of the slide. If there is more information than one label will hold, put another at the right-hand end.

7. Lay the slide in the jig. Place the cover glass supports in position, in the corners of a rectangle or evenly spaced around a circle, just inside the outline marked on the jig. Fasten each with a little clear cement. Place a large drop of balsam in the middle of the slide and spread it with a needle almost to the limits of the outline all around. Allow it to stand for several minutes to become tacky. Remove your specimen from the xylol and place it over the dot at the center of the jig. Spread out the legs and other appendages by the aid of needles. The tacky balsam will help to hold them in place. If several specimens are to be mounted on the same slide, arrange them in some orderly manner. Then flood each with a small drop of balsam, guiding the flow with a needle so that the air is forced out ahead of the liquid, and no bubbles are formed. Only experience can teach you just how much balsam you will need. Try not to spill or smear it on the glass where not wanted. It is a great nuisance to remove. If you get it on your clothes, you can wash it out with xylol or turpentine.

Specimens sometimes come loose and float out of position, even after the cover glass is on. If they are sufficiently tough and rigid, you can prevent this by gluing them to the slide. Instead of the first layer of thick balsam, put a small drop of thin plastic cement on the glass. Dry the surface of the specimen by blotting or blowing. Place the animal upon the drop of cement, and arrange the appendages. Then flood with balsam.

8. Pick up the cover-glass with forceps, and touch one edge of it to the slide at a point indicated by the outline on the jig. Lower the other edge slowly, so that as the glass touches the balsam, the air is driven out before it. Press the cover down gently, until it rests on the supports, and secure it in position by means of a bobbypin clamp. If there is not quite enough balsam under the cover to fill the space, apply a small drop to the slide at the cover's edge, at one side of the empty spot. Tip the slide to encourage the flow in the proper direction, so that no air is permitted to remain under the cover. If there is any extra balsam forced out around the edges of the cover, leave it there.

9. Check the centering of the cover glass by means of the jig, and set the slide away to dry. This will take a very long time, and during that while the slide should be kept clean, dry, and warm, with a good circulation of air if possible. It must remain in a horizontal position, and nothing should be allowed to touch its upper surface. The top shelf of a closet is a pretty good drying spot, if you do not forget what you have there and put a hat on top of the slides by accident.

Inspect the slide from time to time, as it dries. On the first day, you will find that the duco cement has turned milk white, but within a week it will have cleared again. As the xylol evaporates, the balsam shrinks, and empty pockets may form at the edges of the cover. If so, fill them with drops of liquid balsam. After about a month, it will be safe to take off the clamp. You may now examine the slide with the microscope, if you are very careful. However, it will be six months to a year before the balsam is dry enough to permit you to put the slide away in a slide box in a vertical position, or to examine it from the back without grave danger of dislodging the cover-glass. It is doubtful if very thick cell-mounts ever become completely solid. When the cover is so firmly cemented to the slide that you cannot shift it by a gentle shove, you may remove unsightly smears of balsam with a cloth moistened in xylol. There is no objection to leaving a neat ring of balsam around the cover. Indeed, it acts as a protection to the fragile edges of the glass.

It is possible, though risky, to hasten the drying of balsam by heating the slide carefully over a spirit lamp; but if you are ingenious as well as impatient, you can combine a metal box, an electric lamp and some bits of screen to produce a drying oven which will safely reduce the drying time to a few days.

10. Store your finished slides in a slide box, or boxes, arranged in some convenient order, so that you can always find the one you want without looking through the whole collection. The usual plan is to arrange them taxonomically, that is, according to their scientific classification, in the order given by a book of reference. You may find it easier or more interesting to arrange them ecologically, that is, according to the kind of place in which you found them, all the apple tree insects in one place, and all those that live on oak-trees in another, for instance.

Slide mounted specimens are usually viewed by transmitted rather than by reflected light. That is, the light shines through them from below. There are

insects so dark and dense that even when cleared in xylol they obstruct the light and are visible only as silhouettes. Such specimens are often improved by bleaching. Naturally colorless and very thin-skinned specimens may become invisible when cleared. These should be dyed. The stain used to color these specimens will not "take" unless they also have been treated briefly with a bleaching solution, so the very dark and the very light require the same kind of special treatment before the dehydration begins.

The bleach commonly used for this purpose in laboratories is a 10% aqueous solution of sodium hydroxide. Common household "Chlorox," which is a 5% aqueous solution of sodium hypochlorite, does about as well. Put a small quantity of the bleaching solution in a glass dish, and place the dish on a white paper so that can see the specimen easily. Transfer the specimen to this solution from the first alcohol bath. Watch it closely, through the microscope if possible. Great care is necessary to avoid over bleaching. When the appendages become pale and easily movable, it is time to stop. Further treatment will dissolve the membranes of the joints, and the insect will fall apart. Rinse the specimen in clear water to remove the bleach, then return to dilute alcohol and continue the preparation as with unbleached specimens. Bubbles of gas are sometimes formed inside of the body during bleaching. These will probably dissolve before the preparation is completed. If still present when the insect reaches the final bath, squeeze the abdomen gently to force the bubbles out through the needle hole.

There are many stains which may be used to tint colorless specimens. Basic fuchsin is one of the more commonly used. It is a clear purple-red dye which you can buy, ready to use, from a scientific supply house. Apply it to specimens which have been bleached and run up to 95% alcohol. Put a little of the dye in a small container and allow the specimen to soak in it for a minute or two. Rinse in 95% alcohol, If the insect is not bright pink all over, dip it again. but do not permit it to become too dark. After dying and rinsing in alcohol, continue the preparation with carbol-xylene, xylene, and balsam, as has already been described.

After seeing what this method of slide preparation can do, you might like to try more complicated and professional ones. For expert advice, consult an article called "Mounting Aphids and Other Small Insects on Microscope Slides" by E. O. Essig, which was published in the January, 1948, issue of the "Pan-Pacific Entomologist. If you do not have access to a museum or university library which subscribes to this journal, you can obtain a copy for seventy-five cents by writing to the California Academy of Sciences, San Francisco 18, California.

DRY MOUNTING BY CHEMICAL DEHYDRATION

There are many large soft-bodied arthropods which cannot readily be inflated. Some of these can be dry mounted by replacing their natural moisture with a liquid which so hardens the tissues that they shrink but little when that liquid is removed. To minimize distortion, the replacement is accomplished by degrees, delicate and succulent specimens progressing more gradually than leathery ones. The simplest method is to remove the water with alcohol and the alcohol with xylene, exactly as though the animal were to be slide-mounted. Xylene evaporates rapidly, leaving the specimens dry, rigid, and usually unwrinkled, but somewhat smaller than in life. Although a pattern may persist, color will be almost wholly lost. Species which are transluscent when living come out perfectly opaque.

The reagents used to dehydrate large arthropods are those used in slide preparation: 70 and 95% alcohol, carbol-xylene, and xylol.

Additional equipment includes:

1. Stender dishes or small covered jars, 2 or 3 inches deep and big enough around to accommodate the outstretched legs of your largest specimen. If you are preparing one specimen only, one dish will do. Change the liquids. If you are going to mount a series, provide one dish for each bath, and transfer the specimens.
2. Insect or dressmaker's pins, and if possible, some needle points or "minuten nadeln."
3. A few pieces of cork or balsa wood about 1/8" thick and small enough to fit easily into the dishes.
4. Forceps, with which to handle the specimens and the small pins.
5. Oil colors, for restoring the pigmentation of the finished product.

Reagents, dishes, and other equipment, if not obtainable locally, should be ordered from a reliable scientific supply house.

As an example of the process, let us suppose that you wish to mount a large spider in a walking position. First, observe how it stands in life, the height of the body from the ground and the attitude of the legs. Then, kill the specimen by dropping it into boiling water for about half a minute. Spread out the body on a chip of balsa wood and pose it carefully, bracing and supporting it with pins as shown in Fig. 12. During the process of dehydration, the chip floats up-side-down on the surface of the liquid, a fact which must be taken into account when placing the pins. When the specimen is secure against drooping, even in an inverted position, fill a dish with 70% alcohol. Float the chip, face down, upon the surface. Put on the lid, and leave it over night.

On the following day, remove the float from the

bath and drain off all the alcohol you can by blotting gently with absorbent paper. Examine the specimen. If thin-skinned, it may have shrunk a little, so that the pins will have to be adjusted. Any alteration in posture must be made at this time. The specimen will be too stiff tomorrow.

Place the chip with its spider in a dish of 95% alcohol. After 24 hours the spider will be so rigid that you can safely remove all the pins but the few needed to fasten it to the wood. If those pins are short, the amount of liquid required to float the preparations will be materially reduced. Make sure there is no free alcohol clinging to the specimen, and transfer it to carbol-xylene. Unless the last trace of water is removed at this point, the specimen is likely to wrinkle when it dries, so leave it until it is perfectly clear, as near to transparent as its coloring will permit it to become. Then transfer to xylol, and rinse for 24 hours.

Unpin the specimen from the chip, drain it thoroughly, and set it in a warm, airy place to dry. If, in life, it was dark colored and hairy, like the jumping spiders, it will now be finished, ready to be glued into its place in the exhibit. If, like the crab-spiders, it was naked and brightly colored when alive, tint it with oil colors and allow it to dry for several days before fastening it into its permanent position.

This method of dry mounting can be applied, with greater or less success, to immature and adult insects, including the difficult hairy kinds, and to spiders, scorpions, phalangids, myriapods, and kindred creatures. It is more successful with tough, leathery species than with thin-skinned fleshy ones. The opacity which it imparts to naturally transluscent forms is a major drawback which can only occasionally be overcome by soaking the dried specimen in shellac or in a solution of paraffin in xylol.

Species of which it is not possible to produce satisfactory dry specimens for exhibition are best represented by life-size or enlarged models. If carefully made in the likeness of the living creatures, these are more lively in appearance than dry mummies, however painstakingly prepared.

Direction Leaflet Number Seven

HOW TO KEEP AND REAR LIVING INSECTS AND SPIDERS

By ALICE GRAY

Department of Insects and Spiders
The American Museum of Natural History

Insects and spiders are so different from ourselves that it is hard to think of them as pets. Some of them, however, make excellent cage-animals. They are small enough to be easily housed in a home or classroom. Many live so swiftly that their whole life cycles can be observed in a single season; and their ways are unfailingly curious and interesting.

Full directions for keeping all sorts of insects and spiders would fill a library. Here, I can only outline the basic principles and illustrate them with suggestions for the care of a few of the less exacting and more popular kinds.

Successfully to keep any animal in captivity, you have to duplicate within the cage the biologically essential features of its natural environment. The conditions most often determining the survival of insects and their relations are these:

1. Food Supply. Some insects will eat almost anything, some are choosy, and some are restricted to a single article of diet. Spiders eat nothing but living creatures, mostly a little smaller than themselves.

2. Temperature. Most insects are comfortable at any temperature likely to be found in a human habitation. However, there are species extremely sensitive to temperature, as well as some which breed only in very warm places and some which need to be thoroughly frosted at some stage of their development. Direct sunlight falling on an ill-ventilated cage may raise the internal temperature enough to kill the specimens within.

3. Humidity. Insects and spiders live close to the earth or among dense vegetation, and are accustomed to very humid air. Heated buildings, unless air-conditioned, are likely to be arid as a desert. Captive insects often die or are deformed while moulting because of draught.

4. Ventilation. It is almost impossible to smother an insect, its oxygen requirements are so small, but poorly ventilated cages may be responsible for the death of the inmates by fungus or microbial infection. Large-winged and tree-dwelling species are more susceptible to such diseases than terrestrial and subterranean kinds. Aquatic insects from swift-flowing streams will suffocate in a stagnant aquarium.

5. Illumination. Some insects appear to be indifferent to light. Others are very responsive to it, regulating their activities by the illumination. A few underground species, such as termite workers and pale yellow ants, are soon killed by direct sunlight.

6. Space. Primarily aerial insects, such as dragonflies and butterflies, need lots of room in which to maneuver. They will batter themselves to pieces trying to escape from a small cage. Less active species are comfortably housed in jars and boxes. Orb-weaving spiders cannot spread their snares in cramped quarters; though the makers of irregular, sheet, or funnel webs will readily do so.

The insects and spiders whose requirements are most like the conditions prevailing in houses are, of course, the easiest to keep. With forethought and ingenuity you can accomodate others; but many species are so exacting that they cannot be satisfied without great trouble and expense. You will have best luck with cage-insects if you collect them for the purpose with limitations in mind, taking careful note of the conditions of the spot in which you find them.

When attempting to rear insects or spiders with whose habits you are unfamiliar, you can only offer them a choice of foods and the most variable conditions practical, and hope that something suits.

CATERPILLARS

The larvae of moths and butterflies are probably the insects most often reared by amateur collectors. With few exceptions they are leaf-eaters. You have only to keep them in clean, dry jars or boxes with covers of loose-woven cloth or wire screen, and provide them with a constant supply of the proper leaves. They do not need to be watered.

To keep the leaves fresh, insert the stems into a narrow-necked bottle of water, as shown in Fig. 1. Pack the neck of the bottle tightly with cotton. This

prevents the insects from drowning in the water and permits you to lay the bottle on its side without leaking. If you prefer to have the bottle stand upright, be sure it has a broad base and is not easily upset. Wrap it with cloth, adhesive tape or a paper towelling so that, should the insects fall out of the foliage, they will be able to climb back again. Some kinds are unable to cling to polished glass.

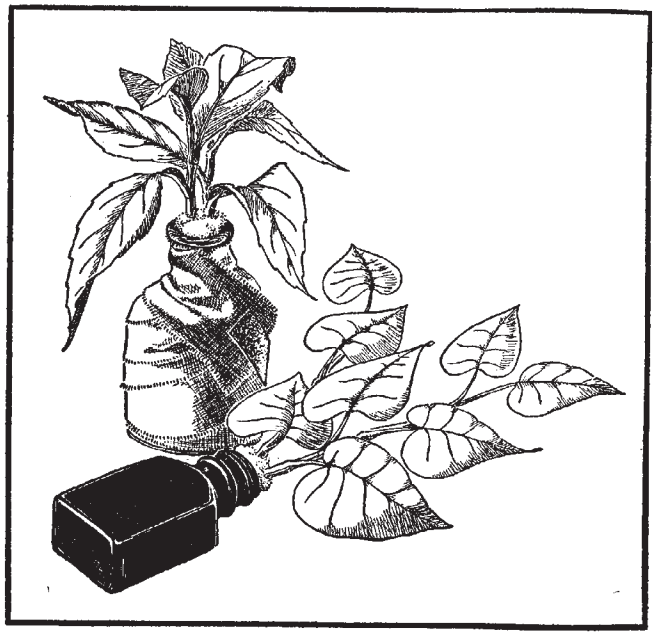

Fig. 1. Method of keeping leaves fresh for feeding insects.

A simple cage designed for leaf-feeders is shown in Fig. 2. It consists of a cylinder of window screen, stitched with cord or wire and closed at the ends by a film can and its lid. Any round metal, plastic, or wooden box would do equally well. This kind of cage is exceptionally well ventilated and easy to keep clean.

Another well-known cage for herbivorous insects consists of a flowerpot containing a living specimen of the food plant enclosed in a lamp chimney covered with netting. It is used chiefly for small insects which will not devour the whole plant overnight. This cage is easier to see into than a wire one, but the ventilation is poor. If a lamp chimney is not to be found, a cylinder of clear sheet plastic stapled or cemented together will serve the same purpose, although it is not so roomy as the bulging chimney.

PUPAE AND COCOONS

When caterpillars have reached their full growth, they loose interest in food and begin to wander, settling down when they find a suitable place in which to pupate.

The kinds which spin cocoons, or form naked pupae above ground, will attach themselves to the sides or top of the cage; or to a twig, if you have thoughtfully provided one. Species which pupate underground should be given a layer of soft damp earth deep enough to cover them generously. If forced, they will pupate on the bare floor of the cage.

Pupae should be kept in containers with an inch or two of damp earth or peat moss to moisten the air. Otherwise the wings of the adult specimen are likely to be deformed, either because desiccation has so reduced the volume of the blood that the hydraulic pressure is not great enough to expand them, or because they dry out before they have reached full size.

If the emergence cage is smooth-walled, it should

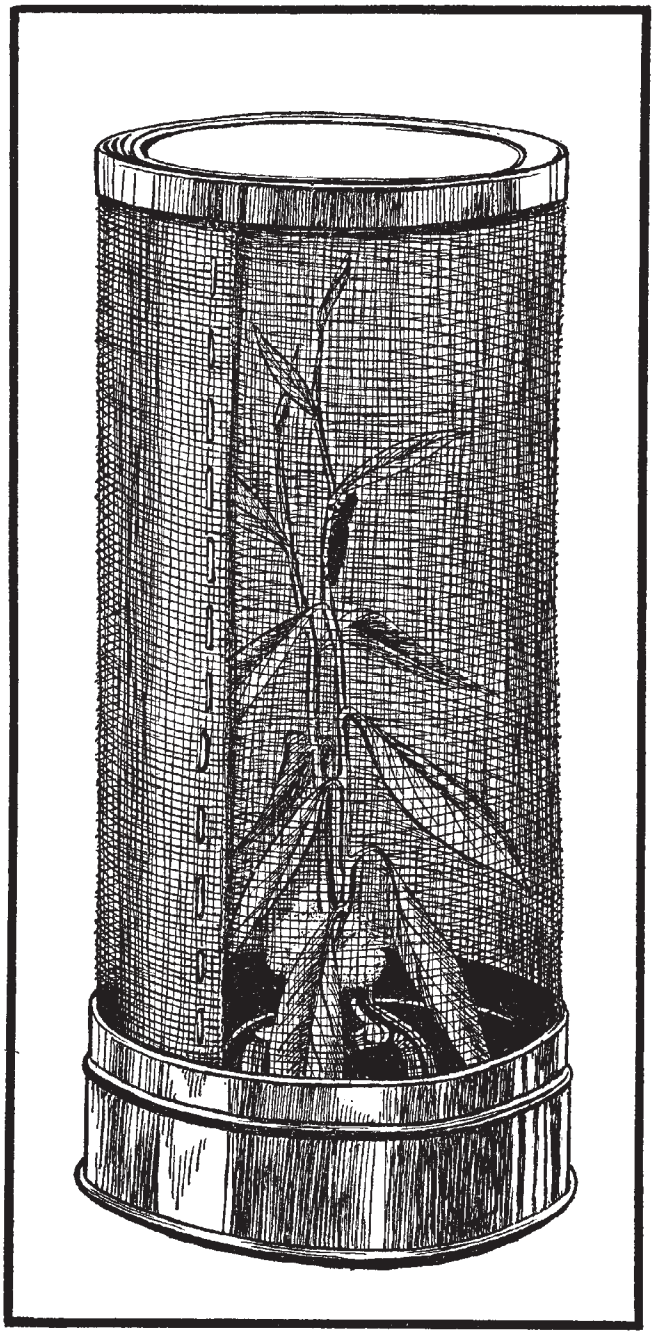

Fig. 2. A simple cage for leaf-eating insects.

have a piece of twig wedged into it so that the insect may easily crawl up and shake out its soft wings, with plenty of room all around.

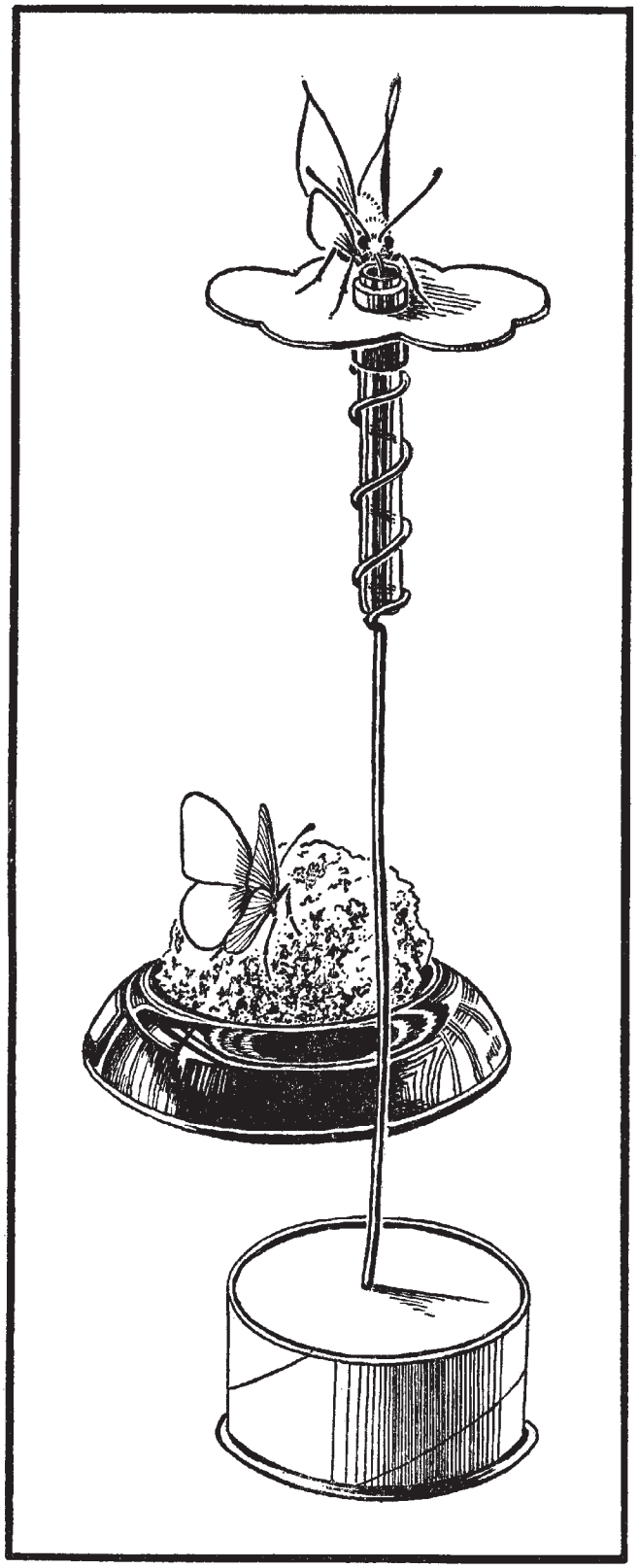

Fig. 3. Butterfly feeders.

ADULT LEPIDOPTERA

Adult butterflies and moths can sometimes be kept alive on a diet of very dilute honey or sugar syrup. So that the insects may not fall into the liquid, it should be poured over a small sponge in a dish, or offered in a narrow vial tube. The vial should be fixed, so that it cannot upset, and equipped with a perch or clinging surface. Garden supply houses sometimes sell butterfly feeders of this kind, made to look like flowers. Fig. 3 shows two feeders for butterflies. A combination drinking fountain and air humidifier for all flying insects is shown in fig. 4A, a wad of cotton tied up in cheesecloth, the ends of which hang in the water below.

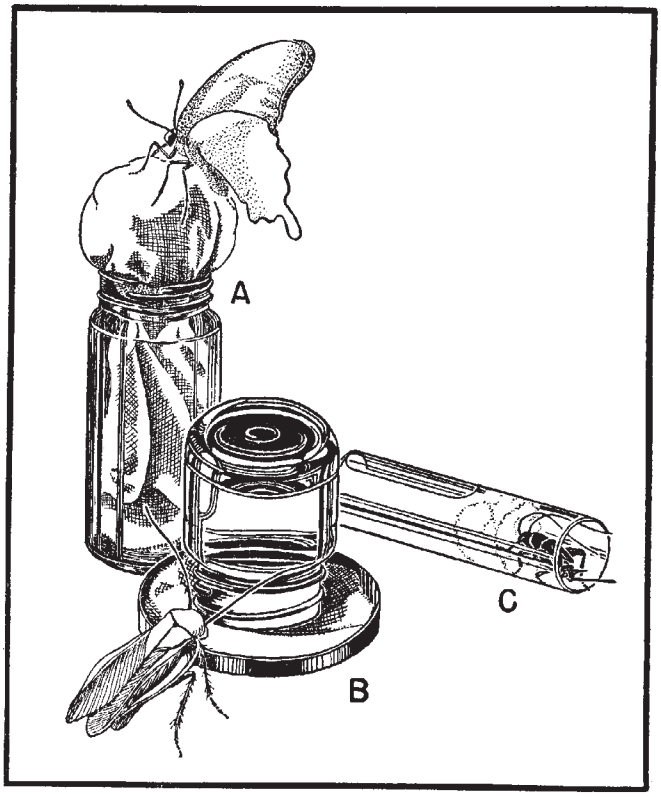

Fig. 4. Drinking fountains for insects.

To breed the adult butterflies or moths, confine a pair in a large airy cage with fresh leaves of the food plant.

The eggs will be deposited singly or in groups, usually on the leaves, but sometimes on the roof, floor or walls of the cage. Where possible, they may be removed to small jars for hatching.

Some kinds of insect eggs will not hatch unless well frosted. It is sometimes possible to force them by putting them in the refrigerator for two or three weeks.

CRICKETS

These lively little insects are so well adapted to life in houses that they often move in of their own accord.

A self-perpetuating colony requires a rather large

cage with high humidity. When the crickets are needed as fish bait or for feeding other animals, a garbage can is satisfactory. If they are to be observed and studied, a large aquarium is excellent. Either of these should have a band of vaseline about an inch wide around the inside, an inch or two below the top. This will discourage the insects from climbing out while you are tending them. Cover the cage with a piece of fine netting. Fill the bottom of the cricket cage with a two-inch layer of soft earth or sand. Crickets lay their eggs underground. The earth should be always slightly damp, never soaking wet. This condition may be maintained with very little attention by means of a wick passing through the bottom of the cage into a dish of water. The degree of dampness will depend upon the size and length of the part of the wick which is buried in the soil. Alternatively, the whole cage may be sprayed with a squirt or laundry sprinkler, as often as required. Drinking water for the insects may be provided by the one of the devices shown in fig. 4, B or C. B is a squatty jar upended in a saucer containing a piece of soft coarse cloth or plastic screen. Fill the jar with water, cover the top with the fabric, then with the saucer, and invert quickly. C is simply a vial of water tightly plugged with wet cotton.

Like many primitive insects, crickets will eat almost anything, and thrive best on a varied diet. Lettuce, bread, fruit, dog-biscuit, and hardboiled egg are among the readily available foods which they appear to relish, Do not give them too much at once, and replace all uneaten food every other day. A dirty cage may mean unhealthy insects.

A sleeve cage of the kind shown in fig. 5 is particularly suitable for active insects of any kind. It is troublesome to make but saves much trouble later. The top as well as the sides should be of glass, so that the operator may see what he is doing. At one end is a very fine wire or cloth screen. Young insects are extremely small and can escape through a coarse net. At the other end is a soft cloth sleeve, big enough to admit a hand holding the largest object likely to be placed in the cage, and long enough to fall in folds around the operator's elbow. When not in use, it is tied shut with the attached cord.

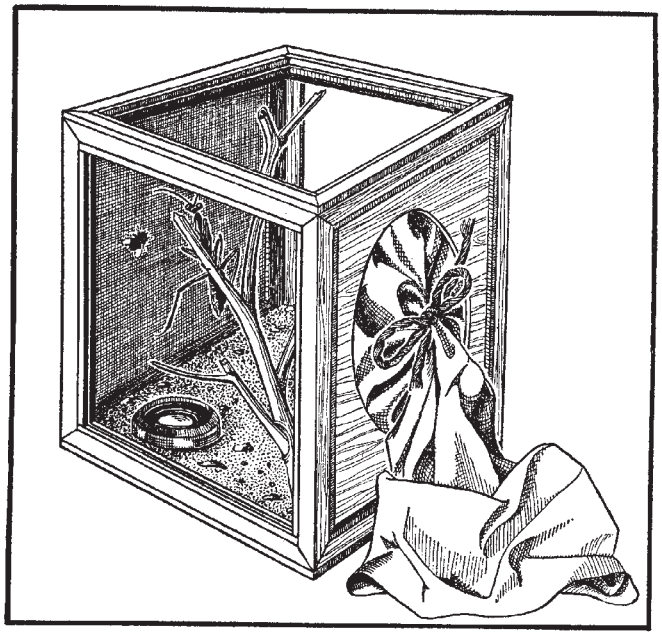

Fig. 5. Sleeve cage, used for active kinds of insects.

The Brown European House Cricket, which has been introduced into this country, is easier to maintain than the Black Field Cricket, and can live and breed in much smaller cages. Otherwise its culture is the same.

FRUIT FLIES

These are the Drosophila flies so convenient for genetic studies. They are very prolific. Their entire life cycle requires only two weeks. For these same reasons, they are often raised as food for small carnivorous insects and spiders.

Wild fruit flies are easily captured during the summer and autumn in a jar baited with over-ripe banana. A fruiterer's shop may have them almost all year round. Only a few flies are needed for a start. The trap may be a standard rearing bottle as described below. Just leave it open till the flies have entered, then pop on the stopper.

Rearing jars for fruit flies are middle sized wide-mouthed glass containers such as 1/2 pt. mayonnaise jars or cream bottles. If great quantities of flies are wanted, larger bottles may be used. To assure a constant supply of flies for feeding, one or more jars should be started every week.

Into each jar slice 1/4 to 1/3 of a banana, the ripest you can find. Sprinkle the banana with a few drops of yeast dissolved in water, and prick several times with a fork. Then put into each jar about half a paper towel, folded to fit. This gives the flies a place to perch, and the maggots a place to pupate. For ventilation, stopper the bottles with wads of cotton tied up in cheese cloth.

When bananas are unavailable, a substitute medium can be made from any cooked cereal such as cream of wheat or corn meal. Cook the cereal as though for breakfast, but a little thicker. When it is done, stir in enough molasses to make it pleasantly sweet to taste. Pour about an inch into each rearing bottle, put in the paper towelling, and allow to cool. When you can touch the bottom of the bottle without distress, drop in the yeast and pick with a fork, as with banana. The gruel should be too stiff to run at all when it is cold.

Fruit flies are so small and active that they would be very difficult to handle if they were not so markedly phototropic. By taking advantage of this natural

compulsion to move always toward a strong light, you can manage them easily.

The customary method of moving fruit flies from one bottle to another uses a test tube and a black cloth. Turn the bottom of the bottle toward the strongest available light, swathing the top in the cloth. When the flies are all in the bottom of the bottle, force the test tube into the top, beside the cotton plug. Then reverse the bottle, covering the bottom. The flies will enter the test tube. Withdraw it quickly and close it with your thumb. The cotton stopper will at once expand to fill the top of the jar again. You will probably lose a few flies in the process, but not enough to matter.

A refinement of this process is illustrated in fig. 6. The fly bottle is equipped with a cover consisting of a cardboard disc cut to fit exactly and cemented to a larger circle of cloth, by which it is secured to the bottle. In the middle of this lid is a hole cut to fit exactly the mouth of a small vial. When not in use, this hole is stoppered with a cotton plug which admits the small amount of air needed by the flies.

The cage containing the animals being fed is equipped with a hole of the same size; in the top, as shown, if the cage is of glass, or in the side, if it is a cardboard or wooden box. This hole may be fitted with a cork, as the cage has other means of ventilation.

By far the simplest way to feed with fruit flies is to keep the eater in a sleeve cage, and put a whole breeding jar of flies into it at once. The jar is covered with netting coarse enough to permit the flies to pass freely, but fine enough to keep the eater from falling in.

A new breeding jar, already covered with netting, may be placed in the sleeve cage every week, and the old one removed when the new one comes into production. Since this takes about two weeks, there will usually be three jars in the cage: one providing flies, one not quite ready, and one just starting.

A jar of flies will continue to produce until all the food is used up, or until mold exterminates the colony. The bottle and netting should be well washed and boiled to kill mold spores before being re-used.

If you need to establish a colony of fruit flies at a season when wild ones are not available, you can buy a culture from a scientific supply house. There are many varieties, all equally nourishing. Perhaps you would prefer to handle the flightless kind.

MANTISES

Mantises are among our most conspicuous insects. Because of their large size and humerous appearance, they are splendid cage-animals. The adults are easy to care for, but they must be confined singly, as they are cannibalistic. Almost any quick-lunch counter will save you a gallon mayonnaise jar, which will make an admirable cage.

An inch or two of moist earth in the bottom of the jar will keep the air humid. Give the mantis a few twigs to cling to, so that it can reach all parts of the cage. Cover the jar with netting, or with a live-feeding lid of the type shown in fig. 6.

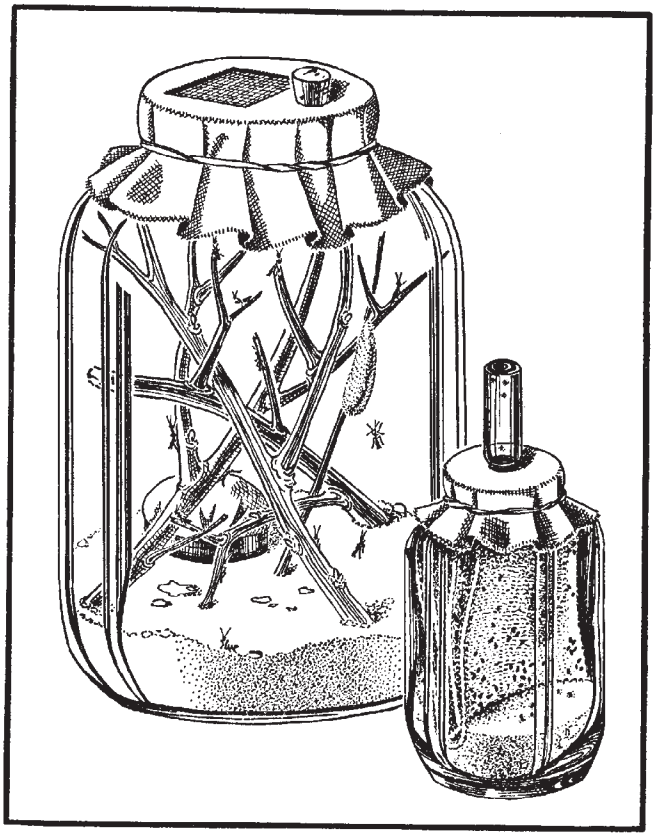

Fig. 6. Fly breeding bottle and rearing cage for mantises, equipped for easy transfer of flies.

The normal diet of a mantis consists wholly of living insects and spiders. Flies, moths, and caterpillars are particularly relished. The mantis' appetite appears to be limitless, but two or three flies a day are adequate. If necessary, a mantis can survive for days or even weeks without eating at all.

If no living insects are available, you can feed a mantis with dead ones or with bits of meat, either raw or cooked. These must be waved before the mantis with forceps or dangled on a thread, so as to produce an illusion of life. Once it has seized the provender, the mantis will devour it, whether living or not.

Water your mantis by sprinkling the whole cage lightly once a day, or equip it with a drinking fountain or a small dish of water. So large a creature is not likely to fall in and drown.

The egg-masses of mantises greatly resemble the cocoons of large moths, and are often collected as such. Brought into a heated house, they may hatch in the middle of winter, producing perhaps 200 lively

miniatures of their parents. A few of these can be reared to maturity without much effort.

Confine the whole brood in a large jar with plenty of twig perches and a drown-proof watering device. Feed with fruit flies, as already described. In the summer, aphids or plant lice are abundant, and equally satisfactory. Just drop them into the mantis jar, host-plant and all. Do not attempt to feed mantises with ants; ants eat mantises.

By the time the mantises are half grown, cannibalism and the hazzards of moulting will have reduced the brood to manageable numbers. Now, put each mantis in a separate jar and feed with larger insects. In the summer, you can capture a great variety of suitable prey by sweeping an insect net through the grass and weeds of any vacant lot. In the winter, you will probably have to use meal-worms. These are really beetle larvae. They are sold by pet shops as food for fish and birds.

Mantises mate readily in captivity, and the females deposit eggs, whether fertile or not. Shortly afterward, they die of old age.

ANTS

Ants are the most fascinating of cage insects because of their complex social behavior. There are hundreds of kinds of ants, with extremely various habits. Some of them are hard to catch and harder to keep, but many are easily dug and readily adaptable to the conditions of captivity. Before acquiring the insects, you should prepare to house them.

Cages for ant colonies are almost as various as ants. They may be horizontal or vertical, earth filled or earth free; simple as an empty bottle, or as complicated as the human ingenuity allows. The one necessary feature which all have in common is a fairly high humidity, preferably in the form of a moisture gradient. That is, one part of the cage wet, one part dry, with intermediate conditons in between. The ants are thus able to find some place just right, whatever their requirements.

If you wish to watch your ants under conditions as near to nature as possible, you will want an earth-filled nest. The earth should be no more than an ant's-length thick, so that the tunnels will be open to inspection. An easy nest of this type is made from two large, wide-mouthed glass jars. One should fit inside the other, with about half an inch to spare. The space between the two jars is filled with earth. A piece of tubing is thrust through the earth to near the bottom of the jar. To maintain the moisture gradient, drop a little water into this tube with a medicine dropper whenever required. This dampens the earth from the bottom, leaving the top relatively dry. If the inner jar is slightly lower than the outer one, the space inside of it can be used as a feeding chamber. A string or ribbon anchored in the earth and hanging to the bottom of this chamber will serve the ants as a ladder. Cover the nest with fine netting or a piece of nylon stocking fastened for the sake of security, with two strong rubber bands.

Another type of earth-filled nest is shown in fig. 7. It

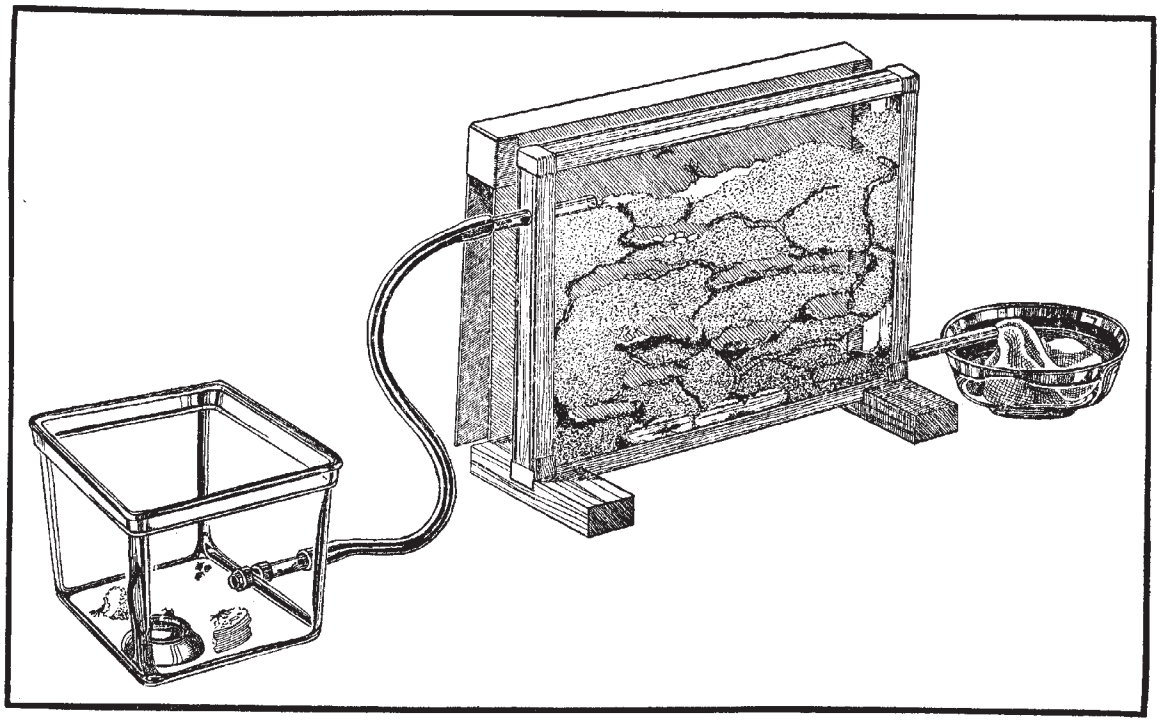

Fig. 7. An earth-filled ant nest with feeding box, automatic watering device, and cardboard cover to shield the nest from light.

consists of two panes of glass, the smallest standard size carried by hardware stores. The panes are separated by a frame about 1/4 inch thick, made from a strip of lumber yard scrap, cork, or thick felt. At one side, near the top, the frame is pierced by a hole admitting a tube which leads to a feeding box. On the other side, near the bottom, a similar tube contains a wick. One end of the wick is buried in the earth, the other hangs in a dish of water. The nest is bound together with adhesive tape. It stands upon feet made by notching two blocks of wood to fit the bottom edge.

This nest is filled with earth before being taped shut. It is never again opened during the life of the colony.

If you wish to observe your ants in great detail, you may prefer an earthless nest, in which there is no place for them to hide. Such nests are made commercially of glass and wood, but an even better kind can be made at home of heavy plaster of paris. The nest may be a block containing a single chamber, or an elaborate system of rooms and passages. These can be carved in the plaster after it has set, or modelled in reverse with plasticene. The nest in fig. 8 was made in this manner.

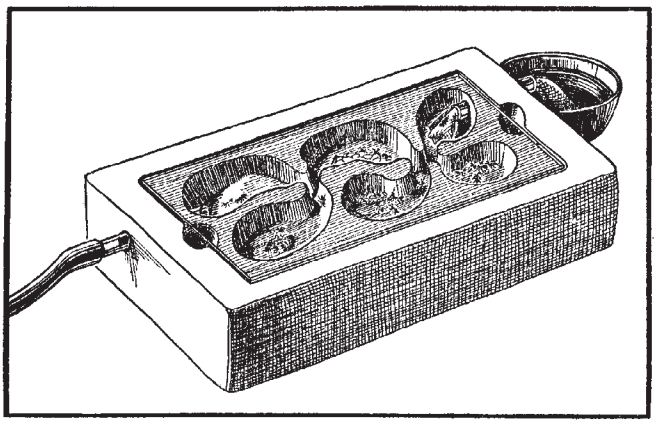

Fig. 8. Earthless ant nest made of plaster of Paris.

A strong, smooth, cardboard candy box was greased inside with vaseline. The glass plate which was to become the cover of the nest was also oiled. On it were arranged the lumps of plasticene representing the nest cavities. The plate was then placed in the box, plasticene uppermost, and the box filled with thick plaster. When the plaster was set, the box was broken off, The glass plate was freed by cutting away a line of plaster all around and making notches at the ends for the fingers. It is a good idea to have an extra plate of the same size in case the original is broken in removal. The plasticene was dug out of the chambers, and the rough spots smoothed with a knife and sandpaper. Tubes leading to a feeding box and water dish may be placed before the plaster is poured, or inserted through holes drilled afterward. If you prefer, food may be placed directly inside the nest, in a chamber provided with its own separate cover. The moisture gradient may be maintained by pouring water over one end of the plaster block as often as necessary to keep it somewhat damp.

Some kinds of ants will bore through plaster of paris. These may be confined by surrounding the nest with a moat. Fill a large baking pan with water, invert four jelly glasses in the pan, and support the nest on these.

All observation ant nests should be covered when not being watched. Ants prefer to work in the dark. They cannot see red light, and a red glass cover may allow you to see something of what goes on beneath it, but an ordinary piece of cardboard or dark cloth will do.

The feeding chamber shown in fig. 7 is a small plastic ice-box jar. The hole for the tube was bored with a heated nail.

It is rather difficult to force a large number of excited ants into the narrow observation nest. The easy way is to make them move in of their own accord. This is accomplished by means of an "arena," a large airy, brightly lighted but ant-tight box attached to the nest in place of the feeding chamber. The ants are collected, earth and all, in a wide-mouthed jar. When dumped into this arena the earth soon dries out. The ants become uncomfortable and start looking for a way out. Finding the damp dark nest to their liking, they all move in. This emigration usually takes place overnight. Next day the arena is removed, and the feeding chamber attached. If a few ants remain in the arena they can be picked out with the fingers and dropped into the feeding box. This method will not work with all species of ants, but many of our large and common ones do respond to it.

The huge black carpenter ants will need a moated cage. Pale yellow garden ants are so sensitive to light that they cannot be watched. Very small ants are hard to see, and those which live in the woods are hard to dig. Choose a small nest of rather large ants in an open place, where the ground is soft and the digging ought not to be too difficult.

On the collecting expedition, take a small sharp shovel, a garden trowel, a hatchet or pruning shears for roots, a spoon to scoop up the ants, and a large covered jar to put them in. If you have planned an earth-filled cage, take another jar for some ant-less earth from the chosen site, so that you can fill the cage before the ants move in. You may think it easier just to take the cage. You may also find it handy to have a sheet upon which to shovel out the earth for closer examination.

Insert your spade about a foot away from the nest

opening, push it well down, and lift out the earth as cleanly as possible, so that the course of the tunnel is not lost. Continue in this manner, following the burrow, and examine each shovel-full of earth. Most of the ants, their wax-white grubs and puffed-rice cocoons light or dark according to species will be found clustered in small chambers. You can spoon up a great many at once and drop them into your jar. You won't be able to catch them all, but try to get some of each. The queen is likely to be lower down or even at the bottom of the nest, perhaps as much as six feet below the surface, so don't be surprised if you don't get her.

Even a queenless colony may live for a long time. If well fed, some of the workers may lay eggs, but being infertile, these will produce males only. It is possible to establish a colony from a winged queen captured during swarming season.

When you have as many ants as your cage will accommodate, replace the earth in our excavation. The remaining ants will soon reorganize their home.

If you have lots of room, lots of time, and lots of help, you might do your digging this way. It will not only find the ants, but give you an inside glimpse of what their home is really like. About a yard away from the nest entrance, dig a very large deep hole—a hole to sit in. Then cut back the side of the hole toward the nest little by little until you reach it. Keep the wall of the excavation a little undercut, so that the earth will fall out of the nest galleries rather than into them. When you strike an occupied chamber, the ants will literally tumble into your spoon. You may have to slice the whole nest to get a queen, but she is not nearly so likely to escape as she would be in the confusion of ordinary digging.

Even in the city where you cannot dig at all, you may be able to capture a colony of house ants—small imported species which often live between the walls or just outside them. Anyone afflicted with these pests will be only too glad to have you take them away! Success in trapping them depends upon making the inside of your trap more comfortable to the ants than the place in which they are living. The ants prefer dark damp places in which there is something to eat. Lay a glass jar on its side, and fit it with a cardboard roof to shut out light. In the jar, place a sponge or cloth, well dampened, but not soaking wet. Make a little paper ramp from the floor to the lip of the jar, so that the ants can easily walk in. Bait the trap with a few drops of sweet syrup on a bit of waxed paper at the head of the ramp, and set it in the kitchen or cellar where the ants have been seen. During the night, the whole colony is likely to move in with their queens and brood. With a little thought, you can probably make the very glass nest in which you mean to keep the ants serve as a trap.

Once installed in the observation nest, ants require very little care. Their tastes in food vary, and you will have to give them a wide selection until you know their preference. Some likely offerings are: dilute honey or sugar syrup, a candy gum drop, bread, hard-boiled egg, cheese, and dead insects. A little yeast occasionally is said to be good for ants.

You need not worry about keeping an ant cage clean. The ants will clean it themselves. Dead ants, surplus earth, and other debris will be brought out into the feeding box and dumped where you can easily remove them. If no feeding box is used, the ants select some corner of the cage to serve as a refuse bin.

SPIDERS

Most spiders are easily kept in captivity, as they are sedentary by temperament and simple in their wants. Those which build round webs require a good deal of space. Burrowing kinds need several inches of earth. All are most comfortable in a somewhat humid atmosphere. Beyond this, a fly a day is more than a spider needs. Probably one fly once or twice a week is plenty. Spiders can fast for months without apparent harm. If you have a spider which does not eat often, water it by sprinkling the cage and the web if any.

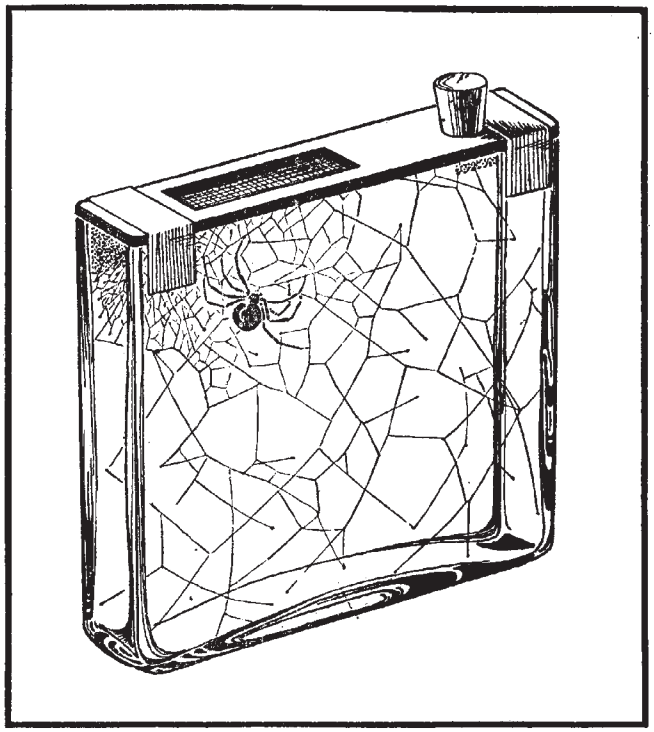

Fig. 9. A spider cage for species making irregular webs. The flat glass container is a museum specimen jar.