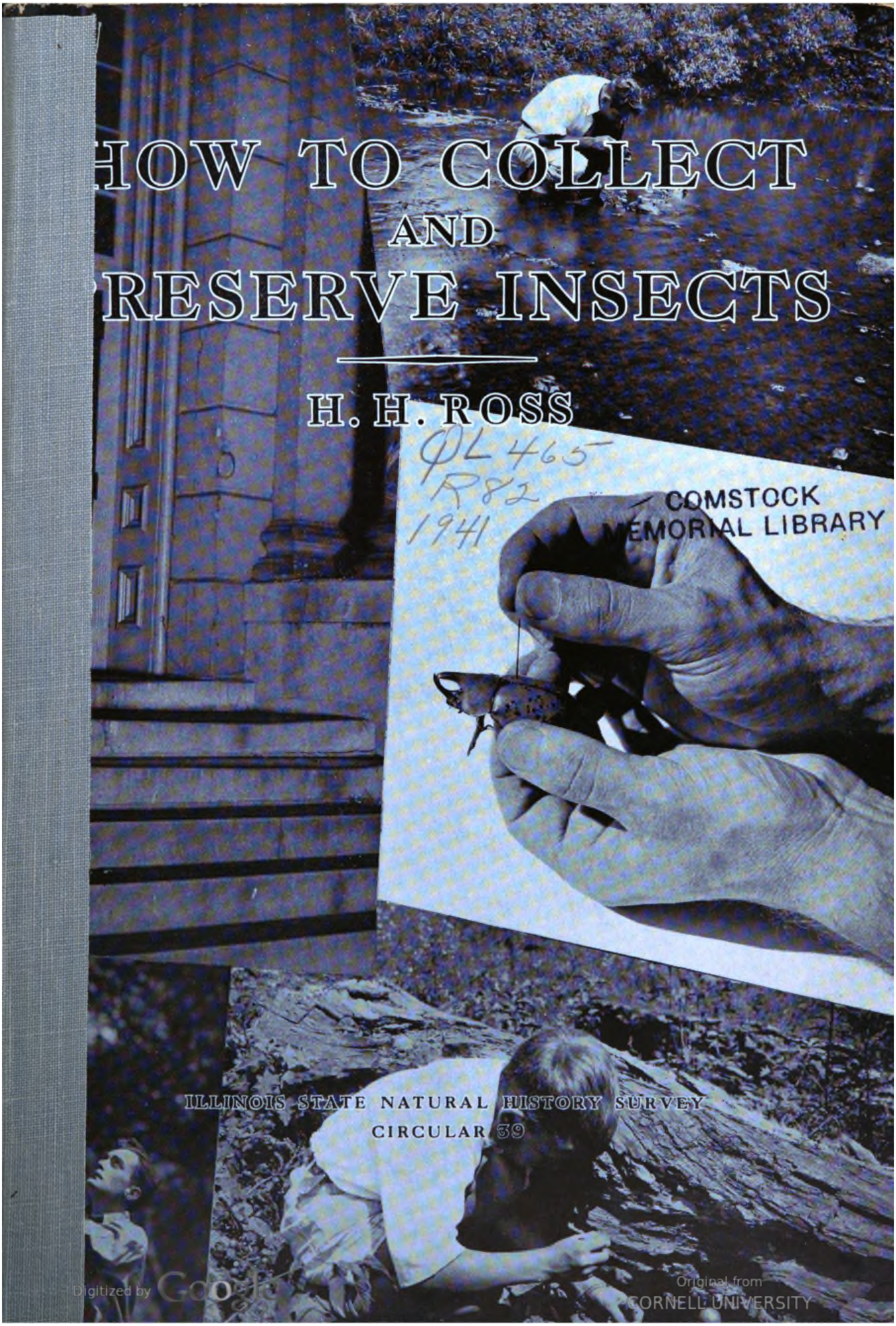

STATE OF ILLINOIS
Dwight H. Green, *Governor*

DEPARTMENT OF REGISTRATION AND EDUCATION
Frank G. Thompson, *Director*

How to Collect and Preserve INSECTS

H. H. ROSS

Printed by Authority of the State of Illinois

NATURAL HISTORY SURVEY DIVISION
Theodore H. Frison, *Chief*

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This paper is a contribution from the Section of Insect Survey

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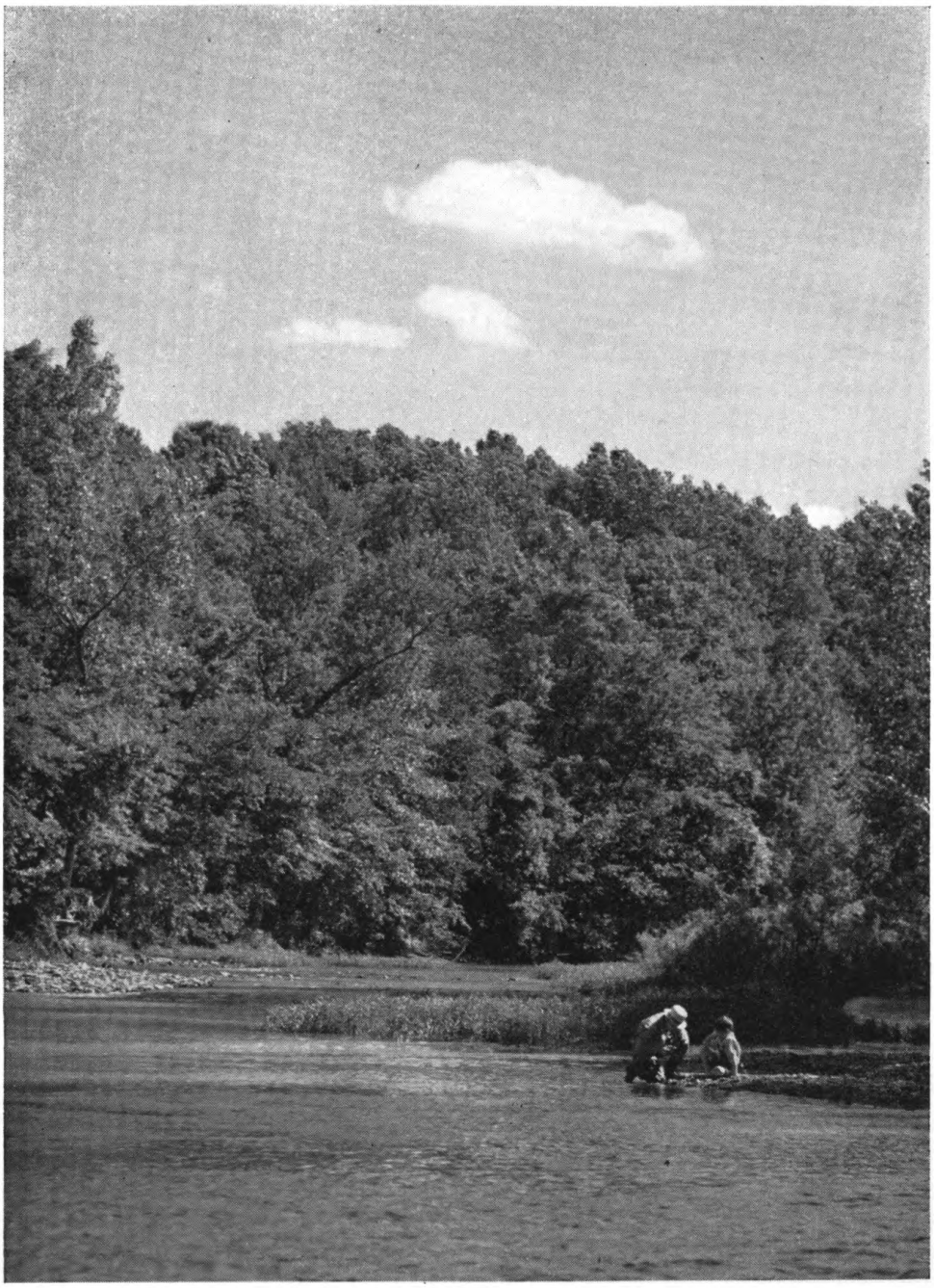

Illinois streams are a source of many insects of interest to the amateur collector. Shown here is the Salt Fork River, south of Oakwood.

How to Collect and Preserve
INSECTS

• • • *H. H. ROSS*

WITH rather simple equipment, the amateur, as well as the trained entomologist, can make a worthwhile collection of insects.

The making of such a collection may have educational and recreational as well as scientific values. Developing this hobby is one of the finest ways for students, especially those in agricultural districts, to become acquainted with the large number of injurious and beneficial insects that they encounter about the home and in the fields. High school classes in biology find excellent laboratory material in the many insects available for rearing and study. Both old and young collectors find a great deal of pleasure in working with the more showy and beautiful insects such as beetles, moths and butterflies; the satisfaction derived comes both from having welcome relaxation from the day's work and from making real contributions to scientific knowledge. Many entomological museums welcome the opportunity to examine or become informed upon individual, carefully prepared and labeled collections, as these supply distribution records for their localities in addition to other information of value to technical entomologists. Also, the amateur collector profits from his contact with specialists who can identify his specimens for him and advise him at any stage of his work.

It is hoped that this circular will show how easy it is to make a start in insect collecting, and will give the student helpful ideas on how and where to begin.

WHERE TO COLLECT

In late spring, in summer and in early fall, insects are very abundant in fields and woods, and large numbers of them may be caught by sweeping through the grass and branches with a strong insect net. Flowers of all descriptions are favorite visiting places of many bees, flies, beetles and other insects, and will afford good collecting. Woods along the banks of streams, open glades in deep woods and brush along forest edges offer some of the best opportunities for collecting by the sweeping method.

In early spring, when insects can be taken only sparingly in the open, the collector frequently finds sheltered hollows where they may be caught in large numbers. Many kinds of insects live only on a certain plant, and to obtain them the collector must search or sweep the host plant which the insect prefers.

Many obscure places harbor insects seldom found elsewhere. Among these are leaf mold and debris on the surface of the soil, particularly in woods; rotten logs and stumps, which should first be turned over for insects that hide under or around them, and then carefully searched or torn apart for others that live inside; in, under and around dead animals; under boards and stones.

Trees sometimes yield valuable specimens. If part of a tree, under which has been spread a large white sheet, is struck with a heavy padded stick, many insects in the branches, such as weevils, will fall to the sheet and "play possum." They can be picked off quite easily.

Lights attract large numbers of certain nocturnal insects such as June beetles and many kinds of moths; at night these insects may be collected at street or porch lights, on windows and screens of lighted rooms, or at light traps put up especially to attract them. Swarms of aquatic insects come to street lights of towns along rivers, sometimes in such numbers as to pile up in a crawling mass under each light. Collecting at this source is best on warm cloudy nights; wind or cold keeps most nocturnal insects fairly inactive. Different species of moths and beetles visit the lights in different seasons so that collecting of this type alone yields many kinds of insects.

Insects that live in the water may be collected by the use of heavy dip nets, swept through the water at various levels and through the mud and debris at the bottom. In shallow water, many insects will be found if stones and logs are turned over and leaf tufts pulled apart.

In winter, insect galls or cocoons may be gathered. If these are placed in jars with a cheesecloth cover tied over them, kept in a warm room, but away from radiators and all intense heat, many insects will emerge from them before spring.

WHAT TO USE

For making even a fairly large insect collection only a small amount of equipment is required. A net and killing bottle are essential, and good work may be done with these alone. A greater

variety of insects may be collected and with better results if a few more items are added to the list. Here is an outfit that will be found very satisfactory in the field.

1. A strong beating net for general sweeping and an additional light net to be used for moths and butterflies.
2. Killing bottles, several small and one or two large.
3. A pair of flexible forceps, 10 to 12 centimeters (about 4 to 5 inches) long, with slender prongs.
4. One or two camel's-hair brushes for picking up minute insects.
5. A few vials or small bottles containing fluid preservative.
6. Folded papers for butterflies.
7. A few small tins or boxes lined with cellucotton.

These items may be purchased from commercial supply houses such as those listed on page 48. Many items, however, may be made by the collector at nominal cost. Forceps, brushes, bottles, chemicals, wire and fabric must be purchased, but nets, killing bottles and accessories may readily be made from these easily obtained basic materials.

Nets

Construction.—Nets may easily be made at home. The necessary parts are a handle, a hoop or ring attached to it and a cloth bag hung from the ring, figs. 1 and 2. The handle should be strong and fairly light. At the net end, fig. 1*a*, a groove is cut down each side to receive the hoop. These grooves are as deep as the thickness of the wire used in the hoop; one is 3 inches long and the other 2½ inches; and each ends in a hole through the handle at right angles to the length. The ring, fig. 1*b*, is made of steel wire, preferably three-eighths inch piano wire, which if bent by rough usage springs back into shape and will stand a great deal of hard wear. The wire is shaped, as the figure shows, to form a ring with two straight arms which at the tips are bent at right angles toward each other. The arms and hooks thus formed must be exactly long enough to fit along the grooves and into the holes in the handle. After the wire has been fitted to the handle and the bag or net attached, the joint may either be wrapped tightly with wire, fig. 1*c*, or bound by a metal cylinder or ferrule slipped up over the arms of the ring, fig. 1*d*.

The bag, about twice as long as the diameter of the ring, should be tapered at the bottom. It is made from four pieces of

cloth, cut in the shape of fig. 2*a*, and a narrow strip of stout muslin or light canvas, 2*b*, which binds the bag to the ring. The four pieces are sewed together to form a cone-shaped bag, and around the circular opening is sewed the canvas or muslin band.

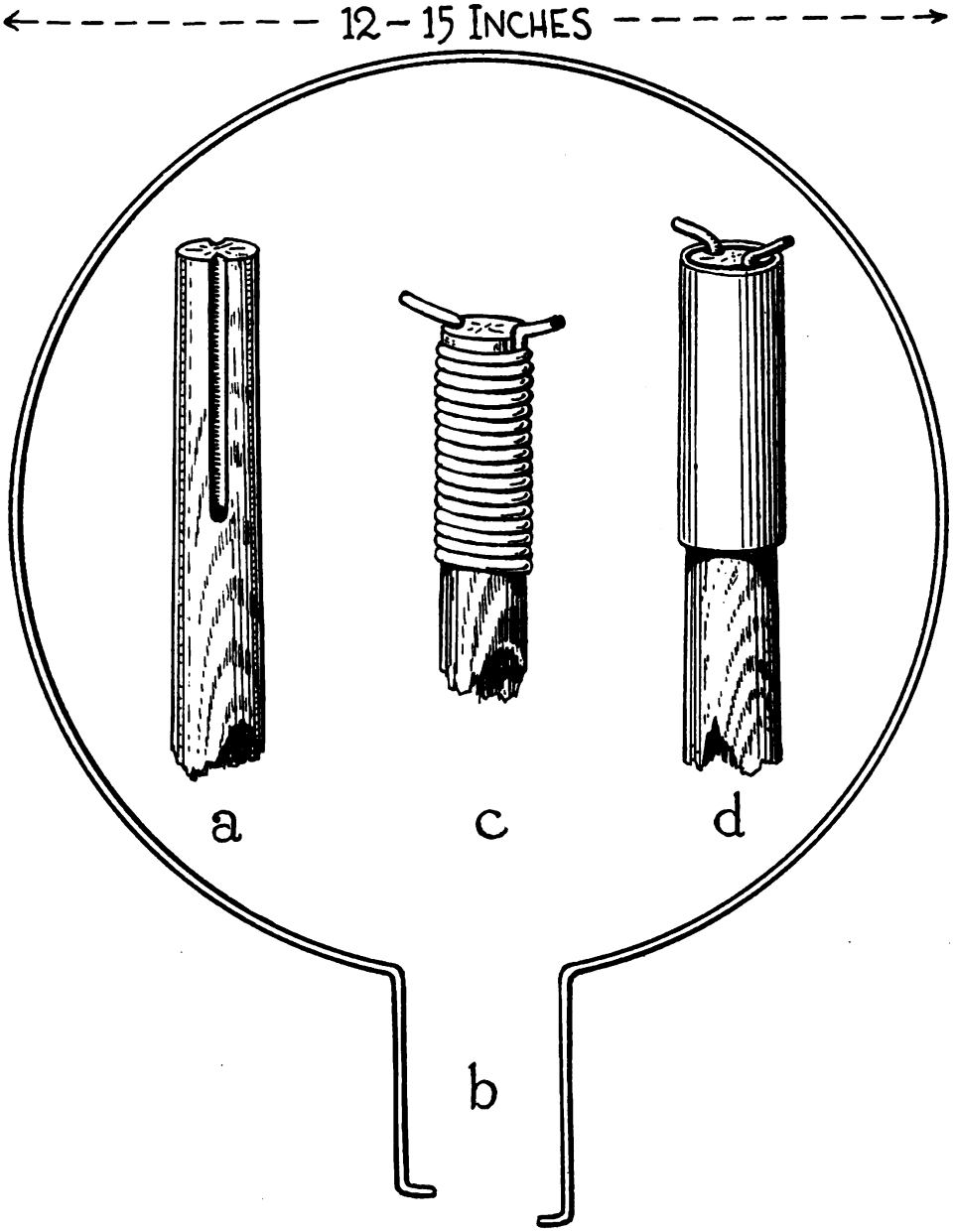

Fig. 1.—Net loop and handle. The short grooves cut opposite each other at the small end of the handle, *a*, end in holes through the handle that receive the hooks of the ring arms, *b*. The ring may be permanently bound to the handle with wire, *c*, or a removable joint may be effected with a metal ferrule that can be slipped up and down, *d*.

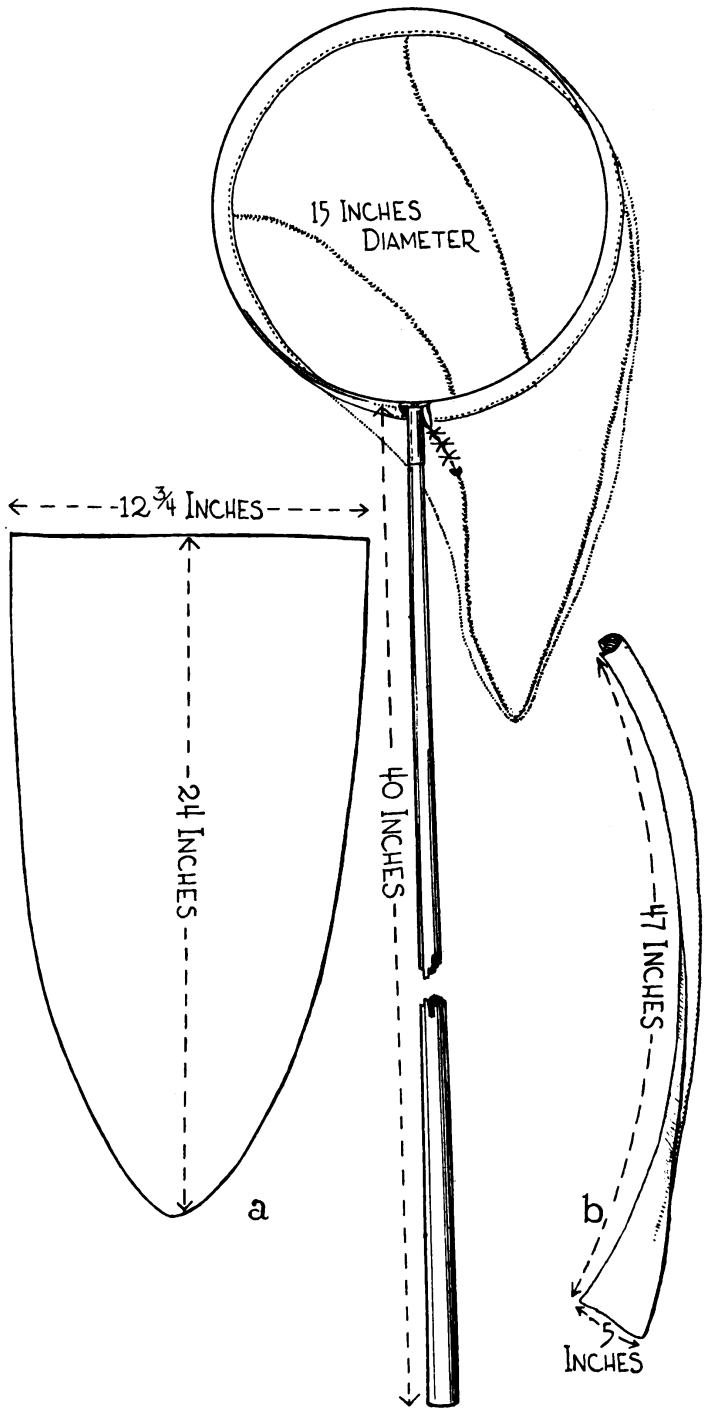

Fig 2.—Bag and completed net. The bag is cut from four pieces shaped as in *a*, and the circular opening at the top of the bag is bound with a narrow strip of stout muslin or light canvas, *b*, by means of which the bag is attached to the ring. After the bag is on the ring, the back vent may be closed with a string lacing, as shown in the figure.

The bag may be attached to the handle in two ways. The band may be folded over the ring and sewed down so that the attachment is permanent; or it may be made into a loop and slipped on the ring before the latter is fastened to the handle. In the latter case the bag must be open along one seam just below the handle a sufficient distance to allow the band to slip on and around the ring; this vent may be closed with a string lacing after the loop is on the ring and the whole fastened to the handle. A combination of this arrangement with a ferrule binding the ring to the handle is most convenient, for it allows the bag to be removed at will and a lighter or heavier one substituted according to the needs of the collector.

The first two nets mentioned below will be found to cover all the demands of the average collector.

General Purpose Net.—Ring, heavy wire, 12 inches in diameter; bag, strong unbleached muslin or light duck, 20 to 24 inches long; handle, hardwood stick 24 to 30 inches long.

Butterfly Net.—As above but with a longer handle and a bag of good quality marquisette or fine netting.

Combination Net.—A net that includes the features and uses of the two nets described above and is a better collecting instrument may be conveniently made instead, although at slightly higher cost because of the better materials. Its ring, of 7½ gauge (three-eighths inch) piano wire, is 15 inches in diameter and allows a greater area to be covered with each sweep. The bag, of finest bolder's silk or best quality marquisette, is 24 inches long and serves equally well for the capture of delicate insects and for beating. The handle, of straight-grained hickory or ash, is 40 inches long and permits the collector to cover greater areas in sweeping. If a cheaper net is desired, one of unbleached muslin will be satisfactory for general use.

Care and Use.—All nets are easily ripped and for this reason should be kept away from barbed wire and thorny trees such as locust and red haw. Also, they should be kept dry. Moisture rots the fabric, making it more easily torn. Almost all insects caught in the net while it is wet are unfit for collection.

Flowers, herbs and boughs should be swept with a sidewise motion. This will collect more insects than an upward or downward sweep and at the same time mutilate the plant less. If care is taken not to damage flowers or foliage, the same patch or plants may be visited several times with profit. The contents of the bag should be removed after every few strokes or sweeps. This prac-

tice will prevent damage to the insects that might otherwise be banged around in the net with a large amount of debris.

Killing Bottles

Construction.—The best killing bottles are made with potassium cyanide, sodium cyanide or calcium cyanide. These compounds give a concentration of deadly fumes sufficient to kill most insects in a very short time, which is desirable. Generally, two sizes of bottles are used, and in either of them one of these cyanides may give good results. Potassium cyanide and calcium cyanide are the most convenient to handle. Only a small supply should be purchased at a time, as they deteriorate rapidly.

A pyrex glass test tube or strong ring-necked vial, about three-quarters inch wide and 4 to 6 inches long, makes a good cyanide bottle of the smaller size, fig. 3. Put about three-quarters inch of granular potassium cyanide or calcium cyanide flakes in the tube or vial. Cover with a tight plug of cellucotton, on top of which put one or two loose plugs. Sodium cyanide is not recommended for small bottles, as it comes in rock form and is difficult to handle. Instead of cellucotton, you may use sawdust and a plaster of Paris batter. In the latter case, cover the cyanide with one-quarter inch of sawdust and over it pour one-quarter inch of newly mixed, thick batter of plaster of Paris and water. Allow the batter to harden for a few hours; then keep the bottle tightly corked.

The larger cyanide bottle, fig. 3, which should be sturdy, may range in capacity from one-half pint to a quart. In the larger bottle, *the cyanide should always have the plaster of Paris covering.* The layer of sawdust and plaster should be a little thicker than that for the smaller bottle. Rock sodium cyanide may be used in the larger bottle if more convenient than calcium cyanide or potassium cyanide.

Label all killing bottles and other containers of cyanide conspicuously with the word **POISON**; keep them tightly corked and away from children or people who do not realize the extreme deadliness of the compounds. *Never test the strength of a killing bottle by taking the cork out and smelling the contents.* As an added precaution and safeguard to the collector, tape the bottom of the cyanide bottle to protect it against breakage.

The bottle should be almost entirely filled with loosely crumpled, soft paper, which should be changed whenever it gets

damp. This paper will help keep the specimens from rubbing against each other inside the bottle and thereby being defaced.

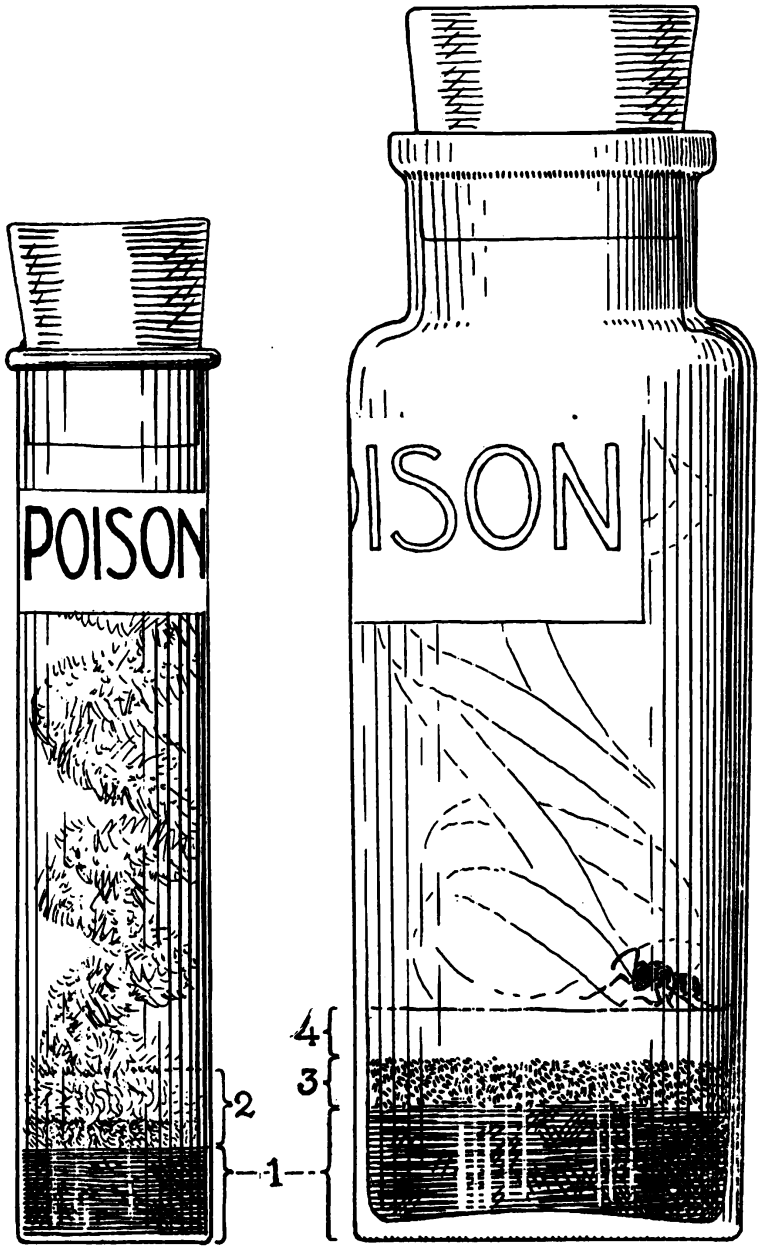

Fig. 3.—Cyanide collecting bottles. Killing bottles of at least two sizes should be included in every collector's equipment. The lethal chemical, 1, is potassium cyanide, sodium cyanide or calcium cyanide, and is covered with a layer of cellucotton, 2, or sawdust, 3, and plaster of Paris, 4. The rest of the bottle is filled with soft, loosely crumpled paper, which should be changed whenever it gets damp. The bottles should be tightly corked and labeled POISON. The collector should *not* test their strength by smelling.

Care and Use.—Each collector should have several cyanide bottles and follow carefully these practices.

1. Transfer insects from net to bottle by holding the uncorked bottle in a fold or corner of the net and crowding one or more of the specimens into it, or "running" the open bottle up the side of the net beneath the specimen or specimens. Most insects can be maneuvered into the bottle easily and the opening temporarily closed by the thumb, or the stopper can be put on. In obstinate cases, it may be desirable to stopper the bottle through the cloth of the net until the specimen is stupefied, after which the insect will drop to the bottom of the bottle.

2. Keep small, delicate insects in a bottle by themselves. Such insects as large beetles are apt to mutilate small flies and other delicate insects in the same bottle.

3. Keep a special bottle for moths and butterflies. When these die they shed large quantities of scales which stick to and partially spoil other insects.

4. Keep the inside of the bottle dry. Cyanide bottles "sweat"; that is, moisture both from the insects and the plaster condenses on the inside of the bottle. Moisture will mat the hair and appendages of insects and discolor the body. Do not crowd the bottle with large insects, especially juicy ones like grasshoppers. Change the paper frequently. Wipe out the bottle with paper or cloth, which should be disposed of in such a way that it cannot poison persons or pets.

5. Take insects out of the bottles as soon as they are dead. Cyanide fumes soon turn many yellows to red or orange, and also make small specimens brittle so that legs and other parts break off easily.

6. Empty the insects out of the bottles before they have accumulated in a ball at the bottom. To do so will prevent damage to the smaller specimens and discoloration due to "sweating."

7. Discard a cyanide bottle that no longer kills quickly. Substitute a fresh one and you will save untold time in the field. Be sure to dispose of old bottles so that their deadly contents will be out of reach of children and pets.

SPECIAL COLLECTING EQUIPMENT

Frequently, after a certain amount of general collecting, the student wishes to focus his efforts on some particular group such as flies, ants or spiders, or on a particular habitat. For

many such projects, there are special pieces of collecting equipment that are easy to make and extremely valuable in obtaining specimens in greater numbers or in better condition.

Aspirator or Sucker

Small, rapidly moving insects, such as leafhoppers, diminutive beetles and flies, may be obtained rapidly by using an aspirator or sucker. This is made from either a piece of glass tubing about 1¼ inches in diameter, fig. 4*a*, or a capsule vial of the same size, fig. 5*a*.

When made from a piece of glass tubing, the aspirator is constructed in accordance with the following directions.

1. Cut the glass tubing, which has an inside diameter of 1 inch, to length, 8 inches, 4*a*.
2. Secure two rubber stoppers, 4*b*, to fit the tubing, and bore a hole one-fourth inch in diameter down the exact center of each stopper.
3. Cut two more pieces of glass tubing, 4*c* and 4*d*, from a piece one-fourth inch in diameter. One piece should be 8 inches long and the other 3 inches long.
4. Insert each piece through one of the rubber stoppers so that one end of the long piece projects about 2 inches beyond stopper 4*b*, the other end about 5 inches beyond; let the ends of the short piece project about an equal distance beyond the other stopper.
5. Over one end of the short tube, tie two thicknesses of cheesecloth, 4*e*.
6. Over the other end slip one end of a piece of rubber tubing, 4*f*, 12 to 14 inches long.
7. Into the other end of the rubber tubing slip a piece of narrow glass tubing, 4*g*, about 1½ inches long.
8. Heat the exposed ends of glass tubing so that the sharp edges melt slightly and round out.

The parts are now ready to be assembled, as in fig. 4, and used. To catch insects, put end piece, 4*g*, in your mouth, grasp the body tube, 4*a*, in your dextrous hand, aim the intake tube, 4*c*, at a bug and almost touching it, and suck. The air current pulls the bug in; the bug usually does not find its way into the intake tube to crawl out. Do not forget the cheesecloth, 4*e*; it prevents the bugs from being sucked into your mouth.

If a vial is more easily obtained than a wide glass tube, the

aspirator shown in fig. 5 can be made. In making this, use only one stopper, 5*b*. Drill two holes in it. Bend the pieces of narrow glass tubing, 5*c* and 5*d*, as shown and insert both in the cork.

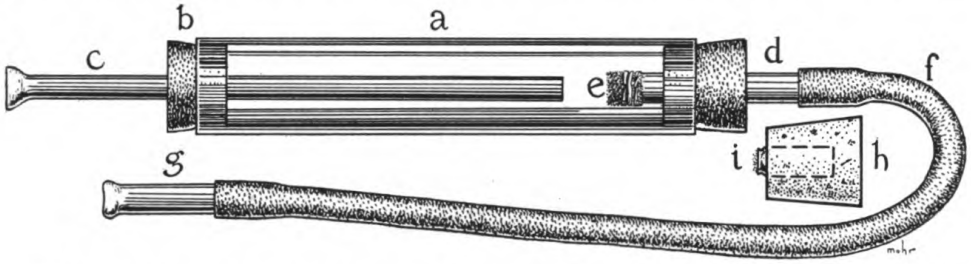

Fig 4.—Aspirator or sucker. This is how the type made from glass tubing looks when assembled; end *g* goes in the mouth, *c* picks up the insects. Shown also is the cyanide cork *i-h*, which is used to kill insects in the aspirator.

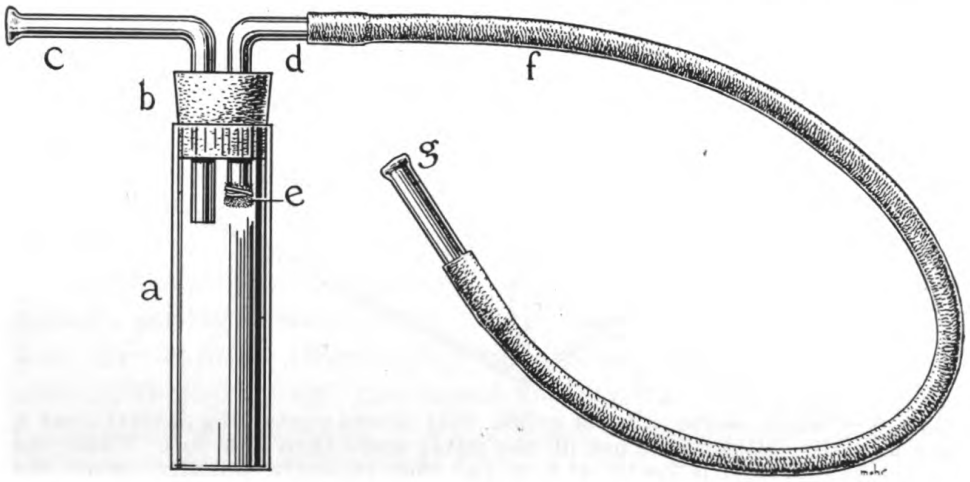

Fig. 5.—Vial type of aspirator. Note the short length of *c* projecting inside the vial, the long tube, *f*. Compare these parts with equivalent parts in fig. 4.

Allowing a longer piece of rubber tubing, 5*f*, complete minor details as described for the first aspirator, not forgetting the cheesecloth, 5*e*, and assemble the parts as shown in fig. 5.

To kill insects in either aspirator, use a small cyanide bottle, 4*i*, which is inserted in a cork, 4*h*, that has been partially bored through to receive it. This cork should be the exact size of the tube or bottle for which it is intended.

To use the cyanide cork with the aspirator shown in fig. 4, plug the intake tube, 4*c*, with a tapered paper plug or a leaf, jar the insects away from the stopper at the opposite end, remove this stopper cautiously, and quickly insert in its place the cyanide cork. When the specimens are stupefied, they may be transferred

to another bottle. If the type of bottle shown in fig. 5 is used, it is necessary only to exchange corks.

Sifter

Perhaps no special collecting method nets more interesting, rare and diverse kinds of insects than that involved in sifting rotten logs, leaf mold, and other forest and prairie ground cover.

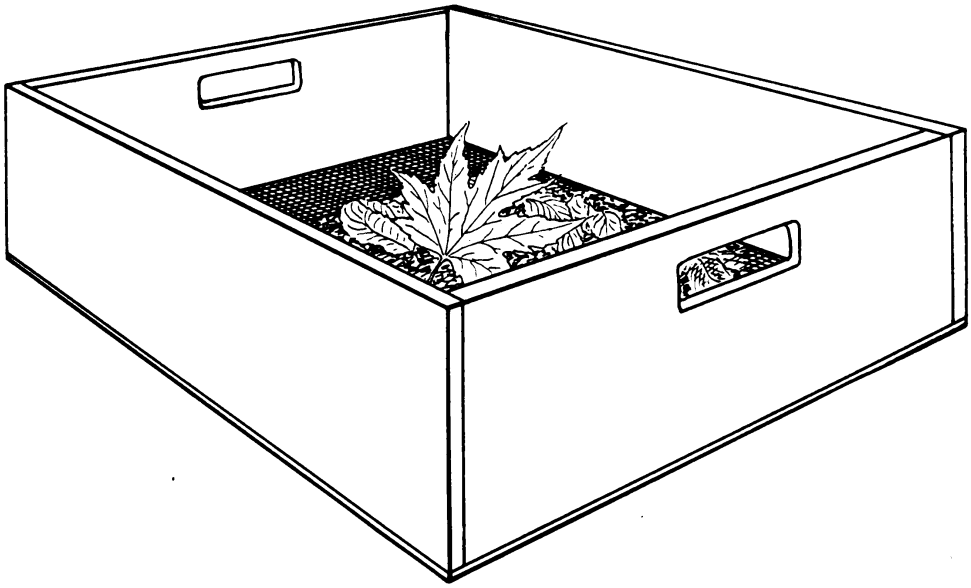

Fig. 6.—Sifter, showing hand grips. Sift debris containing insects over a piece of white oilcloth. Do not fill the sifter more than half full. When you put in a sample, sift it gently at first and then violently. Finally, empty the contents of the sifter on the oilcloth to capture specimens too large to go through the mesh. Patience is required to get the best results with the sifter, which provides one of the best methods for winter collecting.

To do this type of collecting, provide yourself with the following:

1. A stout sifting sieve about 12 by 12 inches and 4 to 6 inches deep, fig. 6. The bottom may be wire screen of any desired mesh; usually 8, 10 or 12 meshes to the inch give good general purpose results.
2. A sturdy piece of white oilcloth about 18 inches or 2 feet square.
3. Collecting equipment, including an aspirator.

Material such as leaf mold is placed in the sieve and this is shaken over the white oilcloth, which has been spread on a level spot on the ground. The small insects fall on the cloth and can be picked up with the aspirator or with a camel's-hair brush.

Many insects feign death when they drop and are difficult to see until they "revive" and start to move away.

In late fall and in winter, sifting is frequently the most profitable type of collecting; at any time of year, it will turn up such things as rare spiders and beetles that can be captured in no other way.

Equipment for Collecting Aquatic Insects

Night Collecting for Adult Insects.—Collecting at lights on warm, cloudy nights, or warm nights without moonlight, gives best results. Two simple methods are as follows.

Drive your car to a spot overlooking a stream or lake and turn on the bright lights. Into a shallow pan, such as a pie pan, pour enough alcohol to cover the bottom with from one-eighth to one-fourth inch of fluid. Hold the pan directly under a headlight. If aquatic insects are on the wing, they will come to the light and eventually drop in the fluid, which traps them. With a small piece of wet cardboard, you can scrape the entire insect contents of the pan into a small bottle of alcohol, which should then be labeled, location, name of collector and place being given.

Lights in signs and store windows (especially blue neon signs) near fresh water attract large numbers of aquatic insects. You may capture them easily by dipping your index finger in alcohol, "scooping up" the insect rapidly but gently on the wet surface and then dipping it in the bottle. An aspirator, or sucker, also can be used with success.

Day Collecting for Adult Insects.—During the day, aquatic insects frequently rest on or under bridges, window ledges and similar places, and show a preference for the denser trees in shaded situations. They are especially numerous in those spots where the heavily leaved branches hang low over the water and form humid, protected areas in the heat of the day. Here sweeping with a stout and fairly wide-mouthed net is very effective. Aquatic insects may often be picked off stones in such places. especially early in the season.

Collecting for Larvae.—Practically every stream or lake harbors aquatic insect larvae, which may be taken by various methods, some simple and others requiring specialized and complicated apparatus. For general collecting, the following hints may be of value.

1. Look under logs and stones. Search out crevices in them;

some insects hide away and demand of the collector a keen and careful search.

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

3. Pick out bunches of aquatic plants and search through them carefully.

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

5. Remember that some insects build cases and hide in them when disturbed. It takes a practiced eye to see these without waiting for the bug to dry out enough to make it squirm along with its case in search of its habitat.

SENDING INSECTS FOR IDENTIFICATION

Many insects attack agricultural crops, stored products, domestic fowl and animals, and man himself. Frequently, it is

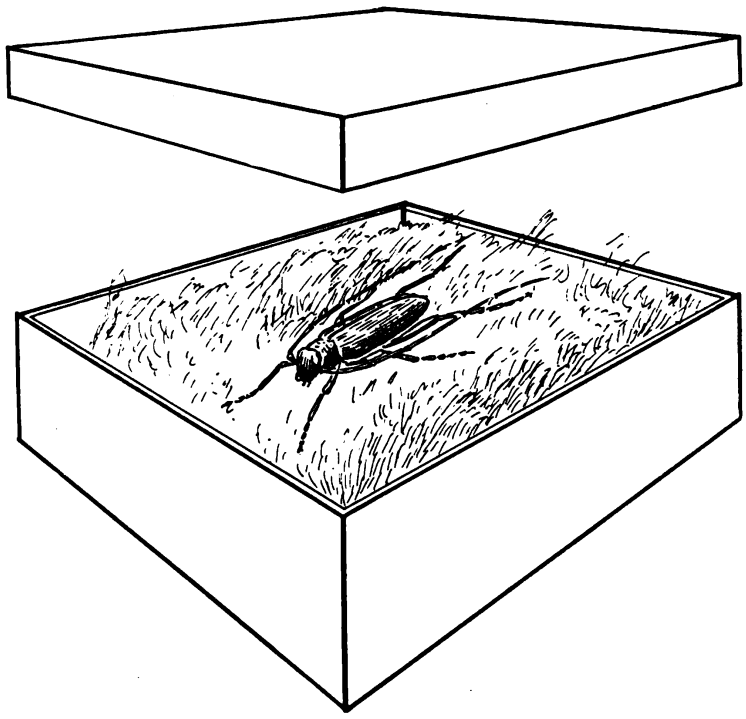

Fig. 7.—Pill box for sending economic insects for identification. Put in enough cotton packing to keep the specimen from rattling about but not so much that it crushes the specimen. *Do not send specimens through the mail in an envelope, unpacked.*

desirable to send these to an entomologist for identification and suggestions for control measures. When sending such specimens, observe these precautions.

1. Do not send insects in an envelope with a letter. Specimens are often crushed or broken beyond recognition if sent through the mail in this fashion and are of no use for identification.

2. Instead, send them in a box, ranging from a sturdy pill box to a shoe box, the size depending on the specimen, fig. 7.

3. Always send full data with specimens, including what they were feeding on when collected, where they were collected and any other pertinent information.

4. If convenient, send the specimens alive. In this case, be sure to mark the package "live insects."

5. Do not use a glass container for shipping live insects. The glass will "sweat," and the insects will rot and mold.

6. In sending insects dead, (a) if they are dry, be sure to pack them in the container with enough cotton to keep them snugly in position but not so much as to crush them; (b) if they are in fluid, pack the container to prevent breakage.

7. Do not try to preserve insects in water. Use one of the regular preservatives, such as formaldehyde or grain alcohol (ethyl), preferably grain alcohol.

HOW TO HANDLE UNMOUNTED SPECIMENS

Temporary Cases

If it is not convenient to mount the specimens when they are taken from the killing bottle, the moths and butterflies should be put in "papers" and other insects in cotton.

"Papers" are simply rectangular strips of paper of convenient size folded as in fig. 8. The moth or butterfly, with its wings folded, is placed in a "paper," the edges of which are then crimped over to lock it shut.

For insects other than moths and butterflies, pill boxes or small flat tins containing cellucotton make good temporary housing. A layer of cellucotton is laid in the bottom, a layer of insects placed on it and another layer of cotton placed over the insects. The lid should fit fairly snugly over all. Cigar boxes and other boxes of like size also may be used in the same way.

Great care must be taken that sufficient cotton is put in the

box to take up all moisture in the insect bodies. If the specimens are large they should be allowed to dry moderately before being put in cotton, and placed in a wood or cardboard container which

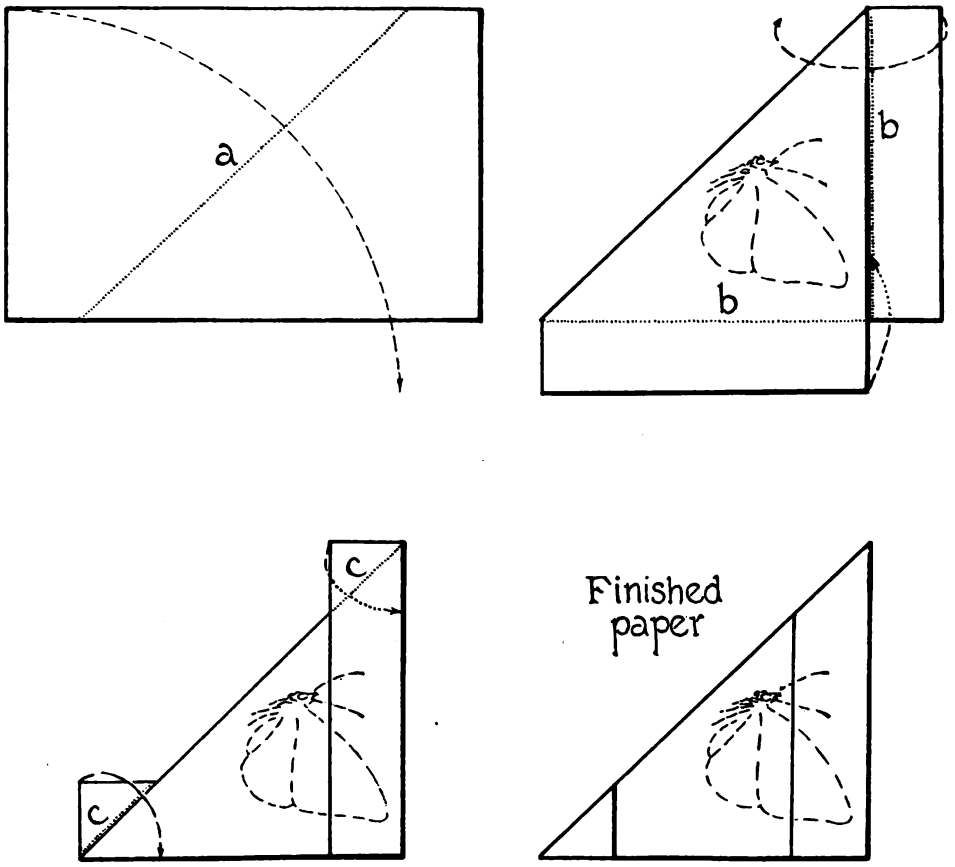

Fig. 8.—Papers. These are temporary means of keeping dragon flies, moths, butterflies and small insects of all kinds until they can be relaxed and mounted. A rectangular piece of paper, varying in size according to the insect it is to contain, is folded along the dotted lines and in the directions indicated by arrows, as shown in *a*, *b* and *c*.

will not "sweat," as will a metal box. If the insects became damp in these containers they quickly mold or rot. They should be packed tight enough to prevent their rolling around and breaking.

Relaxing Boxes and Jars

At any desired time the dry specimens may be relaxed and mounted. A relaxing box or jar is easily made. In the bottom of a wide-mouthed tin or jar, put an inch or two of clean sand; saturate the sand with water containing a small amount of phenol

(carbolic acid) and place over it a piece of cork, cardboard or wood cut to fit the jar. The lid must be practically air tight. Place the dry specimens on the cork, cover tightly, and in a day or two they will be soft and pliable enough for pinning or spreading, the next steps toward permanent arrangement of the collection.

The relaxer will "sweat" if kept in too hot a room, and will spoil the specimens. Also, the insects will be spoiled if left in the relaxer too long. This is a matter varying with each relaxer and can be learned only by experience.

HOW TO MOUNT AND PRESERVE SPECIMENS

Almost all adult insects in collections are mounted on pins. Such insects as beetles, grasshoppers, butterflies, moths, flies and bees are pinned directly through the body from top to bottom. Small insects such as leafhoppers, plant bugs, small beetles and the like are glued on card points. Immature insects and the adults of some groups are best preserved in fluid.

Preservation in Fluid

Caterpillars and other immature stages of insects should be preserved in fluid. Grain alcohol at 80 per cent or formaldehyde at 4 per cent are suitable. Caterpillars, grubs and maggots should first be heated 5 or 10 minutes in water just at the boiling point. This treatment sterilizes the specimens and prevents their discoloration by bacteria in the digestive system.

Soft-bodied adult insects also should be preserved in fluid. If pinned they shrivel to such an extent that few identifying characters can be seen. This is true especially of insects which develop in rivers, lakes and streams, such as stoneflies and caddis flies. The preserving fluid in the vials in which insects have been placed should be changed at the end of the first day or two.

Some hard-shelled insects may be preserved in fluid. Ants and beetles may be thus treated temporarily and later they may be pinned and dried.

Preservation by Pinning

Hard-bodied insects such as beetles, flies and wasps are preserved as dry specimens on pins better than in fluid. The pinned

specimens are more convenient to study and they retain their natural coloring better. Flies and butterflies are covered with hairs or scales which clot or break off if the specimens are bottled, and for this reason they should be pinned.

Common household pins are too thick and short for pinning insects. Longer and more slender pins are necessary and may be purchased from various supply houses. They should be of spring steel; a brass pin will corrode and be destroyed by acids in the insect's body. The pins are obtained in numbered sizes, of which 1, 2, 3 and 4 will be found of most general use, and sizes 0 or 00 of advantage in certain other operations.

Medium to Large Insects.—Medium to large hard-shelled insects, such as moths, beetles, flies, bees and wasps, should be pinned vertically through the body, fig. 9*a*. It is essential that the pin pass through a fairly solid part of the body, and to insure this the following standard procedures should be adopted.

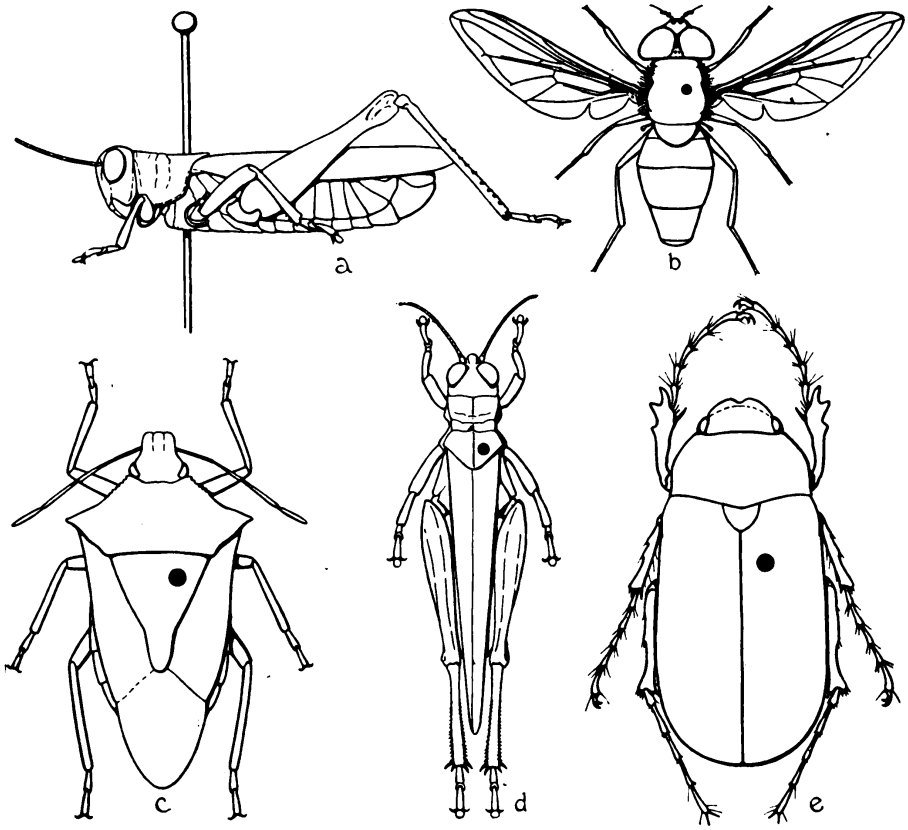

Fig. 9.—Pinning. Medium- to hard-shelled insects are mounted by being pinned through the body in the manner shown at *a*. The black spots show the location of the pin in the case of bees, flies and wasps, *b*; stink bugs, *c*; grasshoppers, *d*; and beetles, *e*.

1. Bees, wasps, flies.—Pin through thorax between bases of frontwings slightly to right of middle line, as shown in fig. 9*b*.

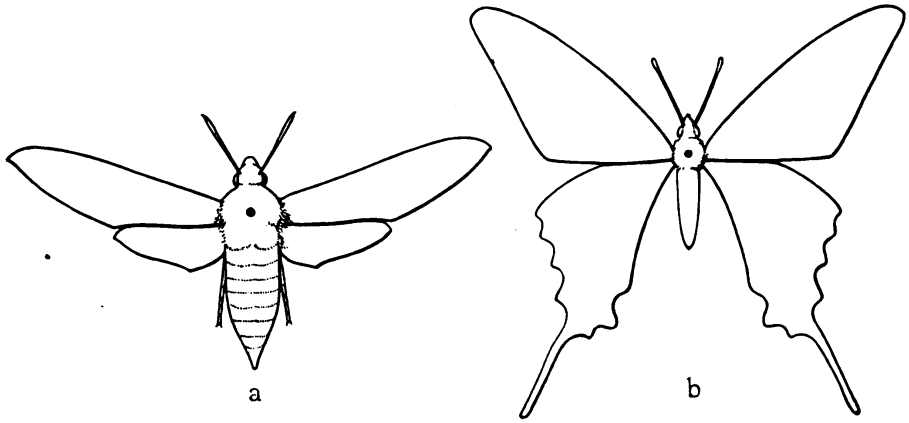

Fig. 10.—Pinning. Moths, *a*, and butterflies, *b*, are pinned through the center of the thorax (instead of to the right of the median line) between the bases of the frontwings.

2. Stink bugs.—Pin just to right of middle line of the scutellum or large triangle between the bases of the frontwings, fig. 9*c*.

3. Grasshoppers.—Pin through back part of prothorax (the saddle behind the head) just to right of middle line, fig. 9*d*.

4. Beetles.—Pin near front margin of right wing cover near middle line, fig. 9*e*.

5. Moths, butterflies, dragonflies, damselflies.—Pin through the center of the thorax between the bases of the frontwings, fig. 10.

The insect should be run about three-quarters of the distance up the pin, but not so close to the top that no room is left for easy handling of the pin with the fingers. It is well to have all insects the same distance from the top of the pin. To insure a uniform distance, the collector should use a pinning block. This

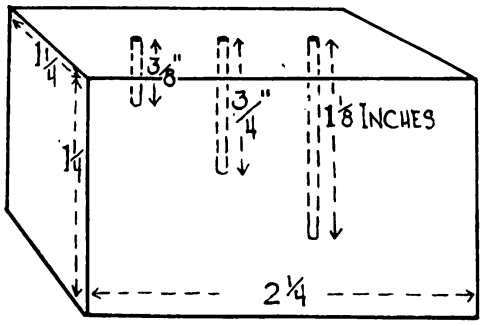

Fig. 11.—Pinning block. The block is 1¼ x 1¼ x 2¼ inches, with holes drilled to the depths shown and having diameters only slightly greater than the largest pin which will be used. A specimen is pinned and the pin inserted into one of the holes until it touches bottom; thus the insects of any class, or in any case, may be pinned uniformly at the desired height.

is a small piece of wood or metal usually in the form shown in fig. 11, into the top of which are drilled holes slightly larger than the pin diameters. Such a block may be fashioned of wood with holes made by small nails and covered with a cardboard square

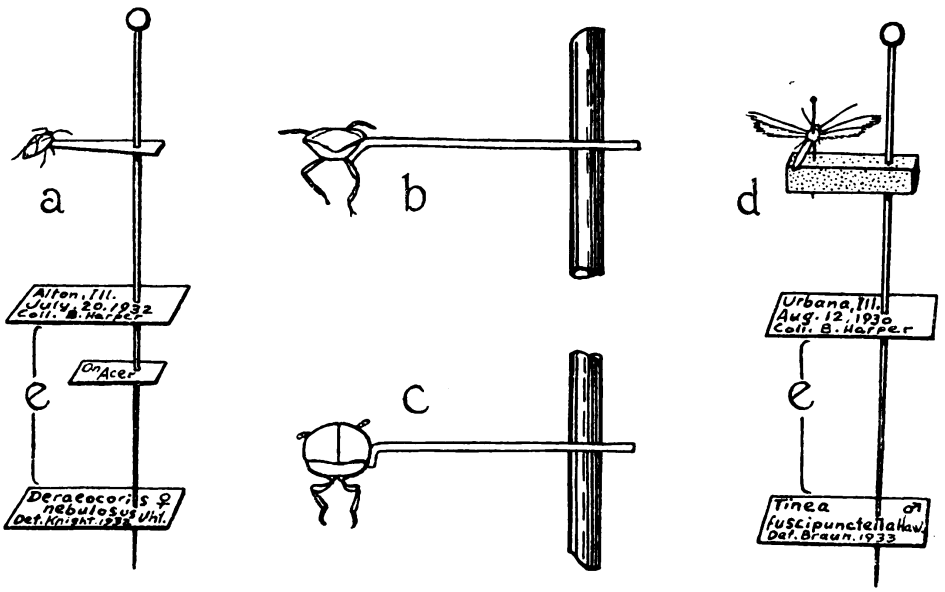

Fig 12.—Pinning small insects and labeling. The insect may be glued to a card point, *a*, which has been crimped to meet the right side of the body, *b*, *c*; or it may be pinned with a minuten pin, *d*, to a piece of cork or pith, which in turn is regularly pinned. All pinned insects should be labeled, as at *e*. In the case of some small insects, such as tiny moths, the minuten pin may be run down through the body and then into the cork; in the case of others, such as mosquitoes, it is often desirable to run the minuten pin up through the cork first and then impale the specimen on the point of the pin.

through which have been stabbed holes the exact size of those in the wood. The depths of the holes in the block should be three-eights inch, three-quarters inch and 1⅛ inches, respectively. To use the block, pin the insect and insert the pin into whichever hole allows the specimen to be pushed up the pin and still leave room, allowing for the thickness of the insect's body, for handling at the top.

Tiny Insects.—Very small insects, of which many will be encountered, cannot be pinned through the body with a regular pin, which will break too many of the insect's parts. Instead they are mounted on card points or on minuten pins.

Card points are small triangles of cardboard or celluloid pinned through one of the sides and crimped over at the opposite apex; a spot of good glue is put on the angled tip, and the right

side of the insect is pressed against the glued surface, fig. 12. The slant of the crimp depends on the angle of the insect's side; the desired product is the insect mounted with its top surface horizontal and its head forward; legs, wings and antennae should be in view and as little of the body as possible hidden by the glue or card point. Very little glue should be used; a small amount holds well and gives a better specimen for study than a large amount. The points may be cut uniformly with a hand punch, and they should be about three-eighths inch long. Good material for making these points is 2-ply Bristol board.

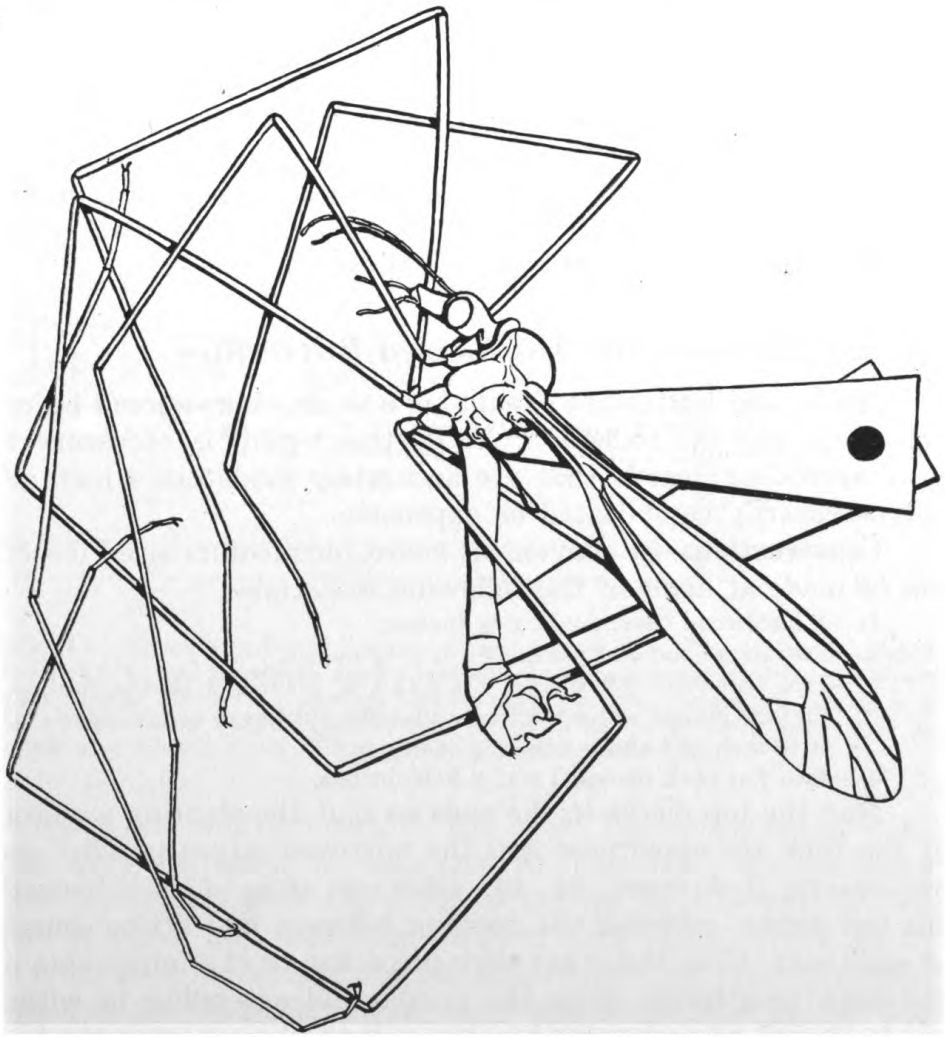

Fig. 13.—Pinning craneflies. Because of their unwieldy legs these insects should have a double card point mount, and the legs should be kept away from the pin.

Minuten pins are short, extremely delicate steel pins, fig. 12*d*. One of these is thrust through the body of the insect and into a small piece of cork, pith or similar substance, which is in turn pinned in the regular way that a card point is. This method is especially desirable for minute moths.

Insects Hard to Pin.—Wasps, lacewing flies, damselflies and like insects have an abdomen that sags readily when the specimen is killed and pinned. This unwanted drooping can be prevented in three simple ways. (1) Stick the pinned insect on a vertical surface of a block so that the body by its own weight dries in normal position. (2) Pin the insect on a horizontal surface and run a stiff paper on the pin beneath the body and supporting it in a natural position until the insect dries. (3) Brace the abdomen by crossing two pins beneath it and thrusting them into the block, allowing the specimen to dry in the angle of the cross.

Craneflies are unwieldy and so are best pinned on a double card point mount, fig. 13. The legs should be directed away from the pin to avoid breakage in handling.

Spreading Board for Moths and Butterflies

Moths and butterflies should have their wings spread before being put into the collection. To do this well it is necessary to have spreading boards that are accurately made but which are not necessarily complicated or expensive.

Construction.—A convenient board for medium sized insects can be made at home of the following materials:

1.—A hardwood base, 4 x 12 x ¼ inches.
2.—Two hardwood end pieces, 4 x ¾ x ½ inches.
3.—Two softwood top pieces, 1⅞ x 12 x ½ inches, with the top surface planed at an angle, so that the thickness at one edge is ½ inch and at the other ⅜ inch.
4.—Two flat cork pieces, 1 x 11 x 3/16 inches.

Nail the top pieces to the ends so that the slanting surfaces of the tops are uppermost and the narrower edges parallel and one-quarter inch apart, fig. 14. Glue one strip of cork beneath the top pieces, covering the opening between and fitting snugly at each end. Glue the other cork piece flat to the upper side of the base, lengthwise along the middle and extending to within one-half inch of each end. Finally, nail the base across the bottoms of the end pieces, so that the two corks face each other.

Use.—Before spreading the specimen, relax it as described

under "Relaxing Boxes and Jars." Then pin it, keeping in mind fig. 10 and the directions given under "Preservation by Pinning." Thrust the pin, with the insect on it, through the upper cork of

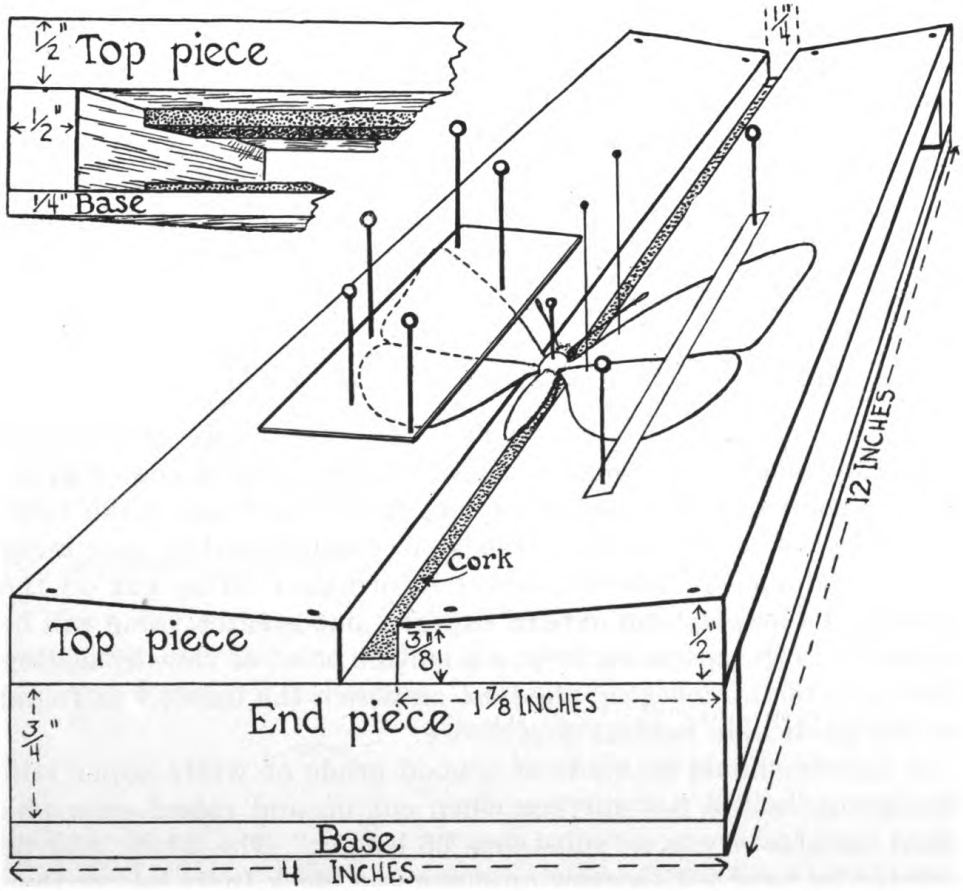

Fig. 14.—Spreading board for moths and butterflies. The insect is pinned into the grove and its wings drawn forward and pinned temporarily as shown on the right. The left wings are shown with pinning completed. Inset is a view of spreading board construction. The top pieces of the board must be smooth and of soft wood. First grade pine is satisfactory.

the board and into the cork on the base. Insert the insect body in the groove so that the wing bases are level with the near edge of the top pieces. Hold the wings at the top level by two narrow strips of paper and pull them forward until the hind margin of the frontwing is at right angles to the body axis, and the front margin of the hindwing is just under the frontwing, fig. 14. Pin the wings temporarily in this position by inserting a pin, size 0 or 00, near the front margin at the base of each wing. When the wings on both sides of the insect are thus adjusted, lay strong

pieces of paper over them and pin them down securely with large pins inserted close to the wings but not through them. Here you may use large common pins, but still better are the large-headed dressmaker's pins about 1¼ inches long. Finally, remove the original adjusting pins and put the specimen in a dry, pest proof container for 2 or 3 weeks. It will then have set sufficiently to be removed from the board.

For good results, spreading boards with grooves of various widths are necessary, and a specimen should be spread on that board the groove of which best fits the insect body. The width of the top pieces should vary to accommodate different wing spreads. The slope of the top pieces should be about as described.

HOW TO LABEL THE SPECIMENS

To be useful to the entomologist and others interested in the scientific relations of insects, as well as to furnish the collector with a complete record of his hours in the field and make more valuable the work he has already accomplished, the specimens should be labeled. The important information to be put on the label is the locality and date of capture, but greater value will be attached to the specimen from a scientific point of view by adding the name of the collector, the host on which the insect was found or the particular habitat preference.

Labels should be made of a good grade of white paper stiff enough to hold a flat surface when cut up and raised on a pin. Most satisfactory is a "substance 36 ledger." The labels may be printed by hand with a crow-quill pen and black India ink, or they may be purchased completely or partially printed from a biological supply house.

The labels should be as small as possible, and of nearly a uniform size. They should be run about half way up the pin, but not too near the specimen, and they should project from the pin in the same direction as the specimen, as shown in fig. 12.

HOUSING THE COLLECTION PERMANENTLY

Insect Boxes

After the specimens have been pinned and labeled, they should be housed in boxes or cases having a soft bottom or inner layer that will allow easy pinning. Such housing not only insures

the safety of the collection but makes for easily handled units once the specimens have been named.

Several satisfactory types of boxes for housing insect specimens may be bought from commercial supply companies. These are usually much better than boxes of home construction, being more nearly dust and pest proof. Home made boxes, however, are quite practical for the beginning collector, due to their ease of construction and extremely low cost. Cigar boxes 2 inches deep or more make ideal insect boxes if a layer of cork or balsa wood or two layers of soft, corrugated cardboard are glued in the bottom. Other wooden or cardboard boxes may be provided with such a bottom pinning surface and used for storing specimens. Boxes of this type, however, afford the specimens no protection against pests, and great care must be exercised in keeping the boxes fumigated.

Manufactured boxes, cabinets and cases may be selected from catalogs which various firms send free upon application.

Precaution Against Pests

Certain insects such as flour beetles and carpet beetles feed upon dried insects, and unless precautions are taken these may entirely destroy a collection. To guard against them, various chemical repellents in cones or bags may be placed in the boxes containing specimens. Naphthalene, of which ordinary moth balls are composed, is one of the best repellents. A few moth balls may be put in a bag and this pinned securely in one corner of the box, or, more neatly, naphthalene "cones" may be made of the moth balls and pins, and stuck in the corners. To make such a "cone," stick a pin in a cork, heat its head in a flame and then push the head into a moth ball. The pin will melt its way into the naphthalene, which will cool and harden again almost immediately. Neat "cones," fig. 15, can with a little practice be made in this way.

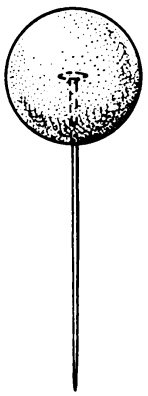

Fig. 15.—Naphthalene "cone." This is easily made with a moth ball and common pin and serves as a repellent to keep away from the collection live insects that might cause damage.

Naphthalene is a repellent only; its odor keeps out pests, but if they are already in the collection the naphthalene will not kill them, and some other substance must be used.

Paradichlorobenzene, called PDB, is a good fumigant to use on pests in the collection. It should be used in a nearly air tight chamber, such as a tight trunk, bin or case, at the rate of 1 pound of PDB to 25 cubic feet of space. The boxes of specimens, with lids open or removed, should be placed in the container, the fumigant scattered or spread on a piece of cloth or paper above them, and the chamber sealed for about a week.

IDENTIFYING THE SPECIMENS

The complete classification of insects is quite complicated. The entire insect group is first divided into *orders*, such as the Coleoptera, or beetles, the Diptera, or flies, and the Siphonaptera, or fleas. Each of these orders may contain from several dozen to 50,000 different kinds of insects in North America alone. These orders are divided into *families*, which in turn may contain from one to many thousands of species. The family names always end in *idae*, as in Pentatomidae, the name for the stink bugs. These families are divided into *genera* (the plural for *genus*), and the various *species* or kinds are placed in the genera. Thus the housefly bears the name *Musca domestica* Linnaeus; this means that the species name is *domestica*, that this name *domestica* was first applied to the species by a man named Linnaeus and that the species *domestica* is placed in the genus *Musca*. Further, the genus *Musca* belongs to the family Muscidae which, in turn, belongs to the order Diptera.

As an aid to the preliminary identification of his specimens by the beginner and also as an aid in arranging his collection, a short, descriptive synopsis is given below. In this are noted the most distinctive features of the common insects occurring in Illinois. There are rare and obscure forms seldom met by the collector which require a most technical key for their identification, but for these the collector will need to consult some of the more nearly complete books listed on page 47. The collector will find, however, that this synopsis will afford a beginning for his classification of the common forms.

Various characters are used to identify an insect to family, genus and species. It is always necessary to see the structure of antennae, wings (if present), legs and mouthparts. Frequently, minute details of these must be examined. Hair or scales covering the body or wings, and the texture of these parts, are important. Hence, specimens should be kept in good condition.

Thysanura Silverfish — Wingless, flat insects that run rapidly. They have long antennae and three long tails. Terrestrial; commonly found in dwellings. Fig. 16 shows one of the common silverfish, *Thermobia domestica* Packard; its habit of eating book bindings and other starchy materials is well known to most apartment dwellers.

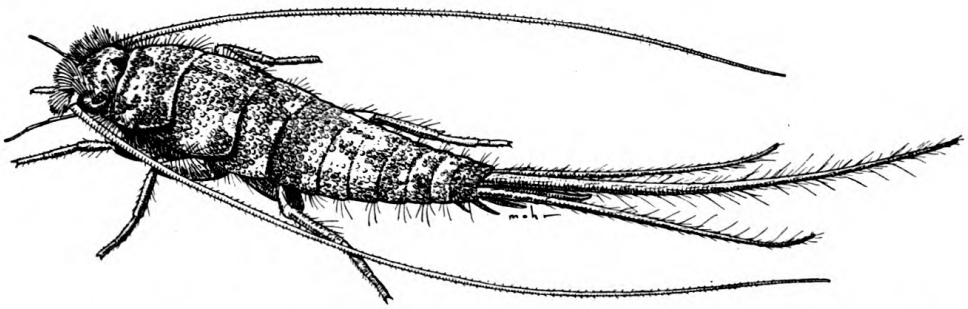

Fig 16.—Thysanura. *Thermobia domestica*, a common silverfish. Actual length about 0.3 inch.

Some out-of-door forms inhabit wooded dells, where they hide under logs and stones and, when disturbed, run with remarkable speed. Others live in the soil itself and are rarely collected.

Collembola Springtails — Small wingless insects that jump and crawl when disturbed. They have short antennae and usually a springing foot on the underside near the posterior end of the body. They live in moist places and are abundant under leaf mold and similar material. Illustrated in fig. 17 is *Achorutes armatus* (Nicolet) which often becomes a major pest in mushroom cellars and greenhouses.

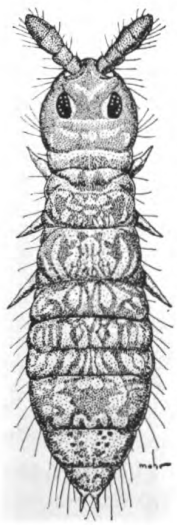

Fig. 17.—Collembola. *Achorutes armatus*, a small springtail found in greenhouses and mushroom cellars. Actual length less than 0.1 inch.

About a hundred different species of Collembola occur in Illinois; they include some of our smallest insects. A few never grow longer than 0.007 inch; the largest approach half an inch in length. These hardy animals are active all year and surprisingly resistant to cold. Certain species occur on snow in winter. In Illinois a small bluish-gray species, *Podura aquatica* (Linnaeus), is found on the surface of still water at the margins of ponds and small streams.

Orthoptera
Cockroaches, Grasshoppers, Crickets and Their Allies

Insects usually with two pairs of wings, each with a very fine, dense network of veins, the front pair thick and leathery, the hind pair delicate and fanlike. Mouthparts fitted for chewing, with stout mandibles. The young look and act like the adults but do not have wings. Terrestrial insects. This order includes all the cockroaches, praying mantids, walking sticks, grasshoppers, crickets and katydids. Fig. 18 shows a native wood cockroach, *Parcoblatta pennsylvanica* (De Geer); fig. 19 shows the migratory locust or grasshopper, *Melanoplus mexicanus* (Saussure). Several of the groups of Orthoptera have adults that never develop wings. These include such odd forms as

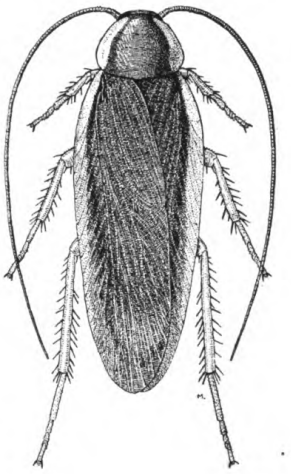

Fig. 18.—Orthoptera. *Parcoblatta pennsylvanica*, one of the common wood cockroaches. Actual length about 0.8 inch.

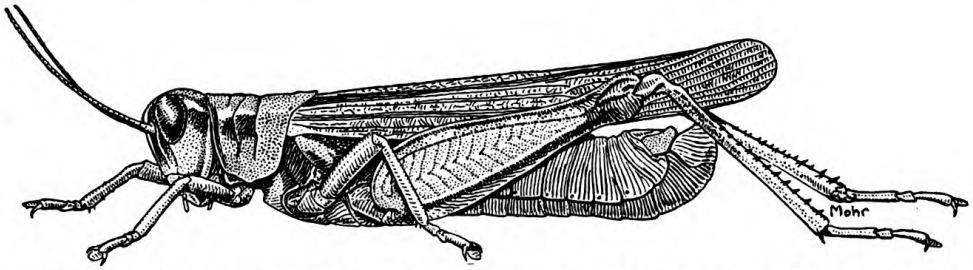

Fig. 19.—Orthoptera. *Melanoplus mexicanus*, the migratory locust, a common Illinois grasshopper. Actual length about 1.0 inch.

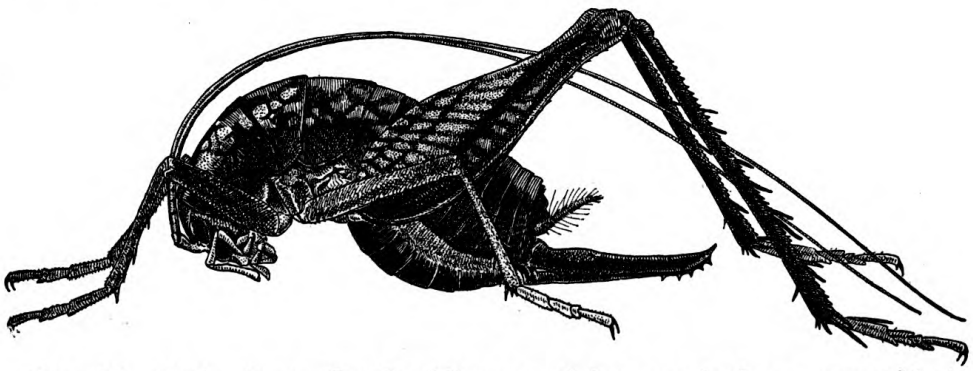

Fig. 20.—Orthoptera. *Ceuthophilus maculatus*, a wingless cave cricket. Crickets of this kind are found in caves, under rocks and in basements. Actual length about 1.0 inch.

the cave crickets, exemplified by *Ceuthophilus maculatus* (Harris), fig. 20, and the walking stick insects, of which our common form is the tree-feeding *Diapheromera femorata* (Say), fig. 21. In addition to these, some species of grasshoppers, crickets and cockroaches either develop no wings or have only short ones.

Cockroaches are among the most persistent indoor pests we have, and several species of grasshoppers do consistent damage to field crops each year. The sporadic outbreaks of the migratory locust and red-legged grasshopper cause tremendous damage to Illinois crops.

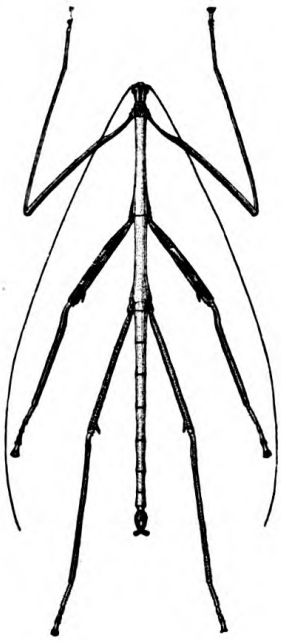

Fig. 21.—Orthoptera. *Diapheromera femorata*, a walking stick insect. Note the lack of wings. Actual length about 3.0 inches.

Isoptera
Termites

Fragile or soft insects with chewing mouthparts. The mating forms are dark brown and have two similar pairs of wings, both pairs delicate and having a fine network of veins. The workers are white and soft bodied, live in colonies in wood and are called "white ants" as well as termites. They are not true ants. Our

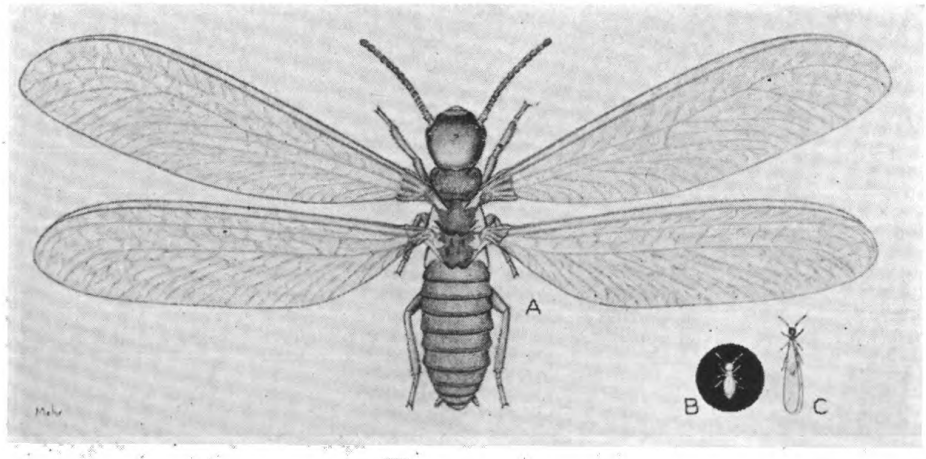

Fig. 22.—Isoptera. *Reticulitermes flavipes*, the commonest kind of termite found in Illinois. *A*, first form queen with wings spread, many times natural size. This is the form that lays the eggs. *B*, worker nymph, natural size. *C*, first form queen, natural size, with wings placed in their natural resting position.

common species is *Reticulitermes flavipes* (Kollar), fig. 22, which is destructive to buildings of wooden construction throughout Illinois; it is most destructive in the southern part of the state.

Plecoptera Stoneflies — Insects that pass the young or nymphal stage in streams. They have slender, soft bodies, long antennae, long legs and two long tails, and they move about rapidly. The adults are terrestrial in habit and occur along streams. Most of them have two pairs of wings, which are folded flat over the back; the number of crossveins varies from many to few. The antennae are long, the mouthparts of chewing type but very reduced. Of exceptional interest

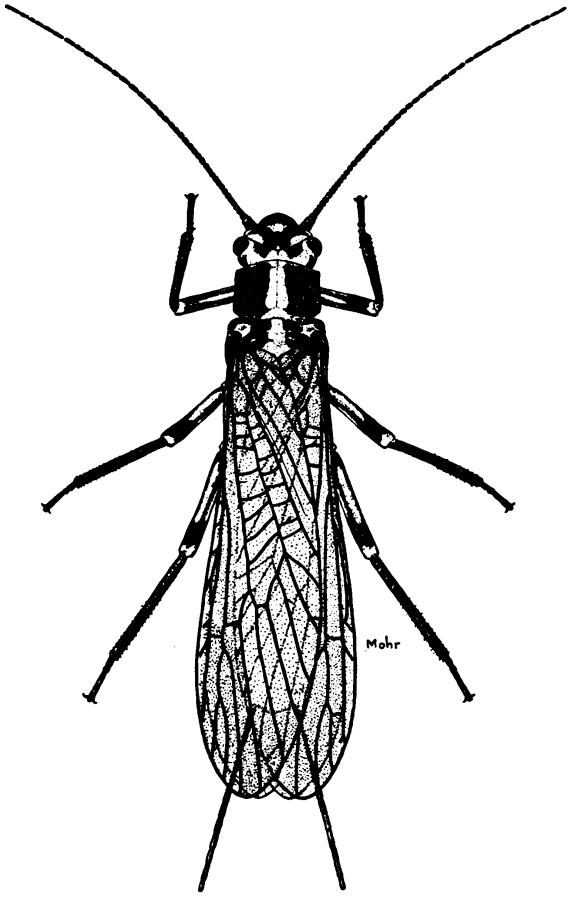

Fig. 23.—Plecoptera. *Isoperla confusa*, one of the typical stoneflies found in Illinois; adult form. Actual length about 0.8 inch. Illinois stoneflies range in length from 0.25 inch to 1.5 inches.

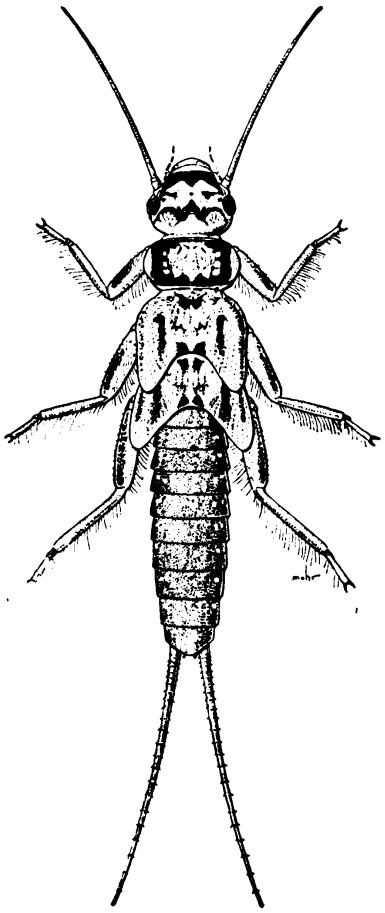

Fig. 24.—Plecoptera. *Isoperla confusa*; the nymph of the species shown in fig. 23. The nymph lives in streams. Actual length about 0.6 inch.

are stonefly adults that emerge in winter and are active on bridges from November through March. Figs. 23 and 24 illustrate *Isoperla confusa* Frison.

Plectoptera
Mayflies

This order is one in which the nymphs or young live in streams and lakes; the adults are terrestrial and are found along the edge of the water from which they have emerged. The nymphs are varied in shape and have short antennae, long legs, which are often flattened, and three tails at the end of the body. The adult flies have very long front legs, short antennae, practically no mouthparts,

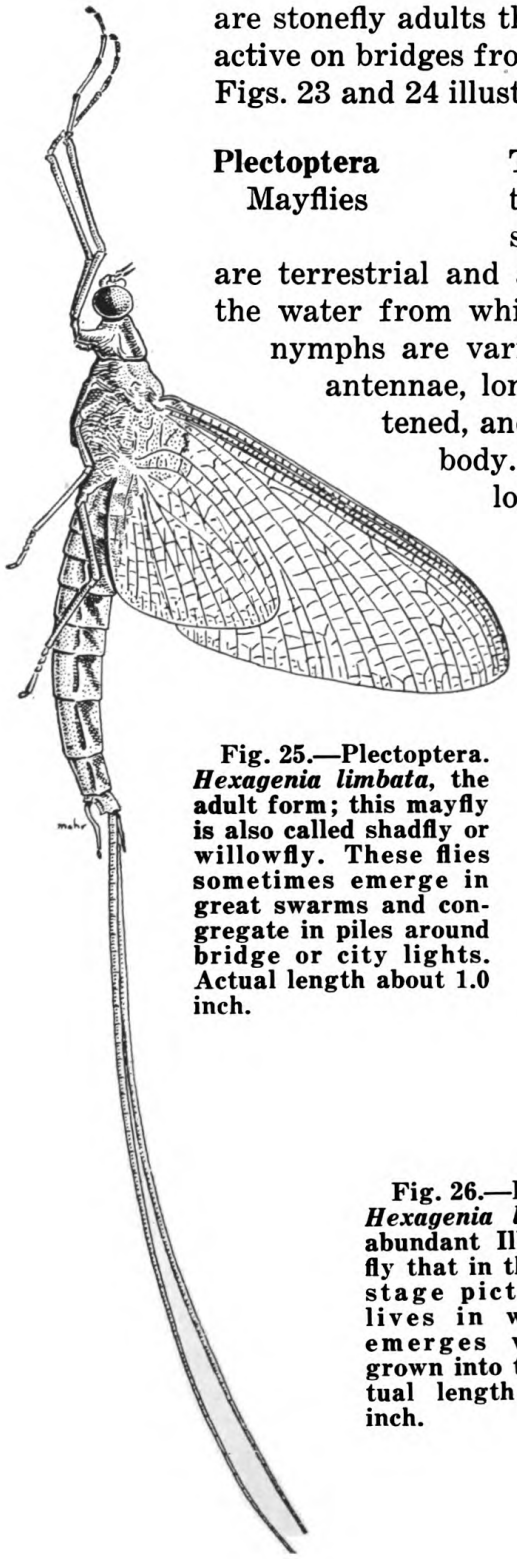

Fig. 25.—Plectoptera. *Hexagenia limbata*, the adult form; this mayfly is also called shadfly or willowfly. These flies sometimes emerge in great swarms and congregate in piles around bridge or city lights. Actual length about 1.0 inch.

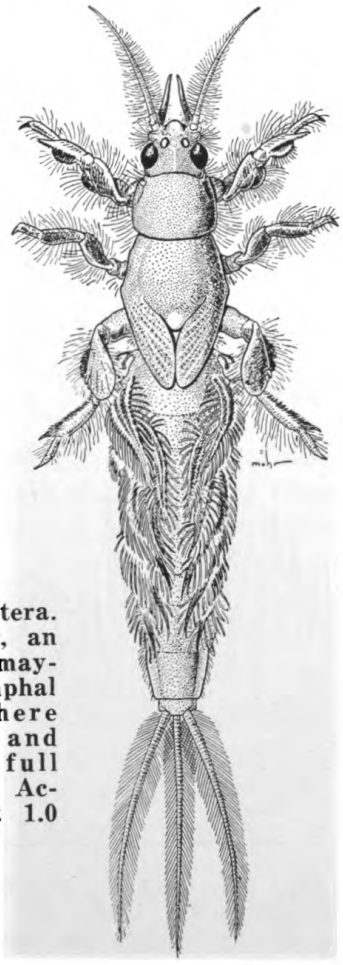

Fig. 26.—Plectoptera. *Hexagenia limbata*, an abundant Illinois mayfly that in the nymphal stage pictured here lives in water and emerges when full grown into the fly. Actual length about 1.0 inch.

usually two pairs of wings, and two or three long tails. When the insect is at rest, the wings are held together above the body. *Hexagenia limbata* (Guérin), figs. 25 and 26, is one of our very common mayflies and is an important factor in the food economy of many Illinois fish.

The mayflies, together with the stoneflies, caddis flies and midges, constitute a very abundant portion of the life of our lakes and streams, and they are important as fish food.

Odonata
Dragonflies, Damselflies

In this order, also, the nymphs develop in streams, lakes or ponds; the adults are aerial. The nymphs have short antennae, long legs and either a stout body with no tail (dragonfly nymphs) or a slender body with three leaflike gills projecting from the end of the body (damselfly nymphs). Most distinctive for this order is an extensile "mask," which fits over the face of the nymph and which is hinged to extend forward and seize the small animals upon which the nymph lives. The adults are large, often beautifully colored, as the *Libellula luctuosa* Burmeister, fig. 27. They have chewing mouthparts and two pairs of large

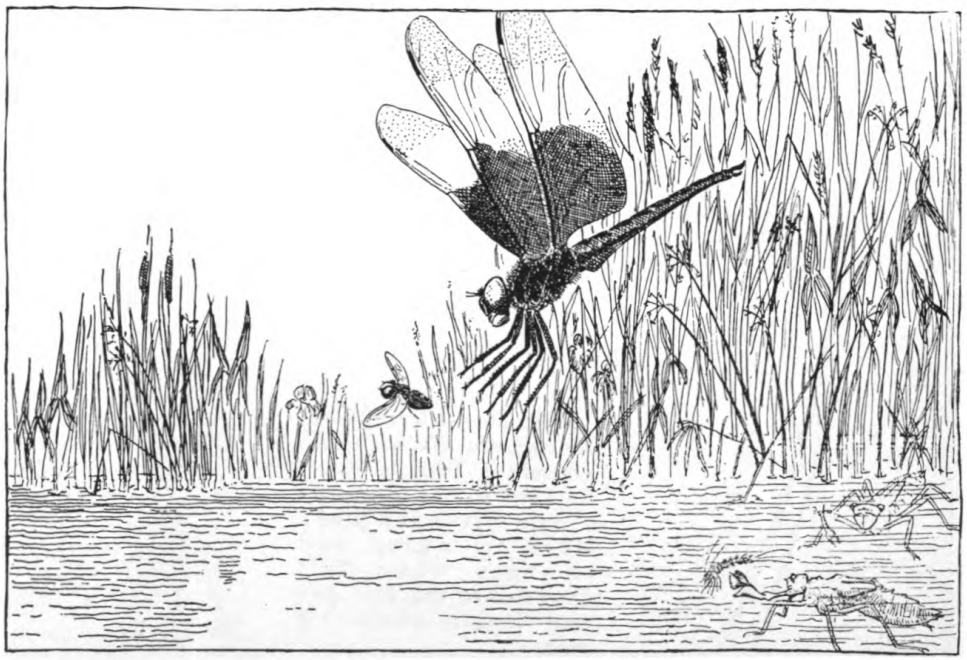

Fig. 27.—Odonata. *Libellula luctuosa*; the adult form of this dragonfly pursuing a fly. Under the water are shown two typical dragonfly nymphs, the lower one with the "mask" outstretched. Actual length of adult about 1.5 inches, wingspread about 3.0 inches.

wings, very finely and intricately netted with veins. The order is divided into two types, the adult flies being told apart as follows:

(a) Anisoptera or Dragonflies.—Body stout, wings broad at base, not folded but held in a horizontal position outstretched from body when at rest. These are strong fliers.

(b) Zygoptera or Damselflies.—Body slender, wings narrowed at base and folded back over the abdomen or up over the back when the insect is at rest.

Hemiptera True Bugs — Insects usually with two pairs of wings, and with the mouthparts formed for sucking. The beak is attached to the underside of the front part of the head. The front pair of wings have the base hardened and only the apical portion membranous or delicate,

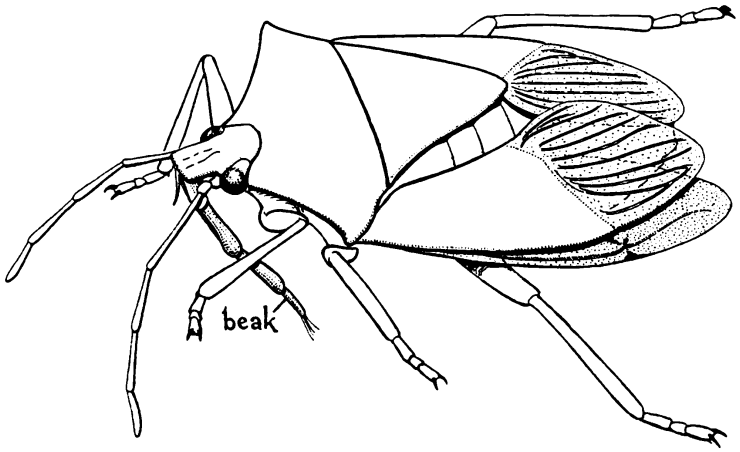

Fig. 28.—Hemiptera. A typical stink bug, belonging to the family Pentatomidae, showing attachment of beak and arrangement of wings. Actual length about 0.4 inch.

the hind pair are entirely delicate; in repose the wings are folded over and flat against the body, the hind pair underneath. These characters are shown in fig. 28, of a stink bug belonging to the family Pentatomidae. The young have the same general appearance and habits as the adults, but lack wings. This order includes many common kinds such as the water bugs, water striders (these seldom develop wings even in the adult stage), ambush bugs, lace-bugs and stinkbugs. Chief pest of this group is the chinch bug, *Blissus leucopterus* (Say), fig. 29. Other pests include many kinds of

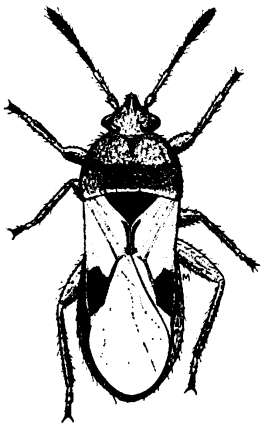

Fig. 29.—Hemiptera. *Blissus leucopterus*, the chinch bug. Actual length about 0.1 inch.

plant bugs, of which *Lygus oblineatus* (Say) is shown in fig. 30. The bed bugs, another group never developing functional wings, belong here also.

Members of one family, the Reduviidae or assassin bugs, prey on other insects. A few species of these, some of them an inch long, occasionally attack people, inflicting an extremely painful bite and causing considerable bleeding. These are called "kissing bugs." One of these bugs frequently reported is *Arilus cristatus* Linnaeus, which has a long, dark body, and, on its back, a raised, notched, wheel-like structure.

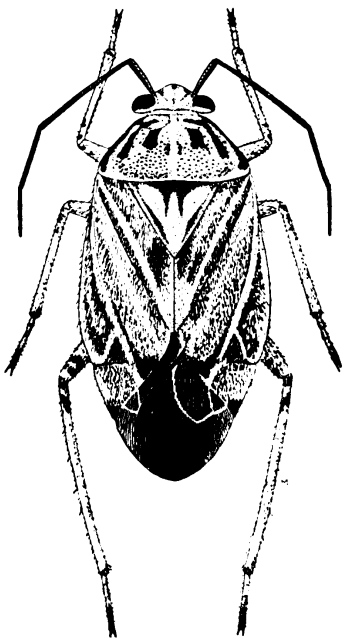

Fig. 30.—Hemiptera. *Lygus oblineatus*, the tarnished plant bug. Actual length about 0.2 inch.

Homoptera
Cicadas,
Aphids and
Their Allies

These insects also have sucking mouthparts, but the beak is attached at the back of the head instead of the front of the head as in the Hemiptera. Typically, the Homoptera have two pairs of wings, both of which are membranous. There are probably as many kinds without wings, however, as with them. The nymphal stages are like the adults,

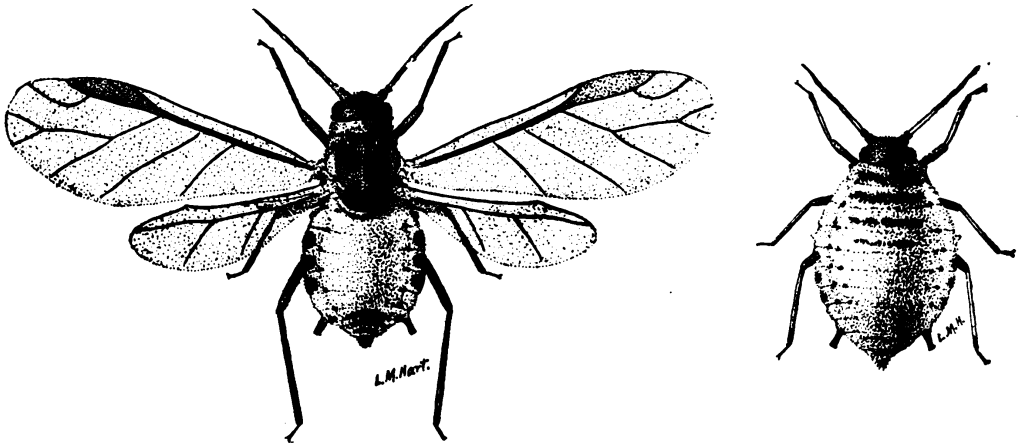

Fig. 31.—Homoptera. *Aphis maidi-radicis*, the corn root aphid. The form at the left is the winged form, that at the right is the wingless form. All of the plant lice have these two forms. This species, as well as other kinds of plant lice, is frequently attended by ants, which feed on the honeydew produced by the aphids. Actual length less than 0.1 inch.

except for lack of wings and sexual characters, which gradually develop as the insects approach the adult or mature stage, when development is complete.

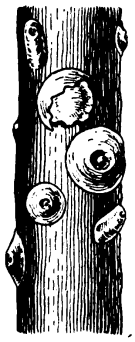

Fig. 32.—Homoptera. *Aspidiotus perniciosus*, the destructive San José scale. Note "scale" cut away on upper specimen to show insect proper beneath. Diameter less than 0.1 inch.

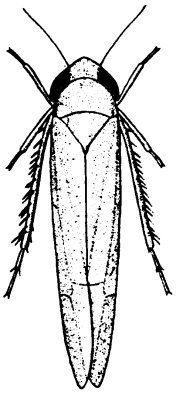

Fig. 33.—Homoptera. *Empoasca fabae*, the potato leafhopper. Actual length about 0.1 inch. This species is pale green. Other species are distinguished by bright red or yellow markings.

This order includes a very large number of economic pests, such as the aphids, scale insects and leafhoppers. Many aphids have a pair of tubular structures near the end of the body; these are called cornicles and can be seen in fig. 31, of the corn root aphid, *Aphis maidi-radicis* Forbes. Scale insects usually form a tough scale to cover and protect the delicate body of the insect, as shown in fig. 32 of the destructive San José scale, *Aspidiotus perniciosus* Comstock. Leafhoppers of many kinds, such as *Empoasca fabae* (Harris), fig. 33, are among the destructive pests of beans, potatoes, grapes, apples and other plants. The cicadas, tree hoppers, spittle bugs and lantern flies also belong to this order.

Mallophaga Chewing Lice — Wingless, flattened insects with short antennae, short legs, inconspicuous mouthparts and no tails on the posterior end of body. They are found exclusively on the bodies of birds and animals. The young have the same general shape and habits as the adults and are found with them. Individuals of most of the species move about with considerable rapidity. Many of them are very prettily banded and colored, as is the chicken head louse, *Lipeurus heterographus* Nitzsch, fig. 34. Anyone who has worked with domestic fowl or animals has seen members of this order scurrying along the feathers or hair. These insects feed on what they can chew from the surface of the skin and in some cases are known to injure their hosts.

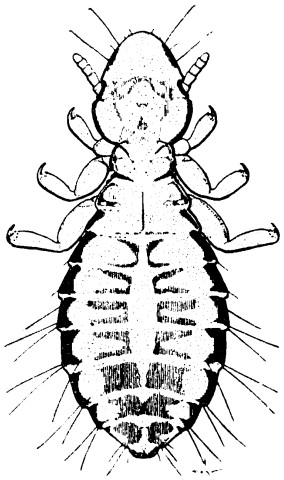

Fig. 34.—Mallophaga. *Lipeurus heterographus*, a chewing louse found on the heads of poultry. Actual length about 0.1 inch.

Anoplura
Sucking Lice

Somewhat flattened, wingless insects with essentially the same habits as those of the above order except that with their mouthparts, fitted for sucking, they suck the blood from their animal hosts. Characteristic of this order are the stout claws at the end of the legs of the horse louse, *Haematopinus asini* Linnaeus, shown in fig. 35. No Illinois birds are known to harbor this group, that attacks most farm animals.

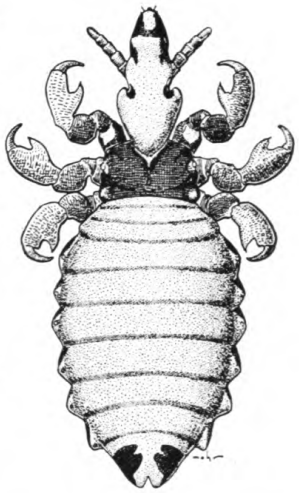

Fig. 35.—Anoplura. *Haematopinus asini*, the blood-sucking horse louse. Actual length 0.1 inch. Other kinds attack other animals.

Thysanoptera
Thrips

Small, active insects, usually about one-eighth inch long, rarely a quarter inch long, very slender, usually with two pairs of very slender wings and with the underneath side of the head forming a sharp, conelike, sucking structure. The wings have a long fringe on the hind margin and the front wings may have one or two veins running the length of the wing. The young of these insects are somewhat similar to the adults but are softer bodied. Fig. 36 shows an adult of *Thrips tabaci* Lindeman, the onion thrips. Thrips suck the juice from plants. They are seldom noticed because of their minute size, but they can be collected in large numbers from blossoms of almost any plant. A few of them, such as the onion thrips and privet thrips, attack agricultural or horticultural plants and inflict considerable damage.

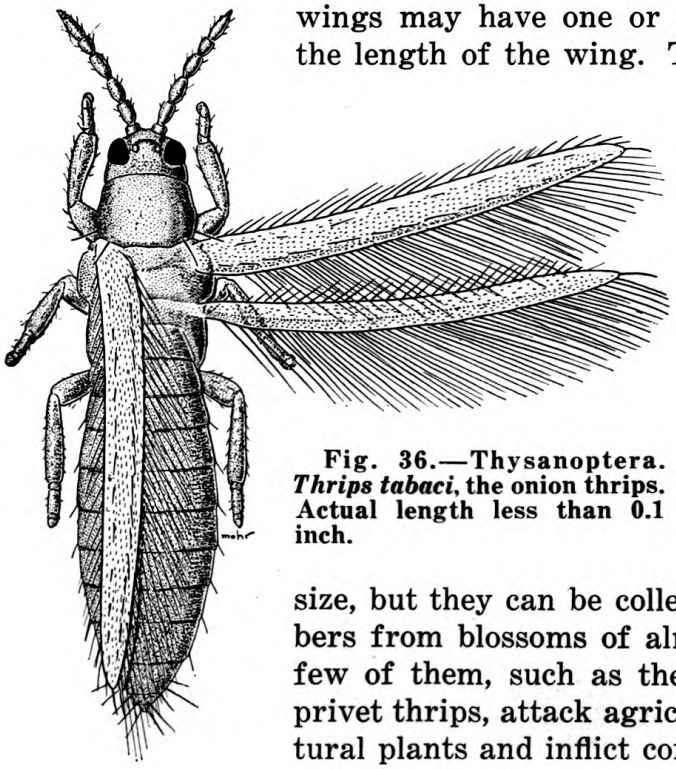

Fig. 36.—Thysanoptera. *Thrips tabaci*, the onion thrips. Actual length less than 0.1 inch.

Coleoptera
Beetles,
Weevils

These are insects with two pairs of wings, the second pair delicate and folded under the first pair, which are hard and thickened and folded back over the body, touching each other at the edges to form a hard shell, as shown in *Copris minutus* (Drury), fig. 37. The upper wings are not used for locomotive purposes, but form part of the body armor and are

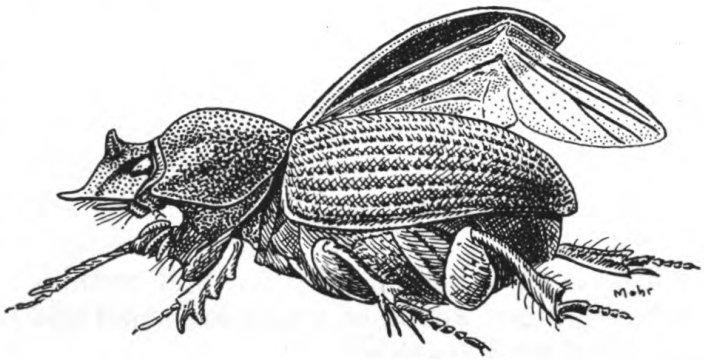

Fig. 37.—Coleoptera. *Copris minutus*, one of the stag beetles. Note one of the elytra exposed and the method of folding the hind pair of wings under them. Actual length 0.4 inch.

called *elytra*. In most beetles they cover the entire posterior part of the body, as in *Diabrotica longicornis* (Say), fig. 38; in many others they are abbreviated and cover only part of the abdomen. The immature stages of the beetles are wormlike or grublike, with a great variety of food habits. Some of them defoliate leaves, others attack roots and still others feed on other insects.

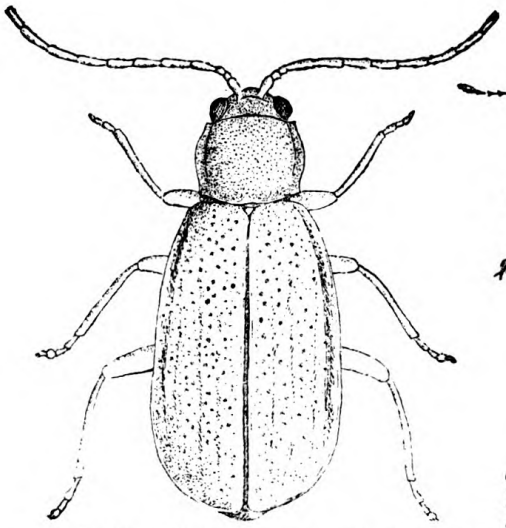

Fig. 38.—Coleoptera. *Diabrotica longicornis*, the corn rootworm. Actual length 0.2 inch.

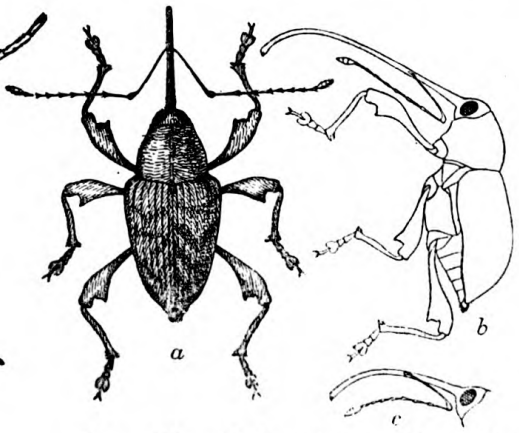

Fig. 39.—Coleoptera. *Curculio caryae*, one of the hickory weevils. Note the beak. In this group it is exceptionally long. In most of the Illinois weevils, the beak is shorter and stouter. Female, *a* and *b*; male head, *c*. Actual length 0.4 inch.

A great many of the serious insect pests, including kinds that attack field crops, stored products and household goods, are beetles. Beetles of one group that has the front of the head produced into a snoutlike structure, as *Curculio caryae* (Horn), fig. 39, are called weevils or snout beetles. This group has maggotlike larvae and contains many of our worst pests, such as the plum curculio, cotton boll weevil, alfalfa weevil and clover weevil. Bizarre and striking forms occur in many beetle groups, notably among the scarab and long-horn beetles. The largest in Illinois is the rhinoceros beetle, *Dynastes tityus* (Linnaeus); the male, shown on the cover, has long projections on both head and thorax; the larva lives in rotten wood.

Tree-boring beetle larvae are destructive to many orchard, ornamental and native trees. These include chiefly the round-headed borers, adults of which are long-horn beetles; flat-headed borers, adults of which are usually flat and metallic; and engraver or shot-hole types, adults of which are small and bullet shaped, and are called bark beetles.

A few families of beetles have both the adults and larvae fitted for aquatic life. Well known among these are the shining whirligig beetles.

Neuroptera Lacewing Flies and Their Allies — Insects with two pairs of wings, both about the same size and shape and intricately netted with veins. Antennae long and slender, mouthparts fitted for chewing, posterior end of the body without tails. The green lacewing flies of the genus *Chrysopa*, fig. 40, are our commonest members of this order. The young of this order are entirely

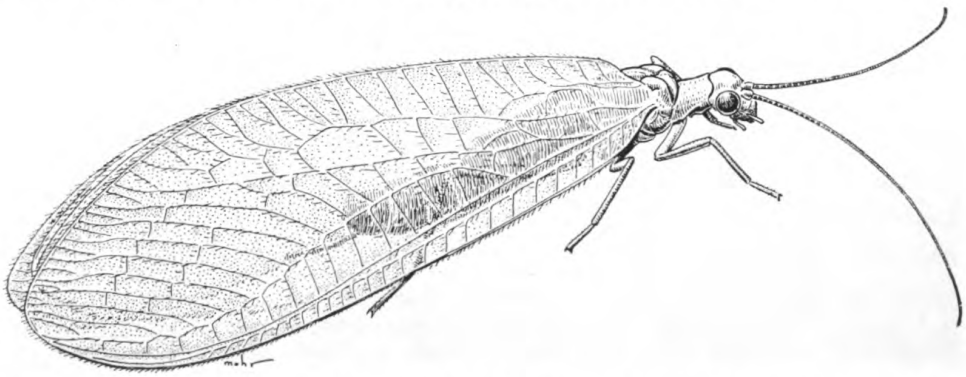

Fig. 40.—Neuroptera. *Chrysopa nigricornis*, a green lacewing fly. When handled, members of this genus give out a very penetrating and disagreeable odor. Actual length 0.6 inch.

unlike the adults and are grublike in form. They are called larvae. The aphid lion, the interesting larva of *Chrysopa*, fig. 41, is frequently taken in sweeping. Another interesting larva of this order is the doodlebug or ant lion, of Huckleberry Finn fame. The adult flies which mature from these ant lion larvae are very similar in appearance to the Chrysopid or lacewing flies. The larva of each of these flies sinks its long, sharp, curved mandibles into the body of its prey and sucks out the body juices.

The female *Chrysopa* has the curious habit of forming a long, slender stalk under each egg; the bottom of the stalk is fastened to the upper side of a leaf. The stalks are thought to have the effect of keeping the first larvae of a hatch from devouring the eggs placed nearby.

When the larva is mature, it spins a globular, silken cocoon or cell around itself and in this changes into a pupa, or resting stage. While the pupa itself does not appear active, within it the larval tissues are reorganized into the structures of the adult, including wings and reproductive organs. When this change is completed, the adult insect emerges from the cocoon.

This order, the Coleoptera and all the following orders in this publication differ from the other insect orders in having a pupal stage.

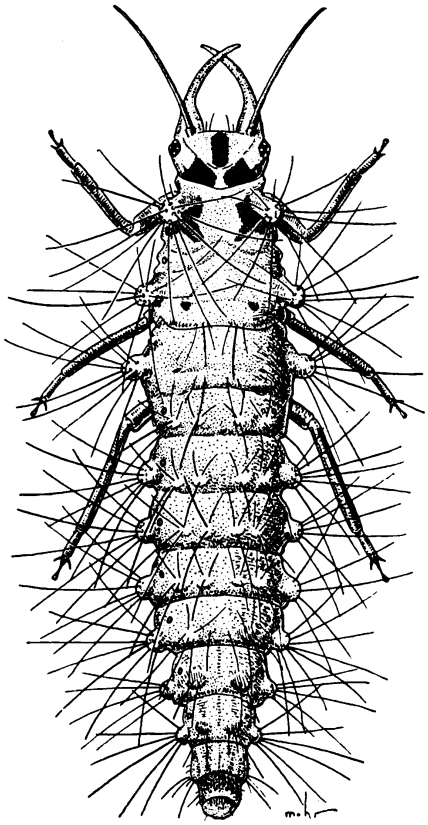

Fig. 41.—Neuroptera. A larva of the genus *Chrysopa*. This form uses the long jaws to impale aphids and suck their body juices.

Megaloptera
Alder Flies,
Dobson Flies

Insects similar in general appearance and characters to the Neuroptera. They have long antennae, two pairs of similar and finely netted wings, chewing mouthparts and immature stages unlike the adult. All our Illinois representatives of this order have immature stages which live in streams or lakes. Typical of their appearance is the alder fly, *Sialis*, whose

adult and larva are shown in figs. 42 and 43. Well known to the fisherman is the hellgrammite, the tough, ferocious, leathery larva found under rocks in streams and prized for bait. This

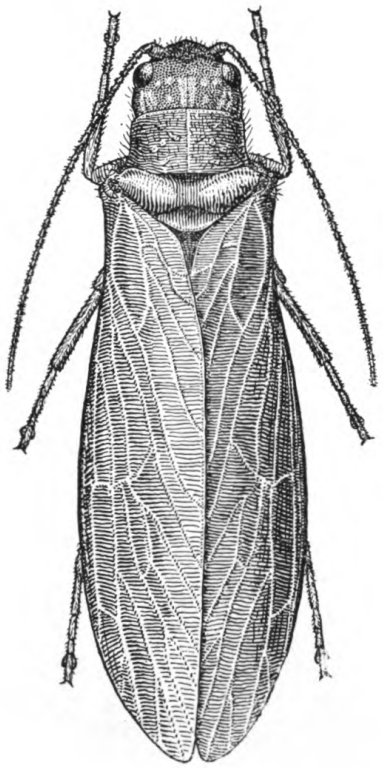

Fig. 42.—Megaloptera. The adult of *Sialis mohri*, an alder fly. Actual length 0.5 inch. Other members of this order reach a length of 1 or 2 inches. They are mostly black, black and white or mottled gray in color.

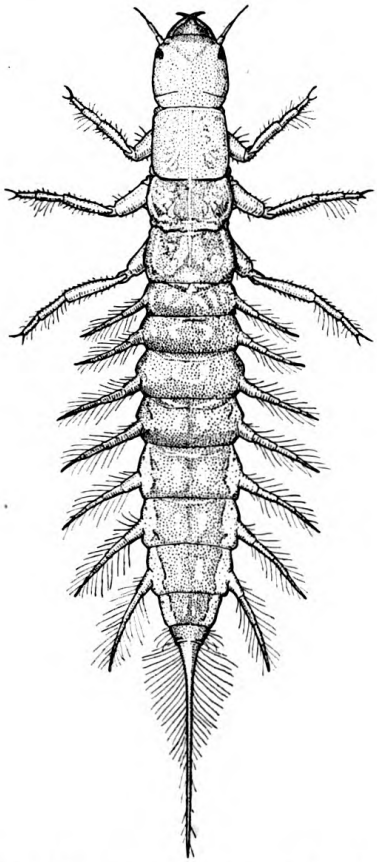

Fig. 43.—Megaloptera. The larva of a species of *Sialis*. This form is aquatic.

larva belongs to the order Megaloptera and matures into the large dobson fly, *Corydalis cornuta* (Linnaeus), which often attains a wing spread of 4 inches.

Mecoptera
Scorpion Flies

Insects of this order have two similar pairs of delicate wings, each with a medium network of veins. In repose the wings are laid almost flat over the back. The mouthparts are fitted for chewing and usually are lengthened into a beaklike structure, as in *Panorpa chelata* Carpenter, fig. 44. The larvae, seldom found, breed in damp woods. The adults, usually 0.5 inch long, are active in

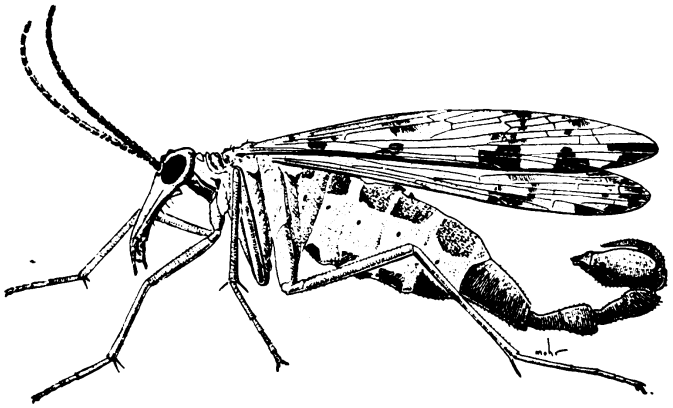

Fig. 44.—Mecoptera. *Panorpa chelata*, one of about 15 Illinois species of scorpion flies. Actual length about 0.5 inch. Note the "scorpion" tail; only the male has this.

early summer in shady woods, flying through the undergrowth. In certain genera the adult male genitalia form a bulblike structure at the end of the body, as in fig. 44; this is harmless but resembles a scorpion's sting, and it is this resemblance that gives these insects the name scorpion flies.

Hymenoptera
Bees,
Wasps,
Ants,
Sawflies

Insects with two pairs of wings, antennae of various lengths, chewing mouthparts; without tails. A typical member of this group is the wasp, *Vespa maculata* Linnaeus, fig. 45. Many adult members of the group lack wings; these include all the true ants, which are without wings except for the sexual forms produced at the time of the nuptial flights. Forms of one species, *Lasius interjectus* Mayr, are shown in fig. 46. The wings, when developed, are without scales, with the venation much less extensive than

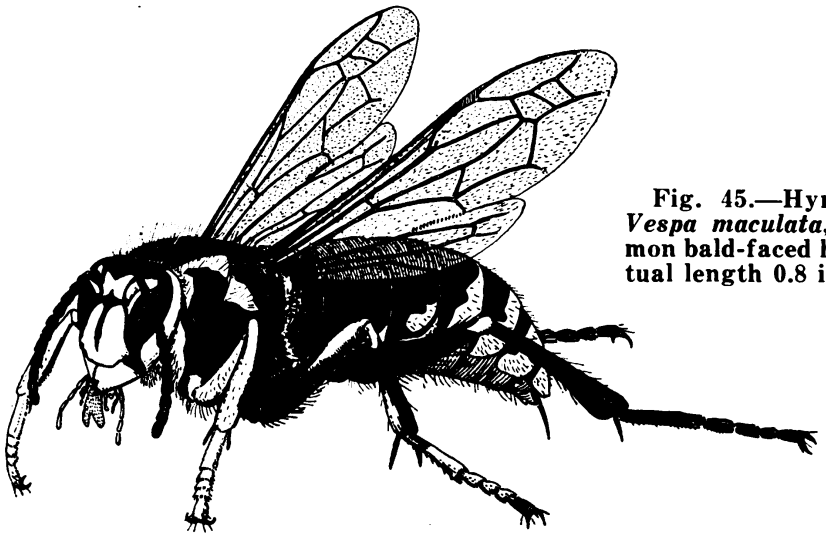

Fig. 45.—Hymenoptera. *Vespa maculata*, the common bald-faced hornet. Actual length 0.8 inch.

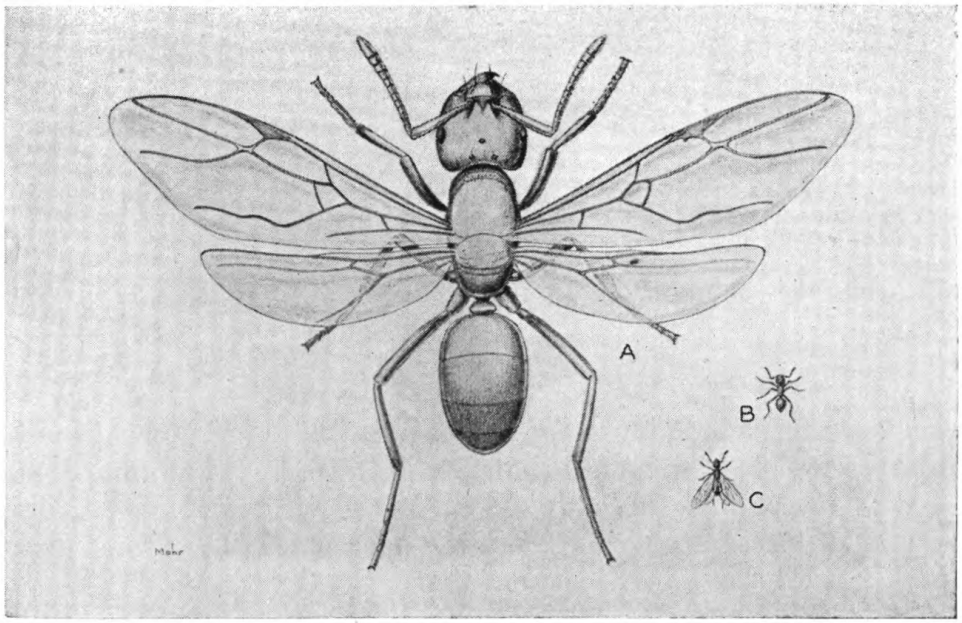

Fig. 46.—Hymenoptera. *Lasius interjectus*, a harmless winged ant, the yellow ant, with which the winged termite is often confused. *A*, queen with wings spread, many times natural size. *B*, worker ant, natural size. *C*, queen, natural size, with wings partially closed and as usually seen. The ant has a narrower waist and shorter wings than the termite. Actual length of queen about 0.3 inch.

in the Neuroptera and with the hindwings different in shape and size from the frontwings. The young stages of the Hymenoptera are caterpillarlike or grublike, entirely different from the adults. This very large order includes such well-known forms as the bees, wasps and ants. In addition, it includes the sawflies, whose caterpillarlike larvae are extensive defoliators of a large number of native and cultivated plants and shrubs; the large and varied groups of parasitic wasps which exert great influence in the natural control of a tremendous number of other insects; and a large number of gall-making wasps, whose galls are espe-

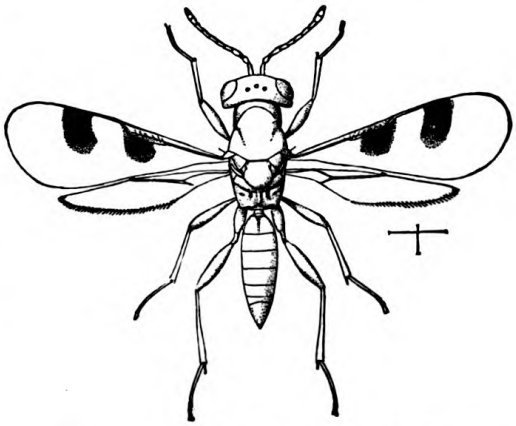

Fig. 47.—Hymenoptera. *Cheiropachys colon*, a parasitic wasp that victimizes one of the bark beetle larvae. Actual length about 0.1 inch.

cially conspicuous on oak trees. A parasitic wasp, *Cheiropachys colon* (Linnaeus), is shown in fig. 47. The parasitic wasps are extremely diverse in size, shape and habits. They range in size between 0.02 and 2.0 inches.

Trichoptera Caddis Flies — Insects with two pairs of wings, poorly developed mouthparts of the chewing type and long antennae; without tails on the posterior end of the body. In repose, the wings are held rooflike over the body and have only a moderate number of longitudinal veins, which are not connected by cross veins into any resemblance of a network. Neither body nor wings are covered with scales. The

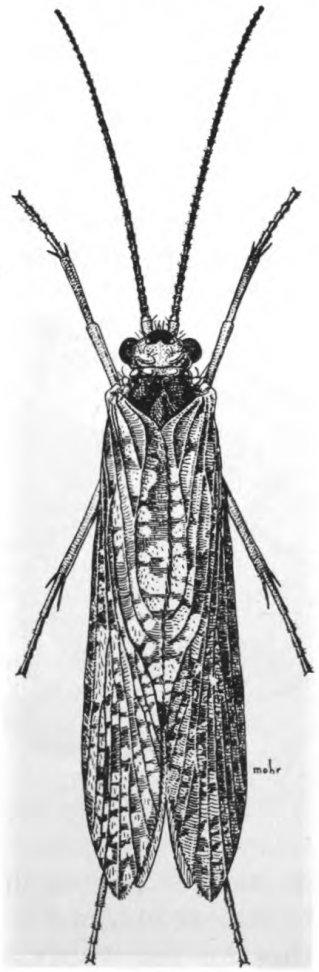

Fig. 48.—Trichoptera. *Rhyacophila fenestra*; the adult form of this caddis fly is shown here. Actual length about 0.4 inch.

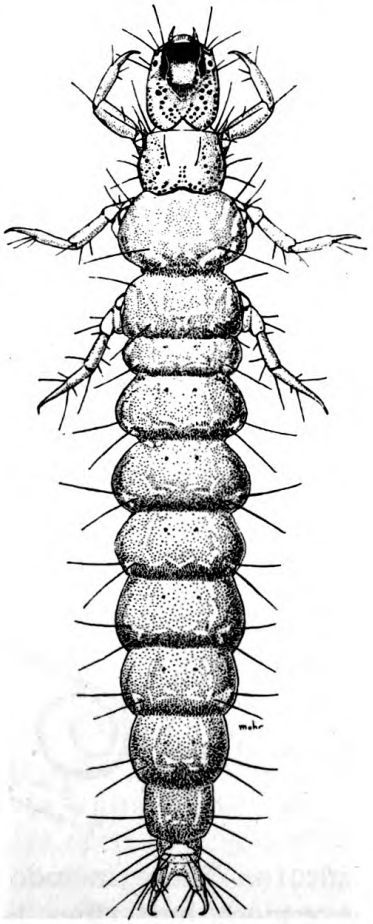

Fig. 49.—Trichoptera. *Rhyacophila fenestra*; the larva, shown here, is aquatic and builds no case. The larvae of some other kinds of caddis flies live in cases made of sticks and stones.

larvae are wormlike and they live in streams, ponds and lakes. Many of them build cases of sticks, stones or sand and move about with only the front end of the body protruding from the case. When disturbed, the larvae withdraw completely into the cases and are then very difficult to see. The adult fly and larva of *Rhyacophila fenestra* Ross illustrate this order, figs. 48 and 49. In many aquatic situations, caddis flies are the predominant small animal life and are an important factor in fish food economy. Also, they are stream pollution indicators.

Lepidoptera Butterflies, Moths — Insects with two pairs of wings, long antennae, and with mouthparts forming a long sucking tube. The body and wings are covered with a dense mass of scales, characteristic for this order, fig. 50. The young are known as caterpillars or grubs. The larval stage in this order is well exemplified by one of the cabbage webworms, *Hellula undalis* Fabricius, fig. 51. Some other larvae are hairy; still others are sluglike.

To this order belong not only a very large number of species, but also a very large number that are especially injurious to agriculture. These include such species as the codling moth, cabbage moth, butterflies, the entire cutworm group, and a host of others. In addition, the various clothes moths, which are a constant source of loss to householders, and various species of meal moths, which cause tremendous damage to stored grain every year, are members of this order.

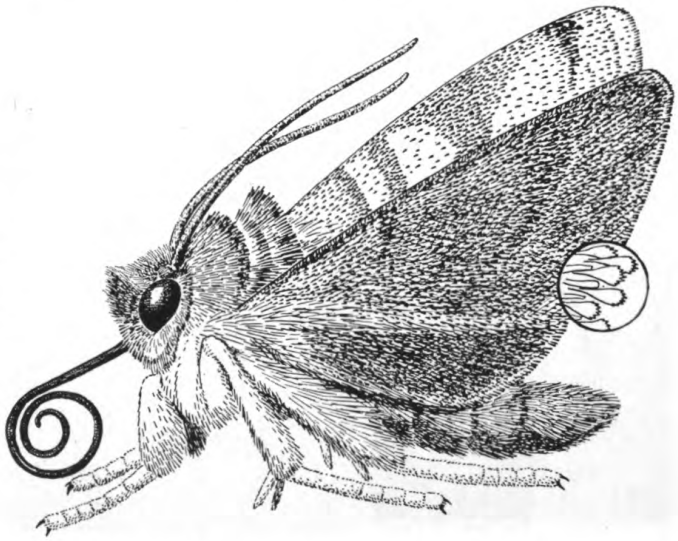

Fig. 50.—Lepidoptera. A typical moth showing scales on wings and body, and the sucking tube, which is coiled up under the head when not in use. Species of this order occurring in Illinois include specimens that vary in size from 0.1 inch to several inches. The largest of these insects have a wingspread of over 5 inches.

In one group of moths, there are clear "windows" on the wings, but these are always surrounded by areas or lines of scales. One or two species of the Lepidoptera are very odd in having wing-

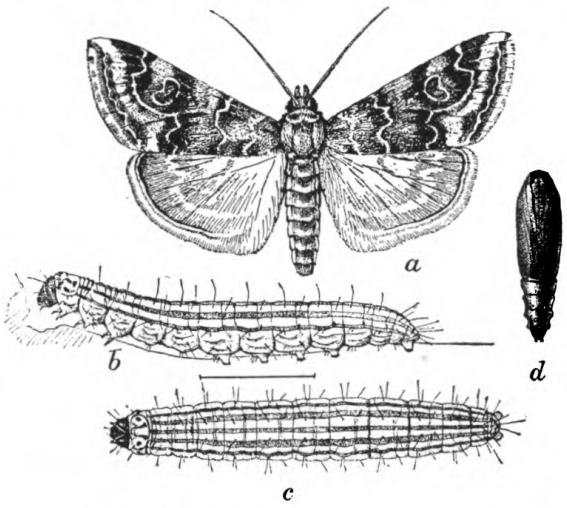

Fig. 51.—Lepidoptera. *Hellula undalis*, one of the cabbage webworms; *a*, adult; *b*, larva, side view; *c*, larva, top view; *d*, the pupa or resting stage from which the adult emerges. The actual length of the adult insect is about 0.3 inch; its wingspread is about 0.8 inch.

less females. Examples are the bag worms and some of the cankerworms. In these species, however, the body of the female is densely clothed with scales, which will serve to identify her as one of the Lepidoptera.

The habits of Lepidoptera larvae are very diverse. Most of these larvae are leaf eaters, but some bore into trunks of trees and stems of plants. Some of the small ones mine within leaf tissue, others live in the ground, where they eat roots, and a few are aquatic, living in clear, rapidly flowing streams.

Diptera Flies, Mosquitoes and Their Allies — Insects with only *one pair of wings*, these with only a limited number of veins. Other characters of the order, including antennae and mouthparts, are extremely varied. Most immature stages are wormlike or maggotlike and always live in some protected situation such as within the tissues of a plant, in water, in leaf molds or in the tissues of animals. A typical life cycle is that shown for the common onion maggot, *Hylemyia antiqua* (Meigan), fig. 52. The ubiquitous housefly is undoubtedly the best known representative of this order. It is also one of our most persistent and dangerous insect pests, when its record as a possible carrier of many diseases and internal parasites is considered.

Mosquitoes, punkies, blackflies and horseflies are equally well-

known members of this order. Mosquitoes are probably the most annoying single group of insects. In addition to economic forms, the order Diptera includes midges, craneflies, beeflies,

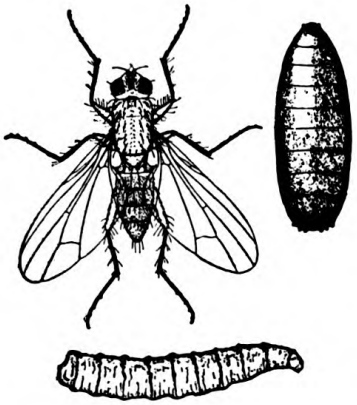

Fig. 52.—Diptera. *Hylemyia antiqua*, the onion maggot. Note the fly with only a single pair of wings, the maggotlike larva without legs, and the darker, egg-shaped pupa or resting stage. The larvae feed on the roots, bulbs and stems of the onion plants, and the pupae are formed in the soil around the roots. The adult flies emerge and lay eggs at the base of the plants or in nearby cracks in the soil.

robber flies, bluebottle flies and a great assortment of other different kinds of insects.

Interesting are the beeflies, which mimic other insects such as honeybees, bumblebees and wasps to an extent that wins them immunity from the attention of many beginning collectors.

Siphonaptera
Fleas

Wingless insects that are conspicuously flattened sideways; with stout, spiny legs and with numerous spines over the body; without conspicuous antennae or tails or a forked posterior appendage like that of the springtails; usually hard; ranging in color from yellowish brown to almost black. The cat and dog flea, *Ctenocephalides canis* (Curtis), is shown in fig. 53. All the fleas, which

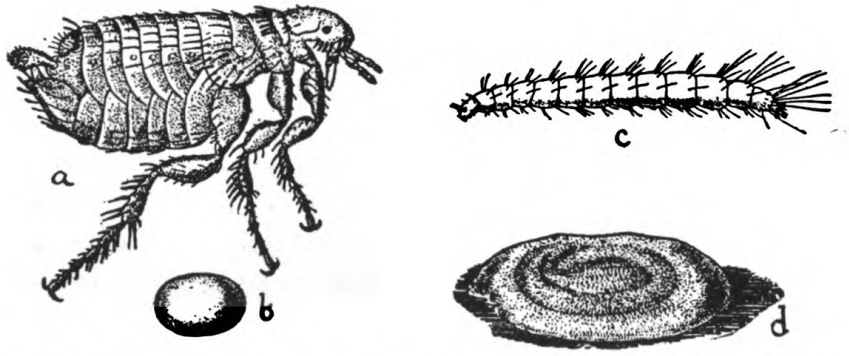

Fig. 53.—Siphonaptera. *Ctenocephalides canis*, dog and cat flea: *a* shows the adult; *b*, the egg; *c*, the wormlike larva; and *d*, the pupa. Actual length of adult about 0.1 inch.

feed on the blood of birds and other animals, have sucking mouthparts. They are powerful jumpers. The young stages are slender, white worms, which live in the nests of various animals; these larvae are seldom collected. The fleas are found on the animals themselves or around their nests. Several species of fleas, including the cat and dog flea, the human flea and the rat fleas, attack man. One of the rat fleas, *Xenopsylla cheopis* (Rothschild), is of especial importance because it is the transmitter of bubonic plague.

USEFUL BOOKS

There is a considerable number of books which can be of great help to the beginner in naming his specimens. The following are perhaps the most easily used. Others are being published from time to time.

Comstock, J. H. An Introduction to Entomology. The Comstock Publishing Company, Ithaca, N. Y. $6.00.

Holland, W. J. The Butterfly Book. Doubleday, Doran & Company, Garden City, N. Y. $10.00.

Holland, W. J. The Moth Book. Doubleday, Page & Company, Garden City, N. Y. Out of print but may be obtained from second hand book dealers; original price $6.00.

Lutz, Frank E. Field Book of Insects. G. P. Putnam's Sons, New York, N. Y. $3.50.

Hebard, Morgan. The Dermaptera and Orthoptera of Illinois. Illinois Natural History Survey, Urbana, Ill. $1.00.

Metcalf, C. L., and W. P. Flint. Destructive and Useful Insects. McGraw-Hill Book Company, 370 Seventh Avenue, New York, N. Y. $7.50.

Morgan, Ann Haven. Field Book of Ponds and Streams. G. P. Putnam's Sons, New York, N. Y. $3.50.

HOW TO SHIP A COLLECTION

Specimens which the collector is unable to name should be sent to specialists or entomological museums for determination. The arrangements under which these specialists will undertake the work vary, but experts often will study well preserved and labeled collections in return for duplicate specimens which they may keep. However, the identification of many insects is so difficult and laborious that rapid service is not always to be expected by collectors sending in material.

The collection needs special preparation and care to guard

against breakage if it is to be shipped to an authority for determination.

See that all pins are thrust securely into the cork on the bottom of the box. Thrust extra pins of the same height in each corner and over the whole lay a piece of thin cardboard which has been cut to fit the inside of the box snugly; then place over this a layer of cotton wool or cellucotton thick enough to press firmly against the cardboard when the top is closed. Wrap the box in paper and then pack it in a larger box, protected on all sides by a layer of excelsior or crumpled paper at least 2 inches thick.

WHERE TO BUY SUPPLIES

The following list, by no means complete, contains names and addresses of companies that furnish entomological supplies. Most of these companies will send catalogs and price lists on request.

Bausch and Lomb Optical Company. 626 St. Paul Street, Rochester, N. Y.

Central Scientific Company. 1700 Irving Park Boulevard, Chicago, Ill.

General Biological Supply House, Inc. 761-763 East Sixty-ninth Place, Chicago, Ill.

Ernest Leitz, Inc. 730 Fifth Avenue, New York, N. Y.

E. H. Sargent and Company. 155-65 East Superior Street, Chicago, Ill.

Spencer Lens Company. 25 Doat Street, Buffalo, N. Y.

Ward's Natural Science Establishment, Inc. P. O. Box 24, Beechwood Station, Rochester, N. Y.