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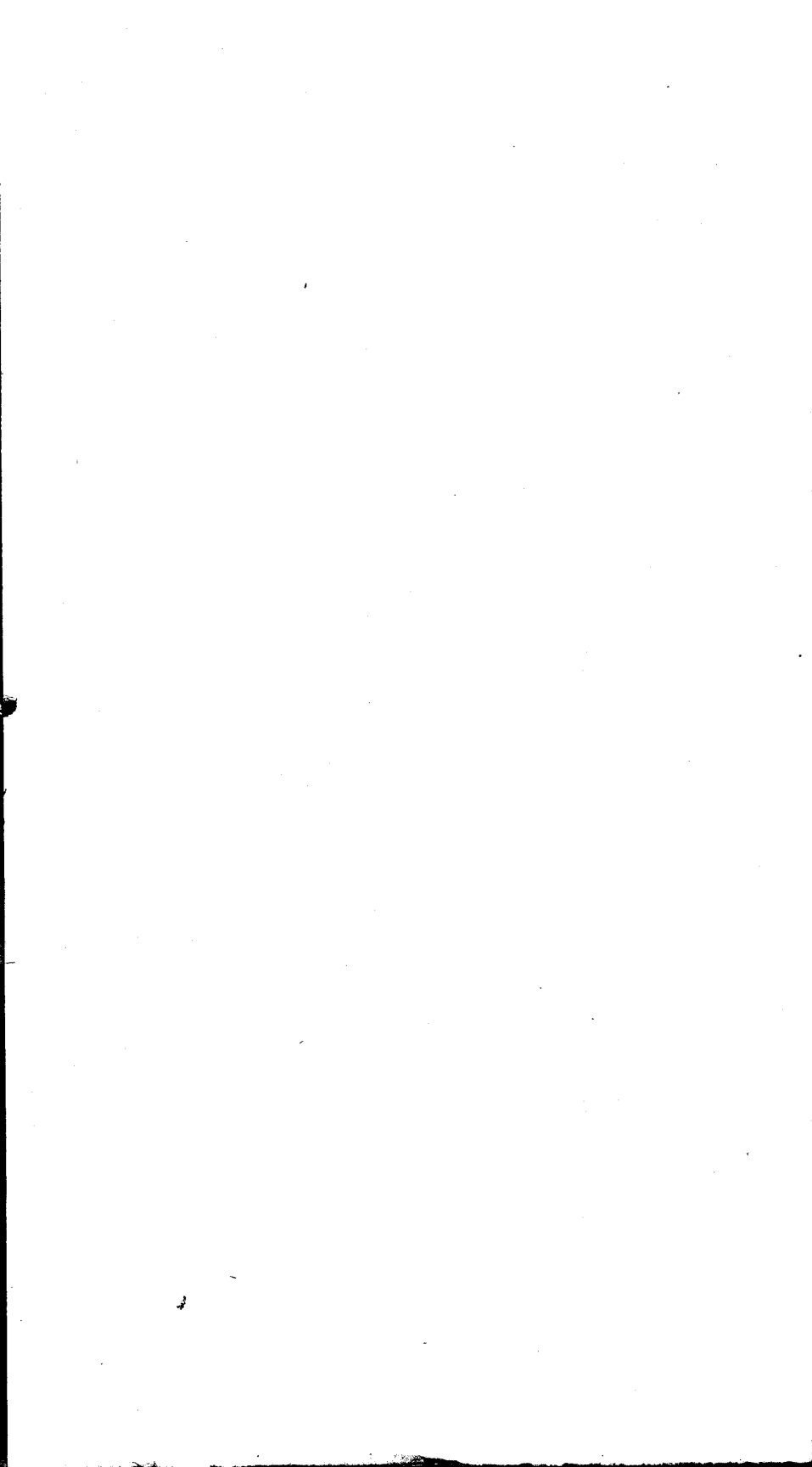
DIRECTIONS FOR COLLECTING AND REARING
DRAGON FLIES, STONE FLIES, AND
MAY FLIES.

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DIRECTIONS FOR COLLECTING AND REARING DRAGON FLIES, STONE FLIES, AND MAY FLIES.

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It is the purpose of this paper to outline briefly some simple and reliable methods of obtaining material illustrating the life histories of some of the commoner aquatic insects. Some knowledge of insects in general and of the apparatus universally employed by entomologists—nets, cyanide bottles, pins, papers, etc.—is assumed. It is proposed merely to supplement the accounts given in the general text-books and in Dr. Riley's excellent paper, *Directions for Collecting and Preserving Insects*,¹ with some new and more detailed methods of dealing with aquatic insects. While the simple apparatus here described has been devised or adapted for the purpose of studying insects of the orders named in the title, it will be found to work well for aquatic insects in general.

COLLECTING AQUATIC NYMPHS.

For collecting purposes the insect life of the water may be divided according to habitat into three groups, each requiring methods adapted to its situation.

1. *Forms living on the bottom.*—Here belong representatives of every order having aquatic species. The organic material which is continually falling upon the bottom of ponds and streams supports a teeming population and forms a stratum of great biologic richness. Few stone flies are found on the bottom in still water, but dragon flies and may flies are there abundant.

Where there is much loose material on the bottom, there is no better collecting instrument than a common garden rake. With it the débris may be drawn ashore and the insects picked by hand. Withdrawn from the water, they generally make themselves evident by their active efforts to get back. The rake is especially useful in the spring, while there is as yet no new growth of well-rooted waterweeds to interfere with hauling it. Its use is to be commended, because the places best adapted to it, such as small bays in the edges of ponds where aquatics grow abundantly, and eddies in streams, harbor also an abundant insect fauna.

¹ Bulletin No. 39, U. S. National Museum, Part F, 1892.

Even where the bottom of the pond seems bare, the rake will bring ashore much loose mud and silted material, containing the burrowing nymphs of dragon flies and may flies (*Gomphus*, *Hexagenia*, etc.); but, for collecting in such places, the sieve net shown in fig. 1 is much better. This is a net and a sieve combined. It has a long handle, and is so shaped that it can be easily used from the bank. The frame is of light

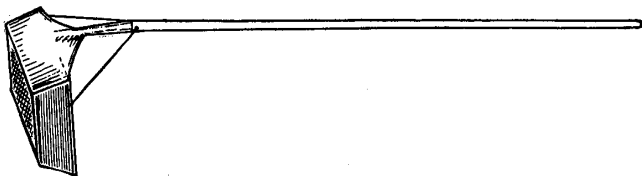


FIG. 1.—Sieve net for collecting nymphs from sand and mud.

steel rods; the sides are of galvanized iron; the bottom is of galvanized wire screen. It is especially adapted for scraping up from the bottom mud, fine silt, and sand, and for sifting out at the surface the nymphs therein contained. It may be used away from shore where a rake is almost useless, and it is much better than a rake for collecting burrowing nymphs (for which it was devised), but it is not so good as a rake where there is much material.

2. *Forms living above the bottom in still or slowly flowing water.*—The more agile nymphs of dragon flies and may flies are exceedingly abundant, clambering among the submerged branches of erect aquatic plants. All but a few of the smallest species are easily taken by “sweeping” the plants with any of the well-known forms of water net.

There are, however, a few little nymphs of may flies that can hardly be dislodged with the net, and that are hardly discoverable on plants withdrawn from the water. These may be found by examining the plant stems, a small bunch at a time, in a white dish of clean water.

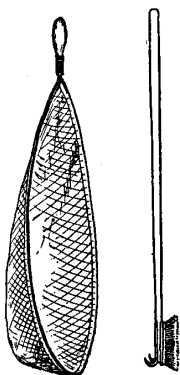


FIG. 2.—Sag net, hook, and brush for collecting in rapids.

3. *Forms living in the rapids of streams.*—Many of these may be obtained by simply picking them by hand from stones lifted out of the stream, but not all. Those which cling to swaying sedge and willow stems may be “swept” with a water net; but a net better adapted for collecting in rapids is shown in fig. 2. It consists of a ring of stout spring wire 3 to 4 feet in diameter, to which is attached a very shallow bag of coarse bobinet, and at one side is a handle only long enough to be held readily.

It is intended to catch insects adrift in the stream, and is accompanied by an instrument for dislodging them. Such an instrument is figured at the right of the net. It consists of a handle

3 to 4 feet long, with a double hook at one side and a brush at the other side at its distal end. To illustrate the use of this apparatus, suppose we wish to collect the insects from the stones obstructing a brook. We place the net directly below the obstruction and in the current, and adjust it to the bottom by downward pressure on the handle with one hand, while with the other we rapidly overturn the stones and with the brush sweep free the clinging insects. These are driven by the current into the net, which is then lifted and emptied.

Most stone flies and many may flies and at least one dragon fly (*Argia putrida*) are found in such situations.

4. *Transporting live nymphs.*—In order to carry home a day's catch alive, a large quantity of water is not necessary. It is well to have a pail and to place within it a few smaller receptacles containing a little water and to pack wet waterweed between these. Then the smaller nymphs taken may be distributed among the receptacles so as to diminish the chances of their eating one another, and all the larger and stouter nymphs may be stowed away in the waterweed, which does not need to be submerged unless left long uncovered in the sun. Well-grown nymphs can breathe air directly, and entangled among the stems will be kept out of mischief. The cannibalistic habits of certain species of the larger dragon flies (*Anax*, etc.), and the predatory habits of all of them need to be borne in mind while arranging receptacles for them, and specimens differing greatly in size should not be put together.

Great care is necessary, however, with some species, especially species of stone flies, which live in rapids where the water is well aerated. If these are to be transported, they must be kept in clean water and hurried home and into suitable permanent quarters.

COLLECTING AT TRANSFORMATION.

The easiest method of collecting life-history material is, doubtless, to pick specimens up when transforming. To be sure, this does not give the complete life history; but, since the cast skin preserves the form of the nymph, and the several nymphal stages are much alike except in size and length of wing cases, it gives the better part. To the general collector with but little time to give to these "unimportant" groups this method should appeal strongly, for by it he may, without apparatus, and with a minimum of time and trouble, obtain most valuable material. One may often find nymphs crawling from the water, imagoes emerging from their old nymph skins, others drying their wings, and others ready to fly, and all in large numbers, needing only to be picked up.

The value of this material may be wholly lost, however, unless attention be given to three points:

1. The maturing of the imagoes.
2. The preservation of the often delicate exuviae.
3. The keeping of the imago and its skin together.

The following adequate and very simple method is commended: Take afield a pocket full of small paper bags, of the coarsest sort used by grocers, and finding imagoes emerging, slip them singly into the bags, each with its own cast skin, writing desired data on the outside of the bag. Before the skin is lifted from its support the claws should be loosened carefully with forceps, else legs will be broken off. Very delicate and easily broken skins may be slipped into envelopes of tissue paper before they are dropped into the bag; this will diminish the danger of breaking from being tumbled about; or, they may at once be put into vials of alcohol and numbered to correspond with their imagoes. The bags are closed by twisting the top. To the rough interior the imago clings easily, with plenty of room for expanding and drying its wings. Bags thus filled may be carried home loosely piled into a large basket or in a large sack. They should be left unopened for a day or two,

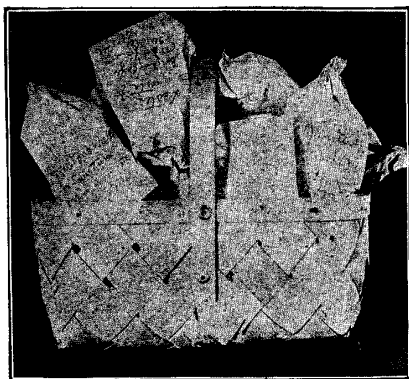


FIG. 3.—A morning's catch of dragon flies taken in transformation and properly fixed for maturing their colors.

until the mature coloration of the imagoes has appeared, and the form of all parts is well fixed by chitinization. With may flies, specimens of the subimago should of course be preserved on the approach of the time for the final molting.

While gathering such material one should endeavor to get besides males and females with their skins (only a few of which for each species need be kept separately for positive determination)

also nymphs leaving or ready to leave the water and others transforming; and, as in other collecting, good series are very desirable.

As to the time and place for such collecting little need be said, since members of these three orders are transforming throughout the open season and live in all sorts of fresh water. Certain stone flies may, indeed, be found transforming abundantly in midwinter. In general, it may be stated that the nymphs all transform at the edge of the water. A few, like *Gomphus villosipes*, may clamber only far enough upon sloping banks to expose their backs, while others, like some of the larger *Libellulidae*, may crawl several rods from the water, when this is necessary, to find suitable place to transform. The majority transform within a few inches of the water's edge. Some species of these three orders transform habitually at night, many throughout the day, but a majority of the dragon flies, at least, transform early in the morning.

The resident collector who knows the season of flight for any common species may get nymphs of that species by going out at the beginning of its season and picking them up as they crawl from the water. If on going out the first time he finds the most recently emerged imagoes are ready to fly, he must go again at an earlier hour.

The invitation to collect by this method comes oftenest from the fluttering of a limp and half-colored imago before one's feet. Near to the place whence this one was flushed and in similar places one may look with some confidence for others still in process of transformation. This method alone will not satisfy the thoroughgoing collector, but, because he may sometimes accumulate a large amount of valuable material in a few minutes and with no more apparatus than may be carried in a single pocket, it deserves to be better known.

REARING NYMPHS.

The best way to rear nymphs is to let them rear themselves. Locate them, collect a few from time to time to watch their growth, preserve the young ones for specimens, and do not take any for rearing until about grown. Their development can be gauged by the length of the wing cases. For species that seem common, and that live in accessible places, there is no advantage in early collecting; they will seem to become more common as the season of their transformation approaches, because, first, they get larger and are more readily seen; and, secondly, they approach the margin of the water and are more easily taken.

The best rearing device is the one that keeps its inmates under conditions most nearly natural. A cage for aquatic insects that hardly disturbs such conditions at all consists of a cylinder of galvanized wire screen, open at both ends, having a loose screen cover with a rim of heavy wire. One end of the cylinder is pushed down into the mud of the bottom in shallow water, the cover is laid on and all is ready. Such a cage merely incloses a small water area with its natural vegetation, and nymphs placed inside live their natural lives and obtain for themselves their accustomed food. Of course the size of the mesh must be adapted to that of the insects to be reared—small enough to confine them and large enough to admit their prey. Fifteen inches is a convenient height.

For burrowing nymphs it will be necessary to set the lower edge of the cage down into the mud of the bottom 2 or 3 inches; this is easily done with a garden trowel.

It is better, owing to danger from freshets, not to plant such a cage in the rapids in the direct course of a stream, but to divert a small arm

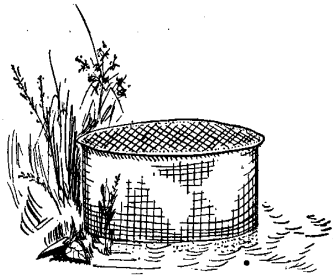


FIG. 4.—Cage for rearing nymphs under natural conditions.

of the stream behind some sheltering rock or log, place the cage there and build miniature rocky rapids inside it. In quiet waters no such precautions are necessary, but where the rise and fall of the water level is great it may be necessary to move cages sometimes. In general, it is better to hide the cages among vegetation, away from the eyes of the untutored and irreverent. For aquatic insects which pupate on land a cage is easily planted half in the water and half out.

Nymphs placed inside will readily crawl up the sides to transform. Young imagoes should be taken out as soon as convenient after transformation is completed (otherwise some will fall into the water and die before they are mature) and placed in paper bags with their exuviae until dry and well colored.

Collectors will find it convenient to have cages of this sort made up in "nests" to fit one inside the other, the size of the mesh decreasing with the size of the cage. A nest of a dozen such cages and covers will be found a slight transportation incumbrance.

One may wish to take nymphs far from their natural habitat and to rear them at home with no streams or ponds near. A simple breeding cage that may be used successfully under such conditions consists of a rough wooden kit, or pail, or tub, or half barrel, with a loose screen cover. It must be rough inside, so that the nymphs can crawl up its sides. It should be half filled with water, the nymphs put in, and some trash with them for them to cling to, the cover added, and the whole set in a place where it will not get overheated and yet will receive the direct rays of the morning sun. Conditions will be less natural in such a cage as this, but if only nymphs which are well grown and require little or no food are put into it, it will be found entirely satisfactory.

A very satisfactory way to rear some of the smallest and most delicate species of dragon flies and may flies, species requiring well aerated water, is to place the nymphs in shallow, flaring dishes of unglazed pottery before an open screened window in one's room. The water will need to be renewed daily or oftener, because of the rapid evaporation, but it will keep very sweet; and the imagoes emerging will go at once to the screen and stay there, and the danger of their falling into the water before maturing and dying is obviated.

COLLECTING IMAGOS.

The easiest way to get good specimens of the largest dragon flies is to rear them. It is idle to run after them with a net; but one may observe sometimes that they are flying upon a regular "beat" and may so station himself that they will once in a while come within reach. When a favorite resting place is discovered, one may wait beside it sometimes to good purpose. After a noonday shower specimens are frequently to be picked by hand from low bushes near the water, and at dusk, also, some of the large species may be found settled for the night in such places, though most of them settle so high as to be out of reach.

While all but the largest species are easily taken with a net, one may greatly economize time in gathering duplicates by "sweeping" the vegetation of the shores at sundown. Most desirable stone flies may be swept from the grasses and sedges overhanging small and rapid streams. One should, of course, take advantage of the "swarming" of may flies. The smallest of the stone flies are best picked up with a brush wet with alcohol and put directly into vials of the same preservative.

It may be worth while to suggest that subimagoes as well as imagoes of may flies should be collected, and that one should try to get both young and old imagoes of dragon flies of the family *Agrionidae*, of these latter many species have been described as dimorphic, so striking are the differences of appearance at different ages. Males and females taken in pairs should be kept together for the certain identification of the females—often a difficult matter, otherwise.

Lepidoptera should be rigidly excluded from the cyanide bottles used for killing these insects, for the shed scales are an intolerable and altogether unnecessary nuisance.

PRESERVATION OF SPECIMENS.

Nymphs are best preserved in alcohol (about 80 per cent). The more strongly chitinized and impervious ones should be dropped first for a few minutes into water almost boiling; the thin-skinned nymphs of most stone flies and of may flies should be put directly into the alcohol. Imagoes also may be preserved in alcohol, and better, so far as preservation is concerned, than by any other method. If kept in the dark the colors will be well retained. Even if one be pinning specimens it is well to have a "stock bottle" of alcohol at hand to catch the large series of duplicates which would never be pinned; for the collector well knows that pinning is a time-consuming process.

Pinned specimens of dragon flies, at least, should have the body "wired," otherwise heads and tails are certain to fall off and be broken or lost. For this purpose it is well to use beheaded, japanned pins, cut to the proper length; one is inserted through the front of the head, pushed through the body lengthwise but not protruding; the body dries fast to it and is then not easily broken. If one be not long enough two may be used, one inserted from each end. Formerly a wire or bristle was used, but the pins being well pointed enter easily and effect a great saving of time and temper. Even if specimens are to be put away in envelopes it is better that they should be wired and pinned first, because specimens once dried do not thereafter stick well to the pins.

The foregoing simple methods and appliances have been abundantly tested in practical work. It is believed they will be found more effective and practical than others generally recommended hitherto. They are offered in the hope that these interesting orders of so much scientific importance may receive a little more attention at the hands of general collectors, and that materials needed for their study may be more rapidly brought together.