UNIVERSITY OF MICHIGAN.

MUSEUM OF ZOOLOGY.

Miscellaneous Publications No. 1.

Directions for Collecting and Preserving Specimens of Dragonflies for Museum Purposes

BY

E. B. WILLIAMSON.

ANN ARBOR, MICHIGAN.

PUBLISHED BY THE UNIVERSITY.

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DIRECTIONS FOR COLLECTING AND PRESERVING DRAGONFLIES FOR MUSEUM PURPOSES.

BY E. B. WILLIAMSON.

The methods of collecting and preserving dragonflies described in this paper are for the most part those which have been worked out by the writer in the course of several years of field work. No attempt has been made to try out the many kinds of collecting appliances on the market nor to experiment with all of the described methods, but an effort has been made to discover simple and yet adequate appliances and methods for the collecting and proper preservation of specimens of this most interesting group. These directions should, then, be considered as suggestions rather than as dogmatic rules.

THE COLLECTING AND PRESERVING OF IMAGOES.

Dragonfly habitats.—Years ago the writer heard Dr. Kellicott say that the way to get all of the rotifiers was to look in all the unlikely places,—the likely places would supply a great many, the unlikely places would complete the list. The same is true of all collecting. Visiting a stream at one point does not determine its Odonata fauna on that day. One may follow it with almost barren results for miles, till a sudden turn brings one on a rocky ripple, grass margined, with clumps of lizard-tail, and broken with patches of water-willow where untold numbers of multicolored and iridescent wings spring into view, a score or more species inviting one to the chase. Or a sunny meadow may rise, brush and forest girded, up the hillside from the brook you are following; along the edges of this meadow more than one rare dragonfly may be basking on the leaves of some bush or low tree. What has been said about visiting streams is also true of lakes. If the lake visited is small the entire circumference should be explored by the collector. For various reasons, such as temperature and soil differences, the inlets and outlets of the lake may differ more or less in their dragonfly species. Prevailing winds through centuries modify the shores of lakes, and one side may be found to be boggy and without a beach while the opposite shore may have a well defined gravel and sand beach, with consequent differences in both fauna and flora. If the lake is large, consideration of the above points should receive the collector's attention when selecting places to work. If one can spend several days along one stream or about some small marsh, the first day or two may profitably be spent in a general survey and in paying attention to the larger, free flying dragonflies, leaving for a later date the close searching of low vegetation and concealed nooks for the smaller, less agile and less readily discerned species. The last day or more may be given to same particularly interesting find of the preceeding days. Remembering, in conclusion, that it has been truly said of the dragonfly collector, "all things come to him who wades."

The collecting net.—The writer has tried only a few kinds of nets. For several years he has used what is known as "Our Own" patent landing net, a steel collapsing ring, which can be obtained from entomological supply companies. The frame used has the two steel sides each about 22 inches long. The bag is made of light bobinet (15 or 16 meshes to the inch) and when flat is about 22 inches long (deep). The edge of the open end consists of two narrow sleeves of stout muslin which slip over the steel sides which make the ring of the frame. This landing net is provided with a three jointed bamboo-handle, two joints of which make a handle of suitable length for insect collecting. This insect net is light, strong, and when not in use, may be conveniently packed or carried. Bags of several kinds, suitable for beating and dredging, for example, can be carried in the field and changes from one bag to another, or the replacing of a ripped bag, can be effected in a moment's time.

Killing bottles.—Of several ways of making killing bottles the most satisfactory has been to place potassium cyanide crushed to about the size of grains of corn over the bottom of the bottle selected; this is then covered with about a quarter of an inch of sawdust, over which is poured plaster of Paris mixed with water to the consistency of cream. The whole need not occupy over an inch and a quarter of the bottle,—less if one is fortunate in pouring in the plaster. The most convenient bottle I have found is the ounce morphine bottle. Four such bottles can be conveniently carried in the double side pockets of a coat or blouse. Smaller bottles can be made in the same way of straight glass vials four inches high and seven-eights of an inch in diameter. Such small bottles are valuable for killing pairs of smaller dragonflies or for particularly small and fragile species. Such vials are also of a convenient size for carrying alcohol or other preservatives in the field.

It goes without saying that miscellaneous collections of insects should never be dumped in the same killing bottle. The scales of Lepidoptera and the juices of various Orthoptera are especially objectionable, and none of these insects should go into the bottles containing dragonflies, or in which dragonflies will be subsequently placed unless the bottles are thoroughly cleaned in the meantime.

A killing bottle made as above described will sometimes "sweat." This moisture is ruinous to dragonflies. For this reason bottles should be made several weeks before they are intended for field use and all moisture should be guarded against by airing the bottle in the sun and packing the bottom with scraps of paper or cloth if necessary.

Specimens should be removed from the killing bottle as soon as they are dead or at frequent intervals. If the bottle is "strong" a short exposure may completely destroy the colors of many species. They must be removed to some convenient and safe receptacle in which to carry them till the day's collecting is over.

The collecting case.—The box here described has been used satisfactorily for several years in various climates and under varying collecting conditions. The pattern for this leather box is shown in the accompanying diagram (Fig. 1).

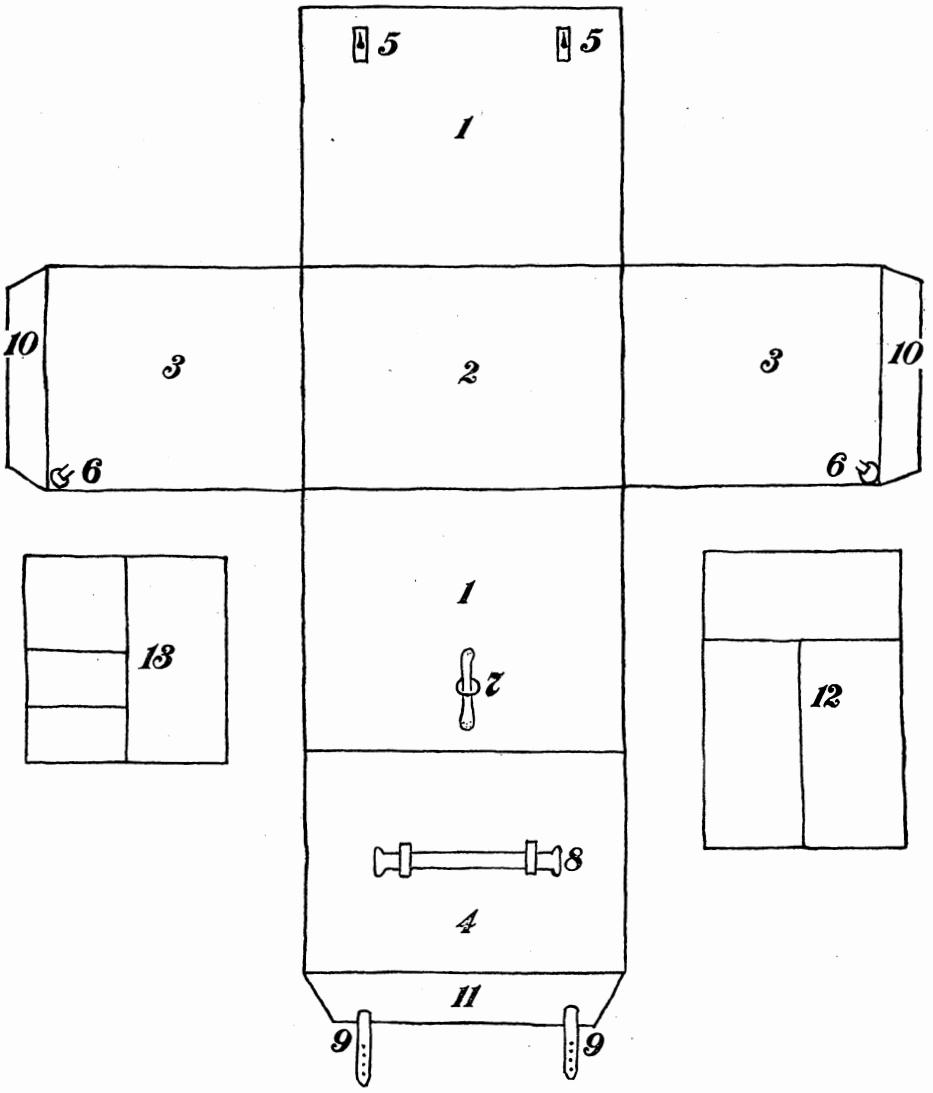

FIG. 1.—Collecting box; 1, side, about 8½ x 11 inches; 2, bottom, about 7½ x 11 inches; 3, end, about 7½ x 8½ inches; 4, top, about 8½ x 11 inches; 5, buckles in which two straps (9) on the top fasten; 6, rings for shoulder strap; 7, ring on strap, so it can slip up or down, in which to fasten snap attached to back of a belt; 8, handle on top of box, to carry when it is not over the shoulder; 9, short straps on flap (11) on top, to fasten in buckles (5) on side; 10, straps on end of box, to turn in and be covered by the top (4) when box is closed; 11, flap on top (4) of box; 12, compartments in the lower or bottom tin pan in the collecting box; 13, suggested compartments in the shallow pan (1 inch deep, 7 inches square) for the collecting box.

The shoulder strap should be about an inch and a half wide over the shoulder and at either end should have short straps with spring snaps for the rings shown on the ends of the box. The strap at one end of the shoulder strap should provide for varying adjustments in length. In the back of a wide belt, fasten a small spring snap to attach to the ring shown in the diagram on the side next the top. This ring is on a small strap, attached at its ends. When the box is on one's back and the snap on the belt is in the ring on the back (side) of the collecting box, the latter is held securely in place without at the same time interfering with one's movements. One may run or stoop over at will without having the box come tumbling in his way.

This leather box which stands 8½ inches high, 11 inches long and 7½ inches wide is now ready for its fittings. Have the tinner make a pan 4 inches deep which will just force down in it. Depending on how the harness maker has made the leather box, this will vary a little but the pan will be about 10¾ x 7¼ inches and should fit tightly in the leather box. This pan should have two partitions dividing it into three equal compartments as shown in the diagram. Make another pan about seven inches square and one inch deep divided by partitions as you wish. I have mine divided in halves, and one-half with two cross partitions dividing it into one larger and two smaller compartments. This pan must be made to slip easily in and out of the leather box.

Make a third pan also about seven inches square and deep enough to just fill the leather box when placed on top of the shallow pan, that is about three inches deep. A fourth pan is about the same size as one of the compartments in the first made pan. It will be about 4 inches deep and 7 inches long by 3½ inches wide. These four pans will just fill the leather box, the one in the bottom being firmly wedged in, the others fitting loosely so they can be readily removed. A piece of tin with turned edges, measuring about 7⅛ x 10⅝ inches, will serve as a cover for the box. Over this the leather flaps on the ends are turned and the leather lid brought down and strapped, holding everything securely.

In the three bottom compartments and in the other pan of the same size, carry ordinary envelopes (3⅝ x 6½ inches) with their flaps removed, set on edge. In these envelopes place your specimens with the wings folded back and the abdomens straight. Several specimens, depending on size, may be placed in the same envelope. The end specimens should have their heads toward the ends of the envelope. In the envelopes in these four compartments a large day's collecting can be carried home in perfect condition and in admirable shape for future papering or pinning. Some other form of collecting box may be used to suit the collector, but no better method I think can be devised for carrying home specimens than to place them in envelopes which are carried on edge. The time required to place them in the envelopes is more than saved by the admirable condition of the specimens when one comes to paper them.

In the shallow pan in the leather box the writer carries a pair of small pliers, fine tweezers for handling specimens, some vials of pins and alcohol, string, lead pencils, memorandum book and a small box or two for exuviæ. In the larger square pan is carried the lunch, some insect bags, etc. On the

return in the evening the lunch is usually replaced by a small turtle, a few small snakes, a set of bird's eggs, some seeds, leaves or flowers, or whatever of interest the day may have yielded. Pairing dragonflies, if it is desired to keep them together, are killed in smaller bottles and the pair put in an envelope by themselves, or, as taken from the net, the pair are impaled on a No. 1 insect pin, and later unpinned and placed together in an envelope. Large dragonflies such as the larger libellulines, Macromia, the aeschnines and gomphines may be carried home alive. Simply rotate the head once till the neck snaps, and place them in the envelopes. They will live a day or more in a comatose condition, expelling the contents of the alimentary canal. In the evening at home they can be killed in a cyanide bottle and papered

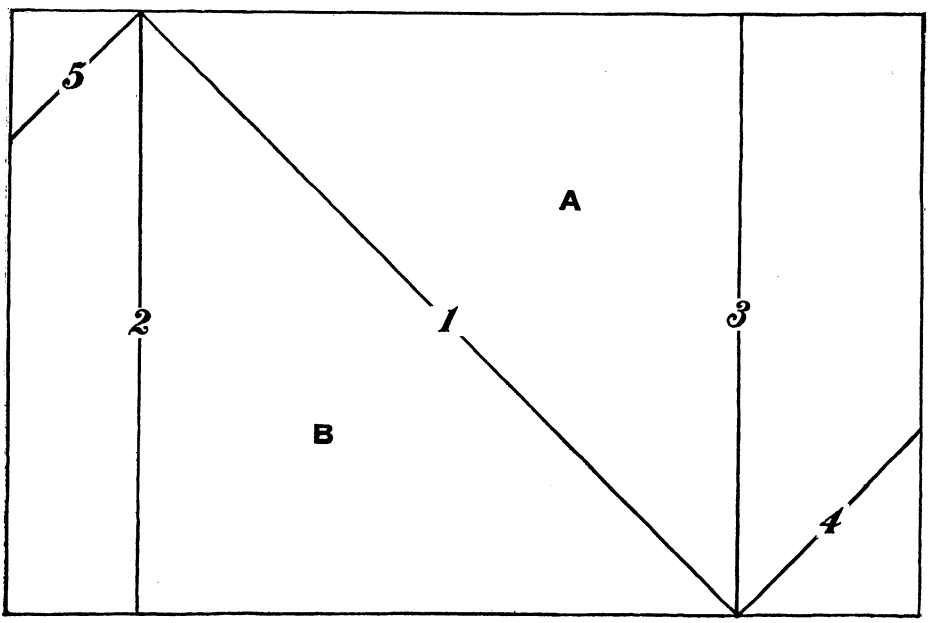

FIG. 2. Envelope for papered specimens.

at once, or they may be allowed to die naturally and then papered. Twisting the heads of large species will prevent their biting and possibly injuring the wings of other specimens if they are dropped into the cyanide bottle in the field.

With the specimens safely home, a piece of white oilcloth spread on a table, makes an ideal place for sorting, arranging and papering specimens. Personally the writer prefers to paper all of the material, later selecting from the dried specimens such as it is desirable to pin. As the conventional methods of pinning and expanding specimens have been so well explained by lepidopterists little will be said on the subject (see page 13).

Papering specimens.—The most convenient envelope is the usual three-cornered one made by folding a rectangular piece of paper as indicated, the folds to be made in the order shown, a and b being the inside of the envelope. Do not fold with a and b outside as the resulting envelope will

be different at the corners, and is less readily opened and closed. Nothing is more annoying in its way than to examine large series of specimens in papers folded some one way and some the other.

Envelopes may be obtained at any newspaper office. Have light newspaper stock cut in rectangles 2 x 3⅜ inches and 2¾ x 4⅛ inches, and have heavier newspaper stock cut in rectangles 3⅝ x 6 inches, 4¼ x 6½ inches, 5 x 7¼ inches, and so on to larger sizes if desired. The last named will paper a dragonfly nearly 5 inches long. Fold your envelopes before the collecting season or before a collecting trip. Cut strawboard corners the size of the folded envelopes, and bunch the envelopes in fifties, with a strawboard corner on either side, all held together by a small rubber band. Put these bundles under a weight or in a letter press for a few days. Nothing is more wasteful of time and energy than to make slipshod envelopes from day to day when the collecting should receive all one's energy, using for material old magazines, newspapers, discarded correspondence, etc., etc. The method here suggested provides uniform envelopes, well folded, of clean paper, unmarred by writing or printing, on which intelligible data can be written or stamped, leaving space for brief field notes or references to other fuller notes in a suitable note book. And they represent less loss of time and energy than the heterogeneous collection of half-folded waste paper in which too many collectors entomb objects of once animate nature for which they might well show more respect.

With the envelopes prepared nothing will save more time and energy than a collection of suitable rubber stamps or a small stamp in which the desired type can be set, and a small line dater. The data should include the place, the collector's name, and the date, to which may be added in writing any field observations. The ink used for the stamp should be one that will not fade or "run" if the envelope is moistened.

In papering material the first consideration is to prevent distortion of the specimen due to pressure by the envelope. The abdomen and especially the appendages are most likely to suffer. For specimens with dilated abdomens or wide spreading appendages, nothing is better than a bit of cord of suitable diameter fastened with a drop of glue on the inside of the envelope along its folded edge near one corner, the head of the insect resting at the other corner. Since dragonfly thoraces are usually larger than the abdomen and are relatively firm it is often well to paper two specimens of the same species in one paper, the heads at the corners and the abdomen of one above the other, not crossed, if the abdomens are long. So papered the thoraces will bear the pressure of the envelope and the specimens will have the abdomens and their appendages preserved without any distortion. Keep the abdomens straight and wings properly folded back together. In the case of libellulines especially see to it that the legs do not cover and conceal the accessory genitalia. When the specimen is in the envelope and the envelope has been carefully closed, fasten the corners down with a bit of gummed paper 1/16-3/32 of an inch wide and about ½ inch long fastened to the flap, at each acute corner of the envelope and around to the opposite side of the envelope. Avoid any pressure on the specimen in attaching these gummed

strips. This method of sealing the envelope is infinitely superior to the time-honored method of turning the corners. It requires less time, endangers less the contents of the envelope, is more secure, and facilitates the ultimate packing of the dried material. After papering, the envelopes should not be tumbled about till the specimens are thoroughly dry. Otherwise abdomens may be thrown up between the wings, may be crossed and constricted or bent at the point of crossing, or other damage may be done.

Drying Specimens.—As has been stated, in papering material the first consideration is to prevent distortion. The second point is to preserve as fully as possible, and that is often far too little at the best, the structures and the colors of the insect in life, or at least to dry it rapidly and thoroughly, and prevent a slow decomposition which would render the preserved specimen unduly fragile. In this connection it may be stated that it is unnecessary and undesirable to make a general practice of passing bristles or other supports through dragonflies' bodies if they have been properly dried. Bristles may be necessary in repairing broken specimens, but such specimens should be considered surgical cases, and this occasional heroic treatment should not be inflicted on all. Another reason for rapid drying is facility in handling a large number of specimens which once dried can be safely packed away, but which if undried and accumulating from day to day would form a serious obstacle to the movements of the collector.

If the amount of material collected is not large, if the collecting days are not continuous, and if frequent changes of locality are not made, papered dragonflies can be dried very well under ordinary conditions without recourse to artificial heat. At his home the writer arranges the papered material on large sheets of cardboard which are placed on tables in a dry room where the full sunlight can fall on them. As stated above, while drying the envelopes containing specimens must not be tumbled about. Rapidity of drying is essential to good color preservation, and is more readily obtained in some climates than others. In a humid climate artificial drying is necessary if good preservation is to be obtained. Artificial drying facilitates handling large quantities of material rapidly, prevents large accumulations of undried material which require the collector's attention, and seriously burden him if he wishes to make frequent moves to new localities.

After several experiments with differently constructed artificial driers, I have made one which seems to answer all the requirements. This is a tin box 15 inches high and 10 inches square, open at the top and bottom. Three sides are of tin without openings. The fourth side is open except for about 2 inches at the top and 1 inch at the bottom (where the tin of the adjacent sides is continuous), with the proper supports for 4 interchangeable drawers, each 3 inches high. The supports for these drawers are placed so the first drawer is just above the inch at the bottom of the box. Each drawer is about 3 inches deep and 10 inches square; the sides are of tin and the bottom of wire mesh, about 6 meshes to the inch; the top is open. These 4 drawers occupy the space between the inch of tin at the bottom and the tin about 2 inches wide at the top. A shallow pan of similar construction to the drawers is made to drop into the top of the box. When all the drawers are in place

the four sides of the tin box are enclosed. To the lower end of this box a tapering, heavy canvas funnel or chimney about 3 feet long is fastened. This must fit tightly over the bottom of the tin box and at the opposite end be tapered to go neatly over a small lantern using a 5/8inch wick. In use the tin box is hung at the proper height against the wall by cords attached to rings at the top of the box. So hung, with the lantern burning in the cloth funnel or chimney, and the drawers in the box, a warm current of air passes through the box and out the top. The bottom drawers are the warmest and

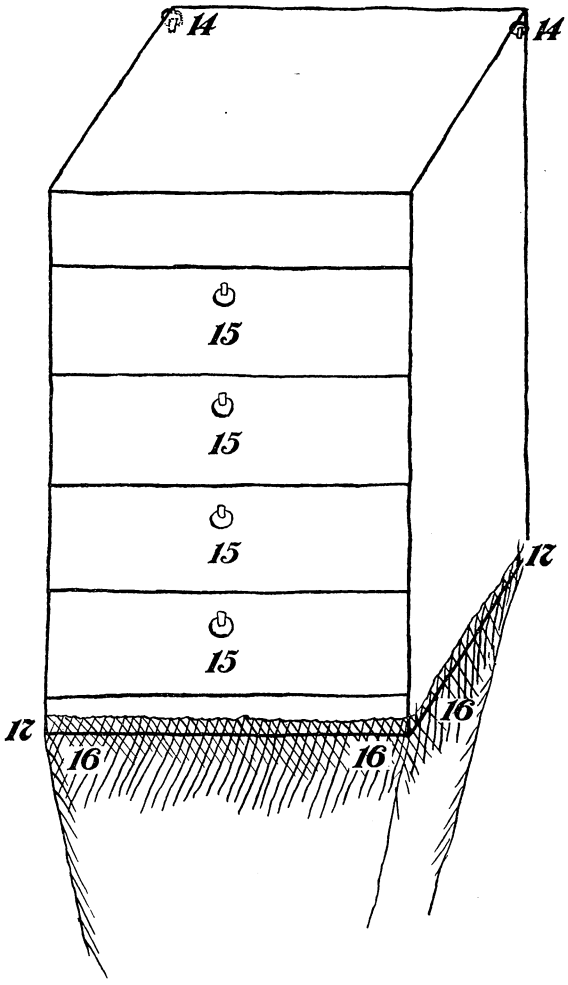

FIG. 3.—Drying box; 14, two rings by which drying box is suspended by cords against the wall; 15, four interchangeable drawers; 16 heavy canvas chimney, fitted closely around box; 17, short, sharpened, upturned wires fastened at each lower corner of the box, over which the canvas chimney (16) is hooked, to facilitate holding the chimney securely in place.

this should be borne in mind, larger species, or the most recently captured specimens being placed in the lower drawers. Place envelopes in the drawers upright or inclining, and resting on their long edge, but not piled up flat, as in the latter case the circulation of warm air about each envelope will be interfered with. Do not put all of one day's catch in one drawer, but, on the basis of size, distribute the papered specimens in two or more drawers. A little experience will teach one when the specimens can be safely removed for permanent packing. In actual practice the writer empties the drawers only as the acquisition of new material requires that room be made for it. Specimens are not injured if left for several days in the drier.

The length of time required to dry specimens is dependent on the size (bulkiness) of the specimens themselves, and on the atmospheric conditions. Small agrionines such as Argia and Enallagma will sometimes be dry at the end of 12 hours, and I have found bulkier things, such as the libellulines, dry in 24 hours.

The packing of papered specimens.—Cigar boxes make as convenient and safe receptacles for packing dried material as any other. If cigar boxes are dipped or otherwise thoroughly saturated with a mixture of equal parts of crude creosote and creolin their contents, if taken directly from the drying box, will be free from the attacks of ants and other pests. A small quantity of napthaline flakes should be placed in the bottom of the box and covered with a piece of paper or cotton wadding. Boxes should be treated with the creosote-creolin mixture several weeks or even months before specimens are put in them.

In packing material in boxes, put in pieces of cotton wadding at frequent intervals cut to the size of the box, building the box up in this way in layers. This will give a certain elasticity to the mass, and prevent shaking about, and the sheets of cotton so interspersed will prevent the envelopes packing and jamming together at one end of the box.

It is an easy matter to accumulate a lot of cigar boxes of the same size, and if this is done one can arrange a space for them in a trunk or suit case more advantageously than if boxes of various sizes and shapes are used.

Pinning specimens.—As has been said, this subject will not be discussed in detail, but one remark on pinning specimens may be permitted. The writer has long since ceased to relax specimens for pinning except in exceptional cases, such as those having highly or densely colored wings. In the great majority of cases the specimens are taken directly from the envelopes and pinned without any treatment, the Zygoptera vertically between the front wings with a smooth No. 1 pin, the Anisoptera laterally through the bases of the hind legs, close up to the body, with a No. 1 or No. 2 or rarely a No. 3 pin for the largest species. Specimens so pinned require less room and are in better condition for critical study. Of course this method is not recommended for material designed largely or solely for public display purposes.

Preserving specimens in alcohol.—The colors of dragonflies may be well or almost perfectly preserved in full strength alcohol. Such specimens should be placed in alcohol while alive or at once after being killed and the vials

or bottles of specimens kept in the dark. After a few days the alcohol in which they are preserved should be replaced with clean, full-strength alcohol.

THE PRESERVATION OF NYMPHS.

Mr. R. J. Tillyard recommends the following formula for preserving larvæ where preservation of internal parts is desired.

15 parts 98% alcohol.
6 parts formal.
2 parts glacial acetic acid.
30 parts distilled water.

Place larvæ in this alive. As soon as possible make ventral incision opposite mid-gut. After 24 hours preserve in 70% alcohol.

Professor James G. Needham, in reply to my inquiry about any special methods, wrote, "I simply use alcohol and, when particularly careful, change it a time or two within a few days after putting specimens in and endeavor to have it, when osmosis is complete, of a strength of 70-80%. Preservation of the nymphs is then entirely satisfactory. I have found formalin an abomination, as it does not penetrate and does make brittle. The glycerine mixtures make things greasy, so I have ended up by using the method that is simplified."

THE PRESERVATION OF NYMPHS AND IMAGOES FOR HISTOLOGICAL AND CYTOLOGICAL STUDIES.

The following notes on preservation of nymphs and imagoes for histological and cytological work have been kindly furnished by Dr. Philip P. Calvert of the University of Pennsylvania.

Larvæ and imagoes of Odonata may be fixed and preserved for study of internal organs as follows. Plunge the living insect into hot water, hot alcohol (30-50%) or hot Gilson's fixing mixture. The temperature should be 80°-90°C. Gilson's mixture is composed of nitric acid (46° strength) 78 cc., glacial acetic acid 22 cc., corrosive sublimate 95 grams, 60% alcohol 500 cc., distilled water 4400 cc. When the entire larva or imago is to be preserved for dissection, and not for histological or cytological work, hot water or hot alcohol (as above) will suffice. The insect should be left in them only until muscular movements cease, then withdrawn from the liquid, one or more slits cut through the chitin (according to the size of the specimen) in places where internal organs will not be injured, always taking care to cut no deeper than through the chitin and underlying hypodermis, and immediately placed in alcohol of greater strength than that employed for fixing. After one or more hours this alcohol should be replaced with stronger and so on until a strength of 70 or 75% is reached. When Gilson's mixture is used, the specimen should be (after cutting the slits) washed in water for an hour or more to remove the mercury salts.

When internal organs are desired for histological or cytological work, section-cutting, etc., the insect should be cut in pieces as it is allowed to fall into the killing fluid. This is for the purpose of affording more rapid

penetration of the fluid into the body cavity and the organs lying in it. In passing such material through alcohols of increasing strength as directed above, the transfer should be carried to 90 or 95% strength.

Permanent preservation of material for dissection should be in 70% alcohol, for histological purposes 85-95% alcohol.

Strickland (Biol. Bull., XXI, 1911, 306), has recommended Kahle's fluid (30 parts water, 15 parts 96% alcohol, 6 parts 40% formalin, 1 part glacial acetic acid) as superior to Gilson's mixture for fixing larvæ of Simulium and it may perhaps be superior for Odonata.

Schulze (Deut. ent. Zeitschr., 204, 1915) suggests a mixture of 200 cc. glycerine, 200 cc. distilled water and 1 gram crystallized carbolic acid for preservation of larvæ for dissection, especially in the tropics.

Further directions for preparation of histological material must be sought in such works as Bolles Lee's "Microscopists Vade Mecum," 7th edition, Philadelphia, Blakiston, 1913.

COLLECTING MANUALS.

For suggestions and directions on collecting and preserving dragonflies see:

1. Directions for collecting and rearing dragonflies, stone flies and May flies, by James G. Needham. Part O of Bulletin No. 39, U. S. Nat. Mus., 1899.

2. Directions for collecting and preserving insects, by Nathan Banks. Bulletin 67, U. S. Nat. Mus., 1909.