COMPENDIUM OF ENTOMOLOGICAL METHODS

PART II

NOTES ON COLLECTING AND PRESERVING ORTHOPTERA

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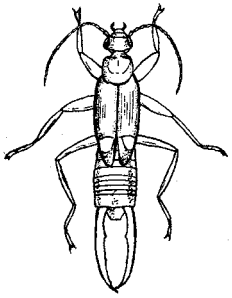

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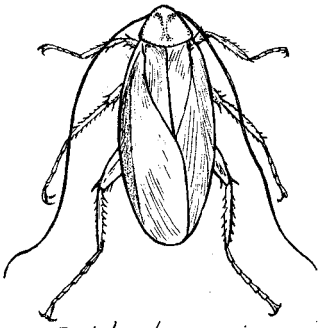

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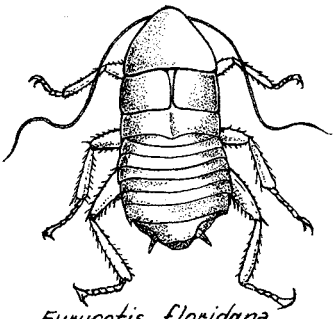

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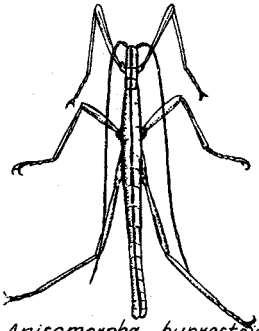

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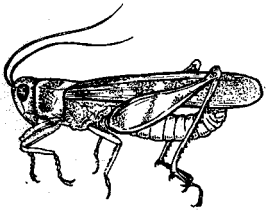

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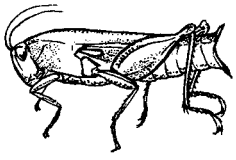

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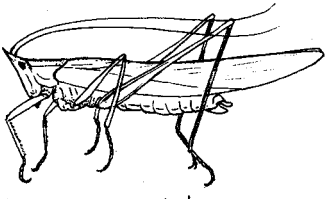

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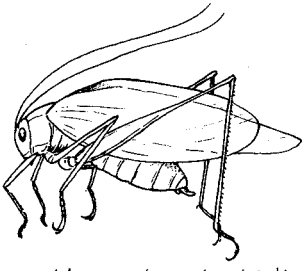
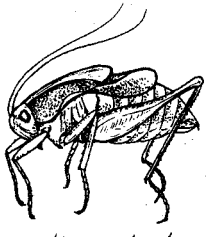
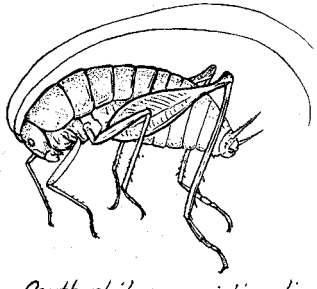


Amblycorypha rotundifolia



Atlanticus testaceus

Stenopelmatus fuscus



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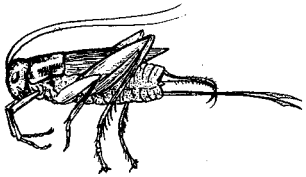
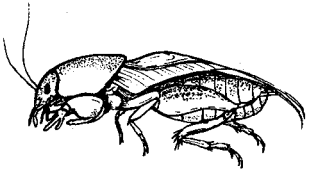


Gryllulus assimilis



Scapteriscus acletus

Some examples of diversity of form in the Orthoptera and Dermaptera. Vostox, an earwig; Periplaneta and Eurycotis, cockroaches; Stagmomantis, a mantid; Anisomorpha, a walking stick; Tettigidea, a grouse locust; Camnula, a locust; Amblycorpha, Neoconocephalus and Atlanticus, katydids; Stenopelmatus and Ceuthophilus, cricket-locusts; Gryllulus and Scapteriscus, crickets.

NOTES ON COLLECTING AND PRESERVING ORTHOPTERA

FOREWORD

The avowed purpose of the *Compendium of Entomological Methods* is to present a series of articles dealing with special methods for collecting and preparing for study the various orders of insects. Each article will be written by an expert on the specific group with which it deals. The sections are being issued separately in the present form and will be distributed free of charge to all interested entomologists requesting them.

The first section, already published, dealt with the *Ephemeroptera* (Mayflies) and was written by Jay R. Traver, Ph.D., Massachusetts State College. The present section is on *Orthoptera* and future issues now in line for publication will deal with *Mallophaga, Zoraptera* and *Coleoptera* respectively.

We wish to acknowledge here our gratitude to Dr. Cantrall and his colleagues for the excellent work they have done on the present section of the *Compendium*. Not only ourselves but the entire entomological fraternity are indebted to them for compiling and describing the numerous methods in use by Orthopterists.

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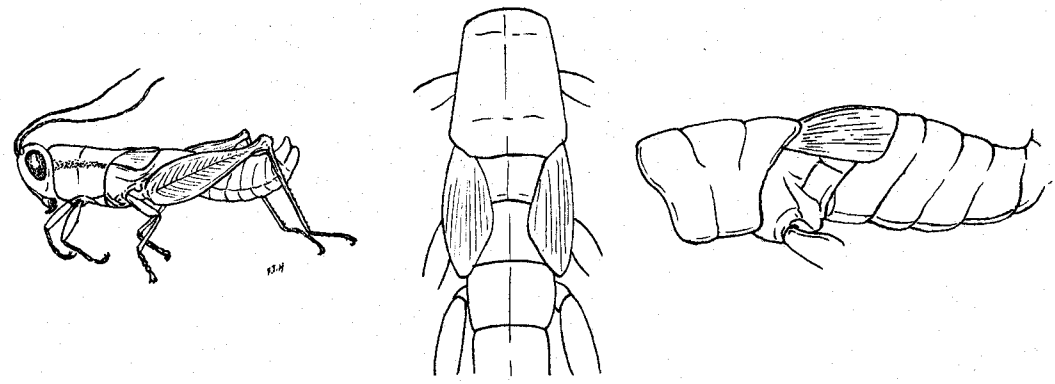
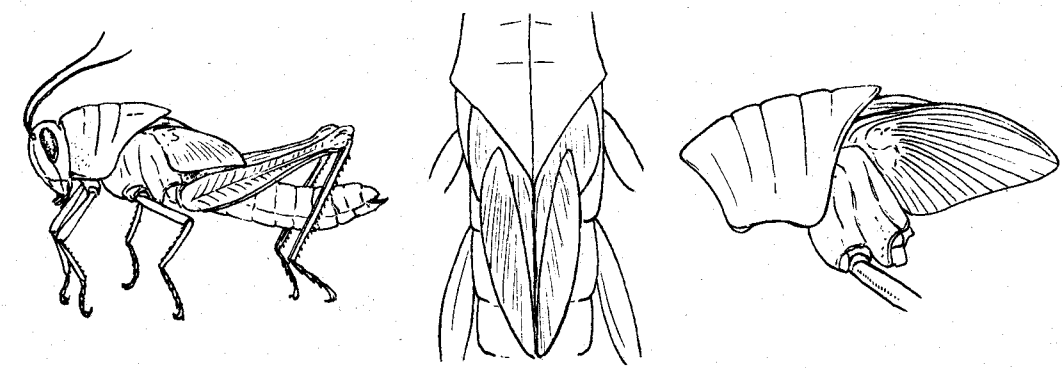
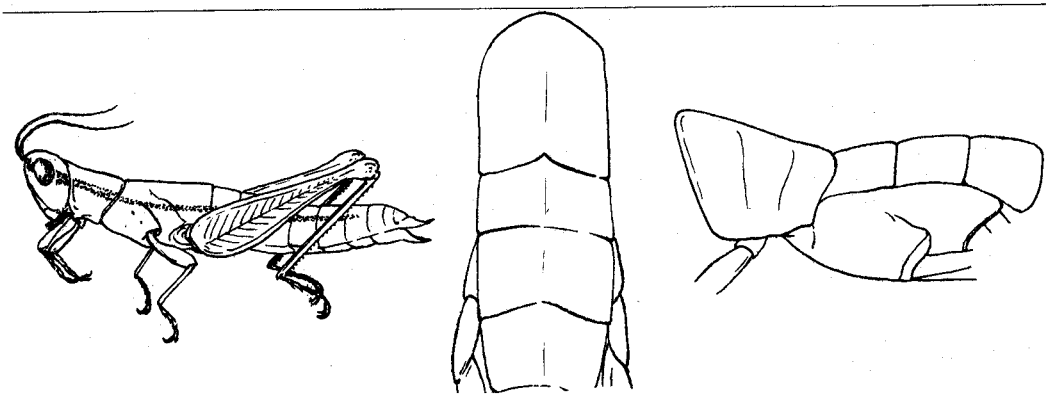


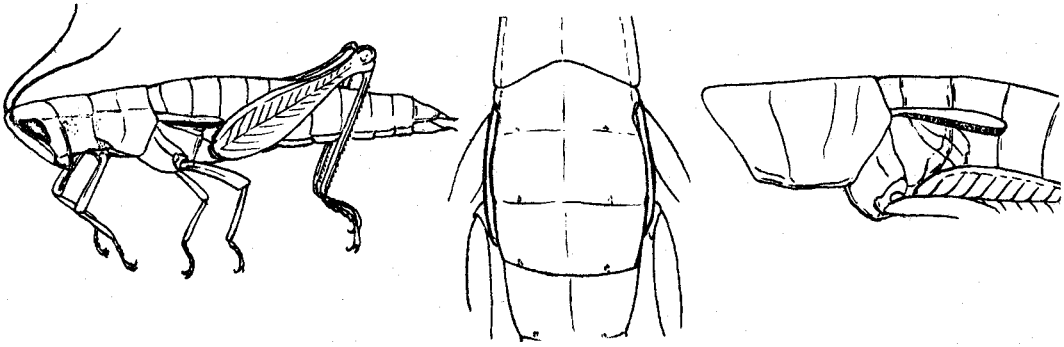
The tegmina of adult individuals of Melanoplus rotundipennis are reduced to mere lateral pads.



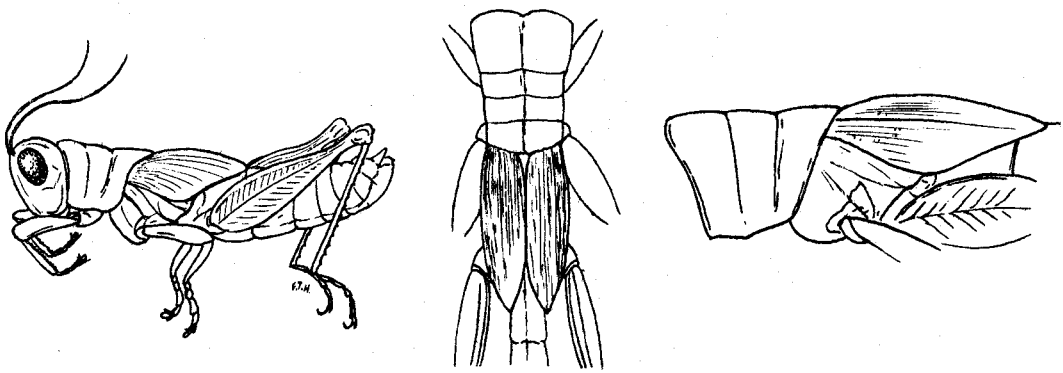
Schistocerca sp. when adult has fully developed wings. Nymphs of alate species, as here illustrated, may be recognized by a general softness of the body and by the overlapping of the fore wing pads by the hind wing pads.



Gymnoscirtetes pusillus, a completely wingless species of grasshopper.



The adults of some forms of the genus Aptenopedes are completely apterus; others have narrow, lateral, strap-like tegmina.



The tegmina and wings of Phoetaliotes are normally reduced, but macropterous individuals are occasionally found.

WHAT TO LOOK FOR

It is unfortunate that there is no single term in ordinary use (such as "beetles" for *Coleoptera* or "flies" for *Diptera*) which includes all the related insects grouped under the name *Orthoptera*. This is because the variety of form and habits within this order of insects is so great that the different types are obviously distinct and recognizable even to the untrained eye. In order to insure that no group of *Orthoptera* is

overlooked by the prospective collector, it is necessary to list a considerable number of common names (often local in application) by which they are known.

Blattidae: cockroaches, roaches, woodroaches, cucarachas.

Mantidae: praying mantids, mantises, praying insects, soothsayers, mule-killers, cortones.

Phasmidae: walking-sticks, stick-insects, twig-insects, fasmidos.

Acrididae: grasshoppers, short-horned grasshoppers, locusts (but not harvest-locusts—cicadas), colored-winged grasshopper, bird-grasshoppers, grouse-locusts, pygmy locusts, langostas, langostones, voladores, saltonas (usually applied to the young of larged winged forms), saltamontes.

Tettigoniidae: katydids, cackle-jacks, meadow-grasshoppers, long-horned grasshoppers, green grasshoppers, cone-heads, bush-katydids, shield-backs, mormon crickets, coulee crickets.

Gryllacrididae: cricket-locusts, camel-crickets, cave-crickets, sand-crickets, stone-crickets, babes-of-the-earth, ninas-del-tierra.

Gryllidae: crickets, field crickets, ground crickets, black crickets, bush crickets, tree crickets, green crickets, temperature crickets, mole-crickets, grillos.

All of the above are members of the order *Orthoptera.* For the sake of brevity and want of a better comprehensive term students of these insects often refer to the entire assemblage as "Orthops," or as "grasshoppers." Another group of insects which, for historical reasons, is usually studied by the same persons who study *Orthoptera,* is the order *Dermaptera,* or earwigs—small insects with elongate bodies terminating at the rear in a pair of forceps or pincers, and either wingless or with wings folded up beneath a pair of short, square-cut wing-covers similar to those of the rove-beetles.

WHERE TO LOOK FOR ORTHOPTERA

Tropical regions are richest in species of *Orthoptera,* the number of kinds diminishing northward and southward. However, even Alaska and Patagonia have some species, and the number of individuals of the species that are present in temperate and cold regions is often much greater than in the case of tropical forms. To illustrate the falling off in number of species as one moves north from the tropics, it is estimated that there may be in the neighborhood of one thousand species in Central America; Florida has 276; Michigan 137; and Alaska less than a dozen. Approximately 1,200 species and races of *Dermaptera* and *Orthoptera* are known from the United States and Canada, the *Dermaptera* making up but a small proportion of this number. While many of the species are widespread, a still larger proportion of the fauna is made up of forms with rather restricted ranges, so that each region possesses species not found elsewhere.

Orthoptera occur in almost every type of terrestrial environment, from the tops of the mountains to the lowest plains. Specimens may be sought for in the débris of the forest floor; beneath logs and stones; in hollow logs and under loose bark; in piles of leaves and débris at the edge of woods; and in the open; and in burrows and runways of various mammals and other vertebrates. Many of the grasshoppers prefer areas of bare or sparsely vegetated soil, or lichen-clad rock surfaces. Many species live in the midst of denser growths of vegetation—in grassy plains and savannas; in the emergent vegetation along the edges of lakes and streams; in marshes and swamps; in thickets of shrubbery; in open and in dense forests; on tree-trunks and even in the tops of the tallest trees. Some forms are confined to salt marshes along the sea-coast; others are characteristic of various types of desert habitat. Almost every type of situation will yield some members of the order, and so varied are the species in size, form, habitat and habits that many different methods of collecting must be employed in securing them.

COLLECTING EQUIPMENT

The Sweeping Net. For sweeping, catching swift-flying grasshoppers, and general collecting the most satisfactory type of net is one made up of the frame of a collapsible landing net such as is used by fisher-

men, and a bag constructed as described below. In this type of net the net-ring consists of two flat pieces of spring steel hinged at one end to a screw attaching the ring to the handle, and at the other bolted together through slotted flanges in such fashion that the two pieces of steel may be bent to form a somewhat oval shaped ring. The handle may be of cane and jointed for convenience of transportation, or may be of a single piece. A home-made handle of hickory or some other tough, resilient wood, tapered and balanced to suit the user, is most satisfactory. At the end of the handle is a ferrule threaded to receive the bolt attached to the net-ring. Some prefer a relatively short handle, to be held near the end while sweeping, but this puts a strain on the wrist which soon tires the user. For sweeping and catching swift-flying insects a long handle is preferable. The handle should be long enough so that the end will reach under the arm-pit when the net is being used for sweeping, and so that it may be swung by both hands in capturing wary grasshoppers when they alight. An excellent net of this type is sold by Ward's Natural Science Establishment, Rochester, N. Y., under the name *American Insect Net.* The durability of this net for sweeping can be increased by putting a pair of extra rivets in the holes near the base of the ring. However, any similar landing net frame of sufficient strength will serve equally well. The diameter of the ring should not be less than fourteen inches.

A type of net bag found by experience to be most satisfactory for collecting Orthops, may be easily and inexpensively made. It should be roundly conical in shape, with the tip not too much narrowed. In depth the bag should be twenty-four to twenty-six inches when hanging from the ring, shallow enough to allow the arm to reach the bottom easily, and long enough to permit the net to be closed by flipping the end over the edge of the net-ring, to prevent the escape of a captured specimen while the cyanide jar is being made ready. The most satisfactory bags are made of three materials—canvas, unbleached muslin, and either marquisette or voile. The upper portion of the net, by which it is attached to the ring and which receives the hardest wear, is made of a strip of canvas about six inches wide, which is folded in half lengthwise and sewed along the edges to form a tube which will slip loosely over each half of the flexible net-ring after the bolt connecting the two has been removed. The lower part of this canvas tube (the sewed edge) forms a continuous ring to which is attached the remainder of the bag; but a slot must be left in the tube at two opposite points—one to accommodate the attachment of the net-ring to the handle, and the other one to permit the two halves of the ring to be bolted together again after the net has been placed on the frame. A strip of unbleached muslin about seven inches wide is sewn to the bottom edge of the canvas tube, and to this is attached the apical portion of the bag, made of marquisette or voile. This part should be carefully shaped, and made in two (or better, four) segments or gores, the proper shape for which can be determined by experimenting with paper patterns. A small piece of canvas is sewed beneath each of the slots to prevent tearing down the sides of the net bag at these points.

This type of bag has several advantages over one made of bobinette or any single material. The canvas rim will survive a considerable period of hard use; the muslin is strong enough to protect the upper part of the net from thorns and briars; the contracted lower part of the bag, which gets somewhat less wear, is more flexible and transparent, yet fairly durable. Marquisette is strong, and has a weave open enough to be semi-transparent, yet close and tight enough to keep thorns from tearing large holes in the bag. Voile is not as strong nor as transparent, it does not become fuzzy with use, and its close weave permits it to slide over briars upon which the marquisette has a tendency to catch.

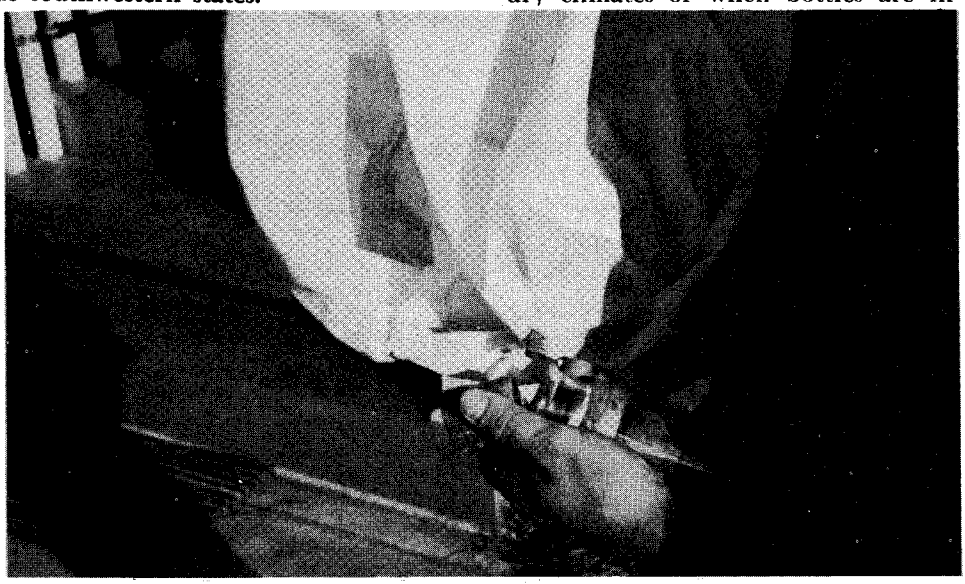
The Beating Net. For beating heavy brush, thorny scrub and trees it is necessary to use a much heavier type of net than that just described, because the lighter net will not penetrate such vegetation and will not long survive such punishment. No satisfactory net of this type is on the market, but one can easily be constructed by the collector. The net rim is made from a heavy steel rod about one-quarter inch in thickness, bent into a circle

with a diameter of fourteen inches, and with the two ends bent out ninety degrees from the circle so that they project parallel to one another and are of unequal lengths. About one-half inch at the tip of each of these straight ends is bent inward at a right angle. The handle is made by sawing off a hoe- or shovel-handle to a length of forty inches; it may be dressed down somewhat to fit the hand, but should be left quite heavy. Two grooves are cut in the end of the handle to accommodate the straight ends of the net-ring. A quarter-inch hole is drilled half an inch deep at the end of each slit to take the inbent tips, and a tight-fitting, metal ferrule is slipped over the straight ends of the net-ring after they have been fitted into place. The ferrule should be riveted to the handle.

The bag for this heavy net is of the same size and shape as that of the sweeping net, but below the canvas collar the entire net is made of unbleached muslin. Even a collar of heavy canvas soon wears through, and for hard use it has been found advisable to stitch a strip of saddle-leather to the part of the canvas that goes over the ring. Heavy beating with such a net is the only satisfactory method of obtaining many species that live in dense scrub in Florida and in the southwestern states.

Cyanide Jars. *Orthoptera* are for the most part best killed in cyanide jars. These may be made from any glass container, but in our experience the most convenient and satisfactory killing bottles are of two sizes —the larger made from 4 oz. wide-mouthed bottles with large corks, the smaller from 8 dram shell-vials. Screw-topped jars are not satisfactory, as too much time and effort are wasted in screwing and unscrewing the lids. Using cork-stoppered jars, the collector can soon learn to take the bottle from his pocket and remove the cork with the thumb and forefinger of the same hand which holds the bottle, leaving the other hand free to insert the specimen.

In charging bottles, about one-quarter of an inch of powdered or granulated sodium or potassium cyanide is placed in each. (Commercial sodium cyanide "eggs" powdered in a mortar are as satisfactory as purer forms of the chemical, and less expensive.) If strong, fast-killing bottles are desired it is best to mix with the cyanide a small portion of powdered citric acid (the amount which will stay on a dime is sufficient for the larger bottles). This increases the rapidity with which the hydrocyanic acid gas is evolved. In moist climates it may not be necessary, but in dry climates or when bottles are in con-



A collector can greatly facilitate the removal of an Orthop from the net by learning to open and close the cyanide jar with one hand. Taped bottles help to prevent breakage. The marquisette, muslin and canvas portions of the sweeping net may be seen in the upper right side of the illustration.

tinual use the citric acid greatly increases the efficiency of the bottle, though it also shortens its life.

The two powders are shaken together and their surface leveled by tapping the side of the bottle. The life of the bottle may be increased by putting one-quarter inch of fine sawdust on top of the cyanide-citric acid mixture. Three disks of blotting paper, cut to a size just slightly larger than the inside of the bottle (made by drawing a pencil line around the base of the bottle and cutting slightly inside it) are inserted one by one and carefully pushed down on top of the sawdust and cyanide. If they fit tightly friction holds them securely in place. After charging the bottle, strips of inch-wide adhesive tape should be criss-crossed over the bottom, a strip wound around the lower part of the side of the bottle covering the ends of the bottom strips, and a narrower strip placed around the shoulder of the jar. The presence of these tapes greatly reduces bottle breakage in the field.

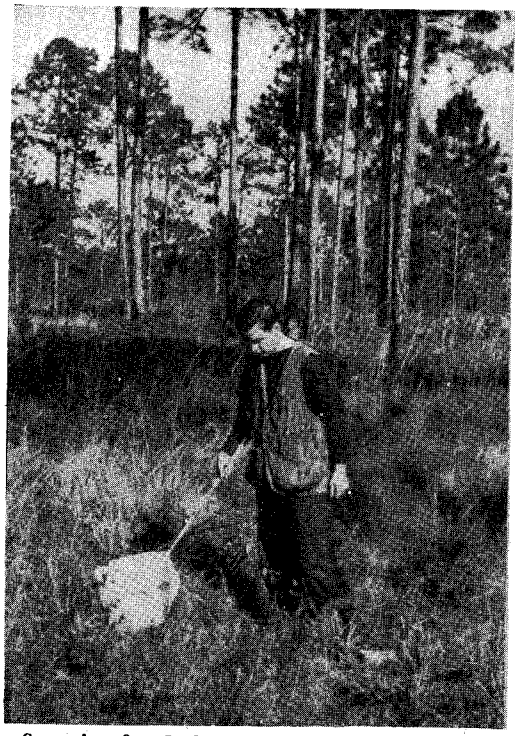
Cyanide jars may be used for *Orthoptera* so long as they retain their strength and the blotters in the bottom do not become saturated and discolored with deliquesced cyanide. (Cyanide will turn specimens brownish or reddish and cause them to disintegrate sooner or later.) It is occasionally necessary to wipe out the inside of the bottles with a moist rag to remove the sticky brown "grasshopper juice" with which they become smeared. Eventually they must be recharged. When this becomes necessary they are taken out of doors, uncorked and submerged in a pail of water. The blotters, sawdust and remains of the cyanide soon soak loose; the bottles are cleaned, rinsed, dried, and recharged. All used cyanide, cyanide-saturated sawdust and blotters, as well as broken cyanide jars, *should be buried at once.* Water used for cleaning cyanide jars should not be flushed into sewers or cesspools. There is little danger from breathing cyanide fumes when making the jars or cleaning them even when the smell of the gas is quite noticeable, provided the work is done in the open or in a large room. One should take great care, however, not to touch the mouth with hands or other objects during the process, and to wash the hands and all utensils used when finished.

Collecting Jacket. A very serviceable piece of equipment is a sleeveless summer-weight hunting jacket with numerous pockets; one without shell-loops is preferred, though some collectors use the loops for carrying alcohol vials and small cyanide bottles. The jacket is light, loose and comfortable, and enables one to carry an ample supply of cyanide jars, vials of alcohol, notebook, forceps and other equipment without inconvenience. A home-made canvas belt with pockets is preferred by some, but is less capacious and makes an awkward bulge around the waist. A bag suspended over the shoulder by a strap may also be used, but is too small and has the disadvantage of swinging around in front of the collector when he tries to kneel or crawl. Other useful items of equipment are described in connection with special collecting methods.

COLLECTING METHODS [1]

Sweeping. In sweeping for Orthoptera the problem of how to handle an insect net so that maximum control and power of sweep may be attained with the least physical effort is soon apparent to any collector. A person grasping and moving a net as one would a broom (see figure *Ward's Combined Entomological and Natural Science Bulletin,* XIII (3), November 1939), especially when great force is required in sweeping thru heavy vegetation, will soon find that the net is difficult to control and that the awkward position of the hand and arm sustaining the upper portion of the net handle will cause great fatigue of the arms and shoulders. It has been found from long experience that if the net handle is placed under the right arm pit, the right elbow, forearm and hand allowed to lie close to and parallel with the handle and with the left hand grasping it slightly lower, that one can sweep for long periods without undue exhaustion. The swing

[1] Many of these collecting methods have been worked out and used over a twenty-year period by Dr. T. H. Hubbell, Department of Biology, University of Florida. Acknowledgment is gratefully extended to Dr. Hubbell for his having read, criticized, and approved the manuscript.



Sweeping for Orthoptera in a Florida flatwoods. Power of sweep may be increased by swinging the body behind and with the stroke. The pockets of the collecting jacket are capacious and accessible.

The left arm, held rigid and straight, steadies and controls the return sweep. Note the position of the net handle in relation to the right arm.

from the right to the left is usually performed without the left hand grasping the net handle. The entire weight of the body may be turned with and thrown behind the force of the swing. On the return the left hand firmly grasps the handle and by holding the left arm rigid a powerful, well controlled swing is brought thru from left to right.

Sweeping in this manner, the collector walks back and forth across an area swinging the light-weight net back and forth so that it brushes thru or over the vegetation; backhand and forehand strokes follow without interruption, the net being turned at the end of each stroke, and the process continued until the collector wishes to inspect his catch. This simple technique may be modified in various ways according to circumstances. Some species that spring into the air well in advance of a moving object are caught only by a rapidly moving net; others of more sluggish reaction are caught only in a slow-moving net, since a rapidly moving one passes over them before they spring; still others are best taken with the net moving at a moderate rate. Some forms cling tightly to the vegetation and can be dislodged only by forceful sweeps; others drop to the ground before the net, and are best taken by other methods. Sweeping in the heat of the day, at dusk, and during the night yield quite different results, due to variations in the activities of the species present. An alert collector who watches closely for slight movements of specimens in advance of his net may often so guide his strokes as to sweep up forms which are not readily flushed.

Flushing and stalking. While sweeping or simply walking slowly along, the collector flushes many grasshoppers and katydids which fly a certain distance before alighting. Carefully marking the spot where the insect has come to rest, the col-

lector may follow it up, rapidly at first but more and more slowly and cautiously as he approaches. With practice the motionless insect can often be "spotted," and captured either by a lateral sweeping stroke as it rises, or by clapping the net over it. If the latter method is used, the insect can often be induced to fly up into the net by lifting the tip of the net-bag while shaking the rim on the ground. If this fails to reveal its presence the edge of the net should be cautiously raised at one side, the specimen located where it rests on the ground, and the hand clapped down upon it. In making the approach to wary grasshoppers one should move very slowly, avoiding abrupt movements of any part of the body, and holding the net behind the back so that the color and fluttering of the net bag will not alarm the quarry. Dull-colored clothing is also helpful in making a close approach. With very suspicious grasshoppers it is sometimes advisable to crouch or even to crawl slowly on hands and knees until within striking distance. The long handle of the sweeping net is distinctly advantageous in this type of collecting.

Beating. Most beating is done with the heavy beating net described above, which is used much as in sweeping, but with the application of much greater force, the net being swung like a club through shrubbery, or brought up smartly from below against branches. The object of beating is to obtain insects which cling tightly to stems and foliage, and which must be dislodged by the force of the blow.

Another valuable method of beating, especially applicable to obtaining insects from the lower branches of trees, is the use of a *beating cloth and club.* A piece of white cloth or unbleached muslin about a yard square is hemmed around the edges, and in each corner a small triangular pocket is sewn. The cloth is carried folded in the pocket of the collecting jacket. For use, two sticks are cut the length of the diagonal of the cloth square, their ends are slipped into the pockets in the corners so that they cross at the center, and a piece of string or a handkerchief is tied around them at the point where they cross. A heavy club or stick, which may be cut in the field, is then used by the right hand to strike the limbs of trees and bushes, while the beating cloth, grasped by the left hand at the point where the sticks cross, is held horizontally beneath. (This is a more convenient modification of the old beating umbrella.) Tiny crickets and other Orthops which are jarred into the cloth very often leap out before they can be captured. This may in part be prevented by placing several handfuls of leaves in the hollow of the cloth, so that the insects will conceal themselves among the leaves instead of immediately leaping out onto the ground.

Collecting on hands and knees. Many of the rarer and more desirable grasshoppers and crickets are best captured by working on hands and knees. The collector crawls slowly along, parting the vegetation as he progresses. When a specimen is seen (particularly if it be a small cricket) it may usually best be caught in one of two ways. One method is to slap the cupped hand firmly and swiftly down over the insect, and then, with the hand still pressed down, to part the fingers slightly. In attempting to escape the insect will try to crawl between them, and may be caught without injury by bringing the fingers gently together. The other method is to place the net cautiously beside the insect, with the opening vertical and the edge of the net-frame on the ground as close to the specimen as possible without alarming it. The free hand is used to "herd" the specimens into the net, which is given a quick snap forward so that the insect will be thrown to the bottom of the bag.

Trampling. In areas of rank herbage, dense grass, sedge marshes, and other types of heavy vegetation that are not too tall, many species that are otherwise very difficult to obtain may be taken by trampling. This is particularly true of forms that are difficult to flush, or which drop to the ground and hide when alarmed. An area about the size of a large room is selected to work. The collector circles slowly around this area using his feet and full weight to bend and press down the vegetation over and away from the center of the space. This is continued until the standing vegetation in the center of the circle has been reduced to an area only three or four feet across. This portion may then be worked

A sturdy net is needed when heavy shrubbery is worked. The beating-net shown has proven very satisfactory for this purpose. The electric headlight permits the use of both hands while collecting at night.

with the net for specimens which have been forced in toward the center and have congregated there. Finally the remnant of standing vegetation is also trampled down; the collector then works back and forth across the area for some time, sweeping up and otherwise capturing the grasshoppers, katydids and crickets as they work their way to the surface of the matted mass of vegetation. Additional collecting on hands and

Beating bay-head shrubbery in Florida. The leaves and debris placed in the beating cloth often prevent the escape of small crickets.

knees will yield many specimens from such a trampled area. This is a very productive (though rather laborious) method, and one which is apparently little known.

Looking under logs and stones. Cockroaches, camel-crickets, crickets and other Orthops may frequently be found beneath objects lying on the ground.

Stripping bark from logs and trees. Earwigs and cockroaches are often found under the loose bark of rotting logs. Many cockroaches and some crickets hide beneath the loose scales of bark characteristic of certain trees.

Searching in Heaps of Decaying Vegetation. This procedure is often productive of cockroaches, crickets, and (in warm regions) earwigs. Piles of rotting leaves and fruit, decaying banana bits and the like are often rich collecting.

The same bait may be used over and over until it loses its attracting powers. Some fermentation increases, but excessive fermentation decreases, its attractiveness. Depending on the weather bait may last from two to six weeks.

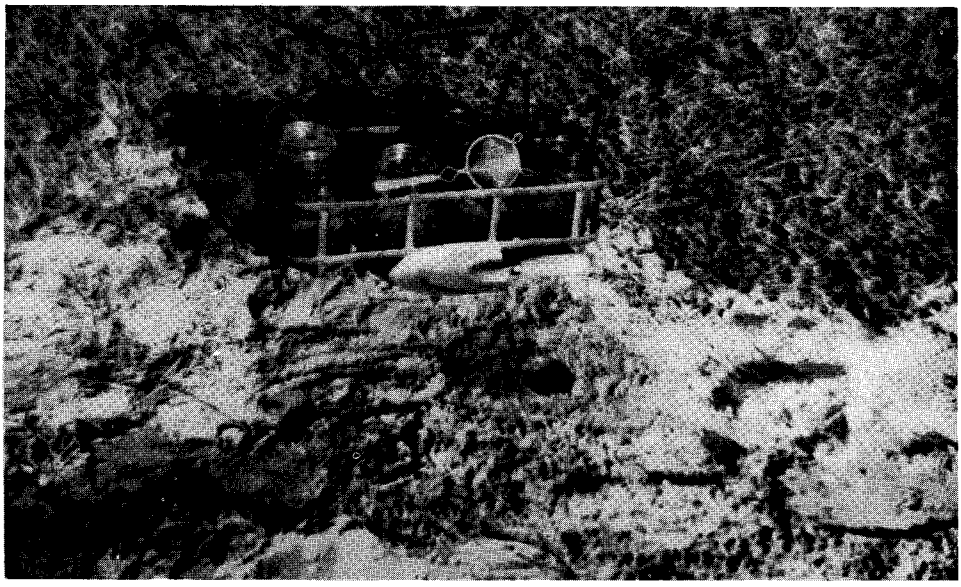
Baiting trees. Painting the trunks of trees with molasses, or with a variety of sweet baits (sugar and rum, sugar and beer, fermented bananas, etc.) in the manner long used in sugaring for moths, is a method very productive of cockroaches and occasionally of other unusual Orthops. The bait is painted on the trunks of rough-barked trees shortly before dusk, and the trees visited during the evening with a headlight. Baiting the same spot on the same trees at intervals appears to increase the effectiveness of the method.

Molasses traps. This is undoubtedly the best way to obtain many terrestrial and subterranean *Orthoptera,* a maximum number of specimens being captured with a minimum expenditure of time and energy. A molasses trap is prepared by placing about an inch of molasses diluted one-half with water in a pint or half-pint glass jar. (Tin cans may be used, but if they are rusty, specimens often succeed in climbing out of them.) The molasses jars are buried in the ground with the mouths flush with the surface, and are best spaced about twenty feet apart. They may be left out over-night or for longer periods. In the latter event they should be visited and the specimens removed every morning in hot weather and not less than twice a week in cool weather. The location of the traps should be marked by pieces of paper placed on twigs, tree-trunks, or other conspicuous situations nearby, as otherwise many traps are lost. The insects attracted by the bait fall into the jars and drown in the molasses.

Molasses traps may be set out in many types of situations with success, but the richest location for them is in forests or other places where there is abundant plant debris and shelter on the ground. One can increase the size of the catch by choosing the places where the traps are set with relation to their proximity to shelter, such as heaps of dead leaves, decaying stumps and logs, stone piles or heaps of angular talus, near mouths of animal burrows and caves, etc. In regions lacking heavy woodland, traps may be placed in clumps of shrubbery, among rocks, near prairie-dog holes, etc. If the soil is too rocky or hard to permit burying the traps, they may be placed on the ground and small rocks or sticks piled up around them to the level of the brim.

For trapping the insect inhabitants of the burrows of such mammals as pocket-gophers and moles—subterranean crickets and other forms which almost never come to the surface of the ground—it is necessary to modify the technique just described. The collector must locate the burrow by digging a hole which intersects it. In this hole the molasses trap is buried to the brim, at or slightly below the level of the burrow. The top of the excavation is then covered with heavy paper weighted down all around the edges with earth—a procedure necessary for success, as many of the inhabitants of the burrows will not venture to the trap if air currents reveal that the burrow is open. Covering the hole also minimizes the danger of confusion as to what was trapped from the burrow and what from outside. In the instance of pocket-gopher burrows it is necessary to set a trap for the mammal at each entrance to the molasses-trap pit, as otherwise the gopher will fill the trap and pit with soil as soon as it discovers them.

Material that has been collected in molasses traps may be fished out with a



Materials used in trapping Orthoptera. Traps (pint fruit jars) are conveniently conveyed in a milk bottle carrier. A "set" trap is shown in the foreground.

long pair of forceps, a bent spoon, or a special instrument made of wire-gauze on the end of a handle; or better, the contents of the trap may be poured through a piece of cheese-cloth supported by a tea strainer. On long field trips, or when much trapping is being done, it is often convenient to tie up the edges of the piece of cheese-cloth to form a small bag containing the specimens; after labelling,

Molasses-trapping in the burrow of a mammal. A trap (behind and to the left of the molasses-trap) captures the mammal so that it cannot fill the jar with dirt. The entire excavation should be covered over to prevent the trapping of non-cavernicolous insects.

many such bags can be placed in the same container of alcohol. Before being placed in alcohol (95%), the specimens or specimen-bags must be gently but thoroughly washed in water until the water is no longer discolored by molasses. Labels should be written on tough paper, either with soft pencil or waterproof India ink; if the latter is used the label should be dried over the flame of a match before being put in the alcohol.

Collecting in sphagnum bogs and wet marshes. Crickets and other Orthops which live in bogs or wet marshes can often be taken most easily by pressing down the sphagnum or by trampling the vegetation to below the water-level; the insects are forced out of concealment by the rising water, and may be captured as they float on the surface.

Trampling clumps of desert vegetation. In arid regions where sage-brush, greasewood and other plants grow in clumps on otherwise nearly bare ground, many Orthops (grasshoppers, crickets, katydids) conceal themselves in and beneath these growths, which may be so stiff and woody that beating them is ineffective. By kicking over and thoroughly trampling the clumps many species have been found in numbers that would otherwise have been hard to secure.

Headlight collecting. Night collecting with the aid of an electric headlight is one of the most important methods of obtaining *Orthoptera.* Most cockroaches, katydids, crickets and cricket-locusts are active chiefly at night and conceal themselves during the day. Sweeping and beating at night produces a quite different assemblage of species than is revealed by the same methods applied to the same habitats in day-collecting. The collector's attention, concentrated on the small area illuminated by this headlight-beam, is attracted by form and movement which pass unnoticed in day-light, and many specimens are seen which can be caught with the fingers. Grasshoppers which are active and hard to capture during the day become sluggish at night, and may easily be caught if they can be located. Most of these usually hide in the ground vegetation at night, and are hard to find; but under certain meteorological conditions they may climb to the tops of weed-stems and other exposed situations, so that on some nights hundreds of specimens can be picked with the fingers.

Most of the crickets and katydids of this night population have songs which are more or less characteristic of each species. By tracing the source of these songs males may be located and captured. This is the only possible way of finding some of the less abundant forms, except by accident. However, many of the singing forms are quite wary and must be approached with care. In such instances it is generally best to "line up" the direction from which a song appears to be heard, then to move to one side and get a second "line" on the sound. The intersection of these two "lines" gives the approximate location of the singer, and the collector can then make a cautious approach. Often the on-coming light will cause the song to cease; when this happens the collector must turn off the light and wait in darkness until the song is heard again. Sometimes it is best to reconnoiter the intervening terrain briefly with the light, and then to make the entire approach in darkness, moving slowly and cautiously until close to the singing insect, whereupon the light may be flashed on in the attempt to see the specimen before it can hide or fly away. Many species are alarmed by too strong a light; sometimes these can be approached by directing the beam to one side, so that only the marginal illumination falls upon them.

The electric headlight is so superior to all other forms of illumination for night-collecting that every field entomologist should be acquainted with its use. A small box or tube containing three or five flash-light cells is carried on the belt; from this a wire runs up the back to the light, held on the forehead by an elastic band. One of the best models is that made by the Winchester Firearms Company; others may be obtained from Montgomery Ward, Sears Roebuck, and various sporting goods houses. In some states use of these lights for hunting is illegal, but the insect collector's innocence is usually self-evident to a game-warden.

Attracting to light. While Orthops are less attracted by lights than are moths,

many beetles, mayflies, craneflies and certain other insects, some species come to light with more or less regularity. One of the best methods of taking advantage of this characteristic is the use of a *lighted sheet*. A white sheet about the size of a bed-sheet is hung vertically between two trees or poles, with its lower edge on the ground, and in front of its center is hung a gasoline lantern or other source of bright illumination. (The headlights of a car turned on a sheet will serve.) It is best to protect the sheet from the wind and to place it facing a direction where the light can penetrate some distance–down a lane in dense woods, on a low hillside overlooking fields, marshes or swamps, etc. Quiet, humid, warm nights seem to be best. Male cockroaches, various katydids and crickets, and an occasional grasshopper may be taken in this way. Use of the lighted sheet goes well with headlight-collecting as the collector can set up the sheet, work about the vicinity, and at intervals come back to the sheet to pick off insects which have been attracted to it.

Light traps of various sorts may also be employed. A small room with light-colored walls may be used as a light trap by surrounding the open window with electric lights, and having another light in the ceiling or near the back wall. A light suspended over a pan of water covered with a film of light oil is effective; specimens caught in this trap should be placed in alcohol. A large tin funnel suspended under a light and with a large and strong cyanide jar screwed to its bottom will also capture many specimens. Many complicated and efficient light traps have been devised; descriptions of some of these may be found in Petersen's *"Manual of Entomological Equipment and Methods."*

FIELD NOTES

A specimen without data is nearly worthless, and the more complete the information which accompanies it the more valuable it becomes for scientific purposes. The minimum information which should accompany every specimen is: where and when it was taken, and who collected it. This much information will eventually be printed on a small label that will always accompany the specimen. Modern standards of work require that, so far as possible, data also be kept on the kind of situation in which the insect was found, the method by which it was taken, and any observations on food, behavior, abundance of the species and other points that can be noted. Obviously it is impractical to record all this information on the label accompanying the specimen, and therefore it has become standard practice to keep a field notebook in which such observations can be noted, and to refer specimens to this notebook by giving them field numbers corresponding to the numbered entries in the notebook. Furthermore, this method results in great saving of time in the field, where time is at a premium.

In our experience the most satisfactory type of field notebook is a small leather or cloth-bound book similar to an engineer's level-book with 50 to 200 horizontally ruled pages. This can be conveniently carried in the field in a pocket of the collecting jacket. (Field notes should always, if possible, be written in the field during intervals of collecting, and not afterwards from memory.) The collector's name and an address to which the book can be sent if lost should be written inside the front cover. Each entry in the book should be given a serial number, which is also given to all the specimens to which the precise data recorded under that number apply. Under each number should be given the locality, the date, the duration and time of the collecting period, the method of collecting, as full a description of the habitat as time and knowledge will permit, and a note concerning the weather.

The locality must be made as definite as possible. The collector may indicate the distance and direction from a town, but in this case should *never* indicate a town which cannot be found on some standard map, and should state whether the distance and direction from the town were measured along roads, or are actual compass direction and air-line distance. If the county is not thickly settled it may be necessary to give township, range and section, or even latitude and longitude where these can be determined from maps. Well-marked physical features and conspicuous landmarks shown on maps can also be used.

In describing the habitat, attention should be paid to the type of soil, nature and composition of the vegetation, amount of shade, amount and kind of ground cover, humidity, and other features that may be noted. Even brief notes on such points are often of the utmost value, and the more exact the data the better. However, it is not necessary to repeat such information in entries made for subsequent collections in the same habitats, except to note seasonal changes or to add to previous observations. Furthermore, since one piece of oak-hickory forest in southern Michigan or one gallberry-palmetto flatwoods in northern Florida is very like another, and since these and other comparable situations are well-marked, frequently described habitats, it is often sufficient to name the general habitat and to note any deviations from the usual condition, such as the density of the tree-stand, height of the undergrowth, etc.

Any change of date, locality, type of area collected, or time and method of collecting requires a new field number for the specimens obtained. If observations are made on some particular species of *Orthoptera* among a number collected on some particular occasion, they may be recorded in any of several ways. Perhaps the best and safest way is to give these specimens a new number, under which it is stated that the data is the same as under a preceding number and the observations were made on this particular species. Or, if the species has some outstanding characteristic which will enable it to be told from the others collected under the same number, it may be left under the same number with them and a special note made about it, mentioning the identifying characters. Students of *Orthoptera* who are familiar with the species usually list those collected under each number in the field notebook, following each name with abbreviated notes indicating estimated abundance, actual number of adult males, females and immature specimens collected, and any notes on the species which seem worthy of record. The following example illustrates how entries in the field notebook may be kept:

75—Lake Co., Florida, approx. 2 miles W. of Tavares, T. 19 S., R. 25 E., Sec. 36. Aug. 4, 1938. Hubbell and Friauf.—Camped in sweet gum-magnolia-live oak hammock margin at edge of small marsh $\frac{1}{4}$ mile from Lake Harris. Collecting one hour just after dusk, headlight, in edge of marsh (saw-grass, pickerel-weed, ferns) in water 1 ft. deep. Hot, humid, moonlight. Marsh bordered everywhere except at camp site by palmetto-flatwoods on Leon fine sand. (Followed by list of species taken, their abundance, and number of specimens kept.) 47 specimens papered and pinned; 8 in alcohol. (Only a part of these were Orthoptera; the rest were miscellaneous insects taken incidentally.)

76—Same as last. Large conehead (*Bucrates malivolans*). Numerous; males singing on all sides. (Description of song.) Some green, but mostly brown; nearly all short-winged.

77—Same locality and date as 75, except Sections 25 and 36. Collecting with headlight about 9:45 to 10:30, in sandy fields covered with tall grass, dog-fennel, *Opuntia*, persimmon shoots, etc. Norfolk fine sand. Occasional patches of turkey oak. (List of species.) 76 specimens papered and pinned.

78—Same locality and date as 75, except at corner of Secs. 25, 30, 31, 36. Collecting 1 hour, 10:30–11:30 P. M., headlight, in small patch of sand-scrub. Scarcely typical—has a lot of palmetto and fetterbush (*Desmothamnus lucidus*), and numerous rather large cacti; no rosemary (*Ceratiola ericoides*) nor sand pine, the dwarf oaks mostly low and little staggerbush (*Xolisma*) present. Possibly transitional to flatwoods. Soil shown on soil map as St. Lucie fine sand. (List of species.) 104 specimens pinned, papered and in alcohol.

Attention should be called to the fact that the large numbers of miscellaneous insects usually collected along with *Orthoptera* can be given the same field numbers, and by so doing much more of the essential data is recorded for them than is usually preserved for incidentally collected material. The record of the total number of specimens preserved under each number is of great value in calculating what kinds of labels and how many of each should be printed before mounting of the collection begins.

In general we have found it best to start a new notebook for each season's work or each field expedition, beginning a new set of serial numbers each time. It is not necessary to transfer the data from the field notebooks to a general catalogue with continuous serial numbers, since the specimen labels with collector's name, locality, field number and year indicate the proper field notebook. Thus: Brodkorb, Chiapas 1938, No. 24, is not likely to be confused with Gaige, Olympic Mts. 1919, No. 24. Even notebooks of the same collector working in the same region for several seasons

are sufficiently differentiated by the year.

It is desirable to fasten a detailed map (topographic or county if available, otherwise a road map) inside the front cover, folding it to conform with the size of the book. On this map indicate all collecting localities by inserting the corresponding field numbers at the proper points.

There are, of course, various useful methods of keeping field notes, each with its own advantages and faults. Many other methods than that described above have been tried by the writer and his friends; but on the whole the one recommended seems both simplest and most satisfactory.

PRESERVATION OF SPECIMENS IN THE FIELD

Material which has been killed in cyanide jars should be removed as soon as possible after it is dead, since the longer specimens are left in the jars the more likely they are to discolor. On long field trips it is best to carry several small containers in the collecting jacket (cardboard boxes serve very well) into which bottles can be emptied. Strips of paper towelling or blotting paper can be put in the cyanide jars and in the carrying boxes to help absorb moisture and to support the specimens.

Very soon after removing specimens from the cyanide jars they begin to stiffen with rigor mortis. During this period, lasting several hours, the hind legs of grasshoppers, katydids and crickets will break off at a touch. Specimens must, therefore, either be put up immediately, or allowed to remain some hours or overnight in a closed container that will protect them from the attacks of ants, roaches and mice.

Field preparation of grasshoppers and their allies generally consists of papering, layering the material, or of preserving it in alcohol. (Formalin is not used, as it causes specimens to fade and unduly hardens them. However, green katydids are said to retain their coloration better if they are submerged in five per cent formalin for about five minutes and then taken out and papered.)

The Use of Alcohol as a Preservative. *Orthoptera* which have a green or greenish color should never be placed in alcohol, as the alcohol will remove all of the green pigment and leave the specimens yellowish. All molasses-trap material must be placed directly in 95% ethyl alcohol and all cockroaches, earwigs and crickets (other than green specimens) may also be preserved in the same manner. If weaker solutions (70% or 80%) are used, the alcohol must be changed several times within the first few days, or the water in the grasshopper bodies will so dilute the alcohol that decay will take place. If ethyl alcohol is not available, the collector may use ordinary rubbing alcohol, but this is only about 70% and hence must be changed as indicated above for weak solutions of ethyl alcohol. Labels bearing locality, date, collector's name and field number should be placed in the containers with the specimens. The labels should be written on tough paper with soft pencil or Higgins' Water-proof India Ink. If the latter is used the label should be dried over a flame before being put in alcohol. The label should never be placed on the outside of the container because of the possibility of its coming loose and being lost. If the collector uses a field notebook, abbreviated temporary labels may be used as described below for papered specimens.

Papering and Layering Specimens. All material which is not preserved in alcohol must be pinned, papered, or layered. Pinning in the field takes more time than either of the other two methods, and also requires transportation and shipping of large numbers of bulky insect boxes. Pinned insects also require very careful packing for shipping. For these reasons most *Orthoptera* are papered, layered or placed in alcohol.

Before papering or layering the catch, the collector should check over material and see that all large and heavy-bodied specimens are eviscerated. To perform this operation a cut is first made with a pair of fine-pointed scissors, on the lower surface of the abdomen near the thorax; this cut should sever 3 or 4 of the abdominal rings a little to one side of the mid-line.

Reaching forward through this cut with a pair of curved-pointed forceps, the large crop is pulled loose just back of the head. Turning the specimen about the gut is now severed at the rear end of the insect and the entire contents of the body are slipped out.

The ovaries and testes may have to be separately extracted and the parts at the tip of the abdomen pushed out into normal position.

Small specimens do not require any stuffing, but larger specimens should have just enough cotton to keep the abdomen from collapsing. Ordinary cotton is chopped or cut up finely and placed in the body cavity. The walls of the abdomen are then carefully pushed back to normal position and the specimen is ready to paper.

Papering may be done by either of two methods. (1) *Paper rolls:* A square of toilet paper is torn loose from the roll and is laid upon the table with the long way of the paper pointing away from the collector.

Date, locality, and collector's name are written in pencil or water-proof ink in the center of the sheet. If the collector is using a field notebook, the necessary reference data may be reduced to the collector's name, the year, and the field number as

D. Ring
1939—#20

or

Van Tyne
Chisos 1936
#182

This abbreviated form may be set up with a moveable type rubber stamp and stamped on the paper, saving much time. To help prevent specimens from rolling about, the nearest end of the sheet is then folded up for about one half inch and creased. One or more specimens (never more than two when of moderate size, no more than six when small) are now placed in the crease. Specimens should be put in the paper with the heads pointing to the outside and legs in a jumping position. In the case of forms with long feelers or antennae, these organs should be carefully bent over the head and along the back. The paper is rolled up like a cigarette and each end of the roll is carefully but tightly twisted to prevent specimens from sliding out. (2) *Envelopes:* Twenty pound, white, number two drug envelopes, procurable at most drug stores, may also be used for papering specimens. Collecting information, either in complete or abbreviated form, is placed on the outside of the envelope, specimens are inserted, and the envelope is sealed. Specimens may be put up more rapidly by this method than by using the rolls, and the envelopes are more readily handled in the drier.

Layering: In dry climates, layering is a very rapid and satisfactory method of caring for specimens. Layers of *cellucotton sheets* (or if these are unobtainable, *glazed cotton sheets*) are cut to fit a cigar box. (Specimens should *never* be packed in ordinary cotton, as the fibers catch in spines and legs and cause much breakage of dry material.) A layer is fitted into the bottom of the box, specimens are placed on it about $\frac{1}{2}$-inch apart until the layer is covered, and a slip of paper bearing date, locality, collector and field number data, is placed with the specimens. Another sheet of cellucotton is now placed over the layer of specimens and more specimens with their proper field data are laid out. This is continued until the box is full. Layering is not wholly satisfactory in the United States except in the arid southwest. Elsewhere, if this method is to be used, some means of drying must be devised, as otherwise the material will mold and rot.

DRYING SPECIMENS

Orthops may be dried in a variety of ways, but no matter how this is done the collector must be very careful of two things. The material which is being dried must be protected from ants, cockroaches, mice and other animals which, if given the opportunity, will eat and destroy the specimens. Also, the material should be dried as rapidly as possible, but great care must be taken that the amount of heat is *not too great* as otherwise specimens will become discolored or even burned.

The method of drying that is chosen will depend upon the means available. Papered material placed in a spare net bag and pinned or layered specimens may be hung over a coal or wood stove, just under the roof in an attic, or may be placed in an oven with the door partly open or directly in the sun. Layered and pinned material dries more rapidly if the box lid is propped open. If placed in the sun, it is necessary to shade the pinned specimens with the lid of the insect box so that excessive fading may be avoided. By tying a

box of specimens under the hood of a car, material may be dried by the heat of the motor while travelling. Material placed on a table under a desk lamp will dry rather well.

A very convenient field drier may be made of sheet metal and quarter inch mesh wire. The body of the drier is made of sheet metal and is 11 x 11 x 15″ in size. Four drawers with sides, front and back of sheet metal and with bottom of wire are made to slip into the drier on sheet metal grooves soldered in place. To the bottom of this drier is fastened a 30″ cloth funnel which tapers to a six inch width at the bottom. If electricity is available, an electric bulb will provide sufficient heat for proper drying. A kerosene lamp or lantern (a gasoline lantern is too hot) is very satisfactory. Heat output may be regulated by the height of the wick and it will burn at least ten hours on one filling of kerosene. Pinned material should not be dried over a kerosene lantern if it can be avoided as the soot and carbon produced by the lantern will soon cover the specimens.

For laboratory use a very satisfactory drier may be made by placing four electric light sockets, wired in parallel so that one or all may be used at will, in the bottom of any wooden container such as an upright phonograph cabinet. Holes should be drilled in the top and bottom and covered with screen wire, both to permit circulation of air and to prevent the entrance of mice. Ants and cockroaches may be kept out by setting the legs of the drier in dishes containing kerosene.

CARE OF MATERIAL BEFORE SHIPPING

After specimens have been collected and preserved, precautions must be taken to prevent destruction of the material before it can be shipped to its destination. Papered specimens should be placed in boxes so that they will not be shuffled about. The papers cannot be forced tightly into the box without causing breakage but the box should be filled as full as possible without crushing. Envelopes should be set on edge and not stacked upon the flat side. Full boxes of layered material should be tied shut.

If papered material is to be held for more than two or three weeks before shipment, the papers should be sprinkled with a fumigant such as paradichlorobenzine to prevent insect pests from eating the specimens. Material should be kept out of the way of ants, cockroaches, and mice.

All vials and jars of alcoholic specimens should be filled to the top with alcohol since, if they are partly empty, the swash of the alcohol moving from one end of the container to the other is likely to damage delicate specimens. Glass-capped containers are filled as full of alcohol as possible. Corked containers are filled to a point a little higher than where the cork finally comes to rest. The cork, with a pin held vertically beside it to form a channel for the escape of air, is then pressed into the vial. When the cork is in as far as possible the pin is pulled out, thus sealing the vial.

SHIPPING ORTHOPTERA

Shipping Papered Specimens. Papered specimens should be placed in a firm box such as a cigar box. The papers are packed as already described, neither crushed and crowded together, nor so loosely that they can shift about. The boxes of layered material are tied shut, wrapped in paper, and placed in a sturdy cardboard container large enough to allow at least four inches of space on all sides of the enclosed boxes. This space is filled with shredded paper, excelsior, or loosely wadded newspapers to act as padding. The shipping box is then securely tied with heavy cord, marked "FRAGILE," and sent to its destination by *express.* (Although parcels receive rough treatment by express they suffer less battering than in the parcel post. Also, if the contents are broken to such an extent that it is advisable to collect insurance on them, express will pay with much less trouble and red tape.)

Shipping Alcoholic Specimens. All bottles and vials should be filled as full of alcohol as possible by the method indicated above. Each bottle is then individually wrapped with paper and packed with others as tightly into a box. When full, this box is tied securely, placed in a larger cardboard box, and packed in the same

manner as for papered specimens. The finished parcel is marked "FRAGILE" and "GLASS" and is sent by express.

Shipping Pinned Specimens. Specimens are firmly pinned into an insect box. A pair of pinning forceps may be necessary to set the pins solidly enough so that they will not jar loose. Should a single specimen become loose and be thrown about the box, the chances are very great that many of the others will be broken beyond repair. All large and heavy-bodied specimens, as well as all which swing loosely on the pins, must be braced. This is done by firmly setting an insect pin on each side of the insect, close enough so that the specimen is braced from the sides. In setting these brace pins care should be taken that they do not snap to one side and break the brittle specimen.

After all specimens are securely in place a piece of lightweight cardboard is cut of such size that it will fit snugly into the box. Enough cotton is laid on top of it so that when the box is closed the cotton presses the cardboard firmly down on the heads of the insect pins. The box of insects is now wrapped in paper and packed in a box large enough to allow four to six inches of packing material to be inserted on all sides. The box is securely tied, addressed, marked "FRAGILE" and shipped by express.

Appendix

SOME ADDITIONAL NOTES ON THE COLLECTING OF ORTHOPTERA

J. J. Friauf, University of Florida

Having done extensive collecting with both Dr. Hubbell and Dr. Cantrall, the procedures discussed in Dr. Cantrall's paper are thoroughly familiar to me. I have used and found many of these methods highly satisfactory, each being adapted to some particular need and highly valuable for its purpose. The general principles which have been set forth by Dr. Cantrall for the taking of notes to accompany collections have been applied in my own work, with occasional modifications to suit my particular needs.

The following additional notes on collecting methods may prove to be of value in certain cases.

A collector may take advantage of a local scarcity of the natural retreats of certain ground-loving and nocturnal *Orthoptera* such as cockroaches and some crickets, by placing gunny sacks, pieces of wood or cardboard carton about on the ground. Such artificial hiding places tend to attract and harbor individuals which may have wandered into an area otherwise devoid of suitable cover, and also to concentrate members of a sparse population into places accessible to a collector. Grain or other foods placed underneath the "traps" may prove to be an additional attractant.

Certain European Orthopterists have collected mole-crickets in numbers by laying boards over suitable areas of soil which have been thoroughly watered from time to time.

Females of *Arenivaga floridensis* Caudell, a rare sand-inhabiting Florida cockroach, have been collected by sifting, with a coarse-mesh screen, the sand from under boards and débris along lake shores and other sandy places. The species of *Tridactylus* (pigmy mole-crickets) may often be collected in numbers by a somewhat related method. The surface layers of the sandy soil which they inhabit are kneaded, pushed and worked about with the hands so that individuals are brought to the surface where they can be captured. This method works best at night, when the pigmy mole-crickets are less active and are more likely to be within their burrows.

For collecting very small Orthops, such as *Tridactylus* or small juveniles of other genera, the well-known insect aspirator is a decided aid.

Very interesting and profitable results may be obtained from the use of the Berlese funnel and of the so-called "bug-separator." In the construction of the latter a one or two gallon milk can and three metal-capped Mason jars are utilized. The center of each of the jar lids is cut out. One of the caps is then soldered with its top against and over a hole cut in the side of the milk can and an empty jar is screwed into it; the other two lids are soldered top to top, allowing a jar charged with cyanide and an empty jar to be screwed together.

A moderate quantity of sweeping is introduced into the can and the lid put on; light coming through the jar attracts many of the small and frequently very agile insects into the jar. After a few moments the jar is removed and quickly screwed onto the cyanide jar, the other uncharged jar taking its place on the side of the can.

A simple modification of the above-described bug-separator can be made as follows: A single hole, large enough to receive snugly the mouth end of an 8-dram, homeopathic vial, is cut in each of the four corners of one side of a cardboard carton. Sweepings are placed in the carton and the lid closed. Positively phototropic insects enter the homeopathic vials and are then transferred to cyanide jars made from 8-dram, shell vials. The holes in the side of the carton are closed, during transfer of the insects, with the corks of the cyanide jars.

Berlese funnels and "bug-separators" do not necessarily need to be carried into the field; material for them can be taken to the laboratory or camp in paper or cloth bags.

It is often difficult to procure *Orthoptera* which live in the tops of trees or tall shrubbery. Individuals which have been located (usually by their songs) can often be made to fall to the ground or to a point in the tree within reach of the collector by tapping them with a long pole such as a bamboo fishing rod. Sometimes a mere touch is sufficient to cause the Orthop to release its grasp and fall. Such arboreal species are sometimes killed or benumbed by a severe frost and may at such times drop to the ground. Benumbed individuals may revive during the daytime and are then often seen climbing up the tree trunks toward their lofty habitats.

The tiny members of the genus *Myrmecophila* are found associated with ants beneath stones and logs, within decaying stumps and logs, and in the nests of certain ground-inhabiting ants.

The use of the druggist envelope for packing specimens in the field may be further improved by the utilization of cellucotton or of a soft paper tissue such as *Kleenex*. Rectangles of one or two layers are cut so that when folded in half they will fit into the envelopes. The insects are placed within the fold and packed in the same manner as indicated by Dr. Cantrall. The tissue serves to prevent the specimens from shuffling against one another and hence reduces breakage.

ADDITIONAL NOTES ON COLLECTING ORTHOPTERA

Dr. B. B. Fulton, Raleigh, N. C.

While there may be a few groups of insects more difficult to catch than the *Orthoptera*, the collecting of the jumping *Orthoptera* is sufficiently arduous to be ranked as a sport as well as a scientific hobby. They have a keen sense of sight, are adept at concealment and when flushed can get away with surprising rapidity. Most of the species which present unusual difficulties may be classified in three groups according to their habits, (1) the alert, strong flying grasshoppers, (2) tree top species, and (3) those living under very dense vegetation. I can offer a few methods which I have found helpful for such species.

Low Temperature. For collecting the strong flying species and active jumpers, one may sometimes take advantage of the retarded activity of the insect during early morning hours or on cool days in the fall. The best temperature is one that causes them to be very sluggish but not cold enough to stop all activity. On one occasion I collected in a few minutes a fine series of a rare *Melanoplus* on Mary's Peak in western Oregon by simply picking them off the bushes like berries. On a warm day they would have leaped into the thickets and it would have taken hours to collect the same number.

Tree top species. Some species of *Orthoptera* are seldom found within the reach of a net. The true katydid is a good example. To collect this species I have found it necessary to go out at night when they were singing and search until I found some in small trees. By climbing a tree and shaking the top vigorously the katydid could be knocked to the ground where it was easily caught but sometimes difficult to find. Another species having this habit is a small greenish cricket, *Cyrtoxipha colum-*

biana. Fortunately this species sings during the day and when a small tree containing a number of them is located it is possible to knock them out by thrashing the branches with a long pole. They fly before reaching the ground and it is necessary to watch carefully and catch each specimen as soon as it lands. They often fly to the trunk of another tree and immediately start running up. The same method may yield specimens of tree crickets (*Oecanthus*) such as the pine tree cricket, if small trees containing them are first located by the song at night. The best place to collect tree top species is a lumbered tract or second growth where only small trees are present.

Collecting in Dense Vegetation. In vegetation so dense that a net cannot be driven through it better results are obtained with a beating cloth and club, as described by Cantrall. The ordinary net can be used less effectively in the same way if you do not have a beating cloth with you. A modification of this method can be used for low dense vegetation by first clearing a small patch large enough for the net. The net ring is propped vertically against the plants with one side in contact with the ground, the bag extended and lying on the ground in the cleared place. Take a club in each hand and start beating and kicking the plants with the feet in a semicircle of several feet radius and gradually converge toward the net. Finally thrash the plants immediately in front of the net ring and swing the net through the air to drive any specimens into the tip. The rewards of such efforts are usually not large and it can be recommended only for certain crickets that remain close to the ground. For dense clumps of grass or very low shrubs simply hold the net vertically against one side and thrash the opposite side with a club.

For some species of crickets I have resorted to the use of sickle, clearing a circular patch and converging toward a center. If the cut plants are thrown out of the clearing, the insects herded into the center can be forced into the open where it is possible to catch them.

I have noticed when taking down a tent that crickets often jump onto the canvas. I have made use of this observation for collecting a quantity of certain grass crickets by spreading out a large tarp. By kicking the surrounding grass the crickets can be made to jump onto the tarp where they can be caught by hand or swept into a net.

One of the most difficult places to collect is in a salt marsh where tall grasses and rushes grow so dense that only those *Orthoptera* that perch near the tops can be swept into a net. During full moon and new moon the tides are unusually high and large parts of the marsh may have as much as a foot of water around the plants. At such times a pole or board can be used to press down a strip of grass and by standing on the board the whole strip can be forced under water. The submerged insects soon come to the surface where they can be dipped up with a net. A still better piece of equipment for this kind of collecting would be a light lattice frame about 3 by 6 feet which would submerge a larger area of grass.

Burrowing Crickets. The best time to collect burrowing crickets is at night when *Anurogryllus*, *Miogryllus* and sometimes mole crickets may be found on the surface of the ground. *Anurogryllus* can be dug out in the daytime by first pouring down the hole a mixture of lime and water. This leaves a white deposit that enables one to trace the hole to the bottom. If mole cricket burrows are found on the low shores of a pond or stream many of them can be driven out by throwing quantities of water onto the mud or sand with a pail or even with a piece of board.

Singing Orthoptera. The method of tracing down singing *Orthoptera* has been described by Cantrall but I think it is important enough to deserve further comment. In general it applies only to two families, the katydids and crickets. In these groups this kind of collecting has netted most of the rarer species in my collection and has added a few new to science. Its peculiar advantage lies in the fact that the collector gradually becomes acquainted with the distinctive songs and can give his attention to collecting the unusual.

Some species sing only after dark but about half of our species also sing during the day and many of the night singers start

in the evening while it is still light enough to collect without a flashlight. The direction of the sound can be determined with fair accuracy but the distance is usually difficult to judge. The method of shifting the direction of approach as described by Cantrall helps to eliminate this difficulty. Two collectors can coöperate to advantage by approaching from different directions. When both are within a few feet of the singer they can point out its location with fair accuracy. Our hearing apparatus is defective in judging the vertical direction of a sound, which is necessary if the insect is in a shrub or tree. To do this one can cup the hands behind the ears and direct them toward different elevations and detect differences in intensity. On close approach the insect may stop singing but if the collector remains quiet long enough it will usually start again. If his patience becomes completely exhausted he can attempt to find the singer where he thinks it is and he may be lucky enough to find it. Even when it is not feasible to trace down individual singers, the habitats where they are most abundant may be located so as to increase the chance of collecting specimens by other methods.

Studying Crickets. Ground inhabiting crickets may be kept in open battery jars or gallon, glazed earthenware jars if they are tall enough to prevent the crickets from jumping out for such species cannot climb the sides. If necessary a piece of wire screen weighted down with a stone or piece of lead may be placed over the top. To raise the humidity and provide a medium for egg laying, there should be about an inch of fine sand in the bottom which must be kept slightly moist. Lantern globes placed over a tray of sand can also be used. A tuft of short grass may be rooted in the sand to provide cover and food. Water can be supplied in a small, shallow dish or watchglass or in a small vial lying on its side with the bottom pressed into the sand so that the water will not run out. Place a piece of absorbent cotton in the vial reaching to the neck so that the crickets may drink from the cotton. If the cotton does not completely fill the neck water may be added with a pipette. Ground crickets may be fed on a few grains of oatmeal daily supplemented by small pieces of fresh fruit or vegetable. Uneaten food should be removed before it molds.

Crickets that live above ground are able to climb on glass and must be kept under screen or cheese-cloth covers. If wire screen is used small bits of food may be pressed into the screen and the crickets will climb up to get it. Branches of host plant may be kept in small bottles with cotton packed around the neck to prevent the crickets from getting into the water. If the breeding cage is a jar, the amount of foliage provided must be small to prevent too much humidity in the cage. If larger breeding cages with screened sides are used, more foliage should be supplied to raise the humidity. The crickets should be watered at least once a day by sprinkling the foliage through the screen. If the egg laying habits are being studied it will be necessary to provide a variety of materials from favorite host plants, such as different sized branches and small twigs, as well as leaves. As a general rule the favorite natural environment of the cricket should be reproduced as closely as possible in the cage.

For studying the habits of burrowing crickets a special cage is needed. If possible find a short cylindrical jar that will fit into a taller glass jar leaving a small space between. The space should be just large enough to permit the cricket to enter. The small jar is inverted in the larger one and the space between filled with sifted, moist, light soil, or fine sand extending not more than half an inch above the inverted jar. Food can be provided in the space above. The sides of the jar should have an opaque cover which can be removed while observing the underground activity of the cricket.

Another type of cage can be built similar to ant colony cages using vertical panes of glass separated by thin strips and filled with soil. At the top a small screened cage should be added to serve as a feeding chamber.

NOTES ON THE STUDYING OF ORTHOPTERA *

Dr. H. F. Strohecker, Kenyon College, Gambier, Ohio

Where specimens such as *Ceuthophilus* or certain crickets (*Cycloptilum*) are to be carried through alcohol and xylol and pinned, I have found it better to pin them from 70% alcohol, then run the pin through a block of balsa wood large enough to support the body of the insect. The pin is thrust through until the body of the specimen rests on the wood. The antennae and legs are then arranged (minutennadeln are excellent for this purpose) and the block floated on the liquid, specimen down. Little arrangement of the appendages can be effected after passage through xylol whereas if this is done while the insect is saturated with 70% alcohol the appendages are very pliable. The specimen should be thoroughly dried after it comes from the xylol before the pins holding the antennae, etc., are removed. The use of absolute alcohol is not necessary; clearing and hardening of specimens can be effected with transfer of them from 95% alcohol directly to xylol.

* Dr. Strohecker's method of dehydrating Orthoptera is a shortened modification of that employed by Hubbell, 1932, p. 47; *in:* M. Hebard, The Orthoptera of Minnesota. *Univ. Minn. Agr. Exp. Sta.*, Tech. Bull. 85:1–61, 1 map.—I. J. Cantrall.

SUGGESTIONS ON COLLECTING AND STUDYING ORTHOPTERA

Mr. Herbert S. Wallace
Research Biologist in Wild Life
Colorado Game and Fish Department

Field Notes. For field notes a LEAFAX notebook with $\frac{1}{2}$-inch rings may be used. This is a loose-leaf notebook of pocket size with pages $3\frac{3}{4} \times 6\frac{3}{4}$ inches. Sheets may be had in a large number of different forms; blank and cross-section sheets are probably the most useful. Field notes may be filed at the end of the day in any order desired and no more than one day's work will be lost if the notebook is lost. Various sheets and forms may be arranged in the notebook for the convenience of the worker so that it will not be necessary to thumb through the pages to find any particular sheet desired.

In the description of habitat, Dr. Cantrall proposes to obtain, in part, about the same information which has been recorded in the wild-life work at the Colorado Game and Fish Department. For this purpose "VEGETATION ANALYSIS" forms were printed; a sample of which is here reproduced. With some modifications this form might serve very well in entomological work. The form is not copyrighted and may be reproduced by anyone who so desires.

VEGETATION ANALYSIS

Purpose of Study_____
Location _____
Drainage _____
District_____ County_____
Observer_____ Date_____
Dominant Vegetation of Region _____
Type of Soil and Lay of Land _____
Condition of Range_____
Distance from Feed or Salt Grounds, if any_____

PLANTS	% of VEG.			

Preservation of Specimens. Instead of eviscerating, whenever practicable, the collector may inject his specimens. A hypodermic syringe with an assortment of needles ($\frac{1}{2}$-inch and 2-inch will suffice) is needed. (Mercuric chloride is hard on hypodermic needles; one needle will ordinarily last only one collecting season.) The needle is inserted between two of the posterior abdominal sternites or in other soft parts of the posterior end; it should be long enough to reach nearly to the head. A five per cent solution of formalin saturated with mercuric chloride is injected until the body becomes turgid but not stretched out

of shape. The solution is injected as the needle is slowly withdrawn from the body. This method is satisfactory for all but the largest specimens, and *Brachystola magna* (Girard) which were treated this way two years ago still have their natural colors preserved. Specimens with *red* coloring should have the formalin left out of the injection solution.

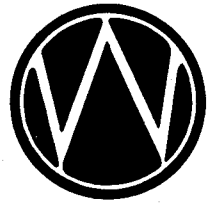
In the case of *Decticinae,* instead of having the specimens eviscerated and "stuffed," it appears much more satisfactory to soak them about an hour in five per cent formalin, then inject with the formalin-mercuric chloride solution. After a day or two the abdomens will begin to distort, another injection is then made (leaving the specimens undisturbed on the pinning board), sometimes a third injection is necessary to distend the abdomens before they will finally dry in that condition. Relaxed specimens may be injected in this manner also.

Specimens injected with mercuric chloride do not appear to be nearly so susceptible to the attack of dermestids as do untreated specimens. Dermestid larvae have been found dead in insect boxes after inflicting but slight damage on injected specimens.

The theory behind this injection method is that the formalin will kill organisms present in the body of the specimen and will prevent the establishment of others for a short time, until the slow-penetrating mercuric chloride has a chance to get into all the tissues. The formalin soon leaves the specimen but the mercuric chloride continues to act as a preservative while the specimen finishes drying, after which it discourages museum pests. In spite of the fact that considerable water is injected in this method, specimens dry more quickly than do untreated specimens.

Orthoptera which were folded into a square of wood-fiber sheeting and then placed in paper envelopes, folded after the manner of drug envelopes, came through in fine shape. Specimens which were put up in envelopes without wood-fiber sheeting were usually damaged, particularly if they were small. Only in the case of the smaller specimens is it safe to place more than one specimen in an envelope and then the wood-fiber sheeting is very necessary.

Specimens put up in paper towel rolls with no further protection next to the specimen came through very badly damaged.



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