

ASSESSING AQUATIC INSECT FLIGHT BEHAVIOR WITH STICKY TRAPS¹

T. L. Harris and W. P. McCafferty²

ABSTRACT

A suspended sticky trap was designed to analyze flight behavior of aquatic insects, including both direction and vertical distribution of flight. Specifications of trap construction are detailed. Possible applications were explored and preliminary results from the study of a small Indiana stream demonstrated primary upstream migration of females, and indicated vertical partitioning of flight activity at the species level.

Investigations of the aquatic insect fauna of particular habitats, whether it be for life history or monitoring studies, are often dependent to some degree on the study of aerial adult stages of the aquatic species present (Provonsha and McCafferty, 1975). Because of the variation in emergence and flight behavior among aquatic insects, the habitat might ideally be sampled continuously, 24 hours a day, over the entire emergence season. Since this is not usually feasible, investigators have had to resort to various representative sampling methods which may not be ideal. The two methods most commonly utilized by aquatic entomologists have been light trapping, and aerial and sweep netting (Lattin, 1968). Both methods are unfortunately qualitatively biased, since light trapping must take place at lowered light intensities and netting may be efficient only during daylight hours. Emergence traps are limited by sample size. Madson et al. (1973) first used a crude sticky trap to capture Plecoptera and Ephemeroptera flying over a stream in Denmark. This sampling principle was promising since most of the above mentioned sampling bias could be avoided.

A study was initiated to design and test a unique sticky trap which was hoped would greatly improve sampling of running-water insects, and provide a method of assessing flight behavior in time and space. The construction details and operation of such a trap are presented herein. In addition, some preliminary results from an investigation which incorporated the trap are given in order to illustrate the potential utility of this new methodology.

TRAP DESIGN AND OPERATION

Sticky traps work in much the same manner as "fly paper". Upon contact, animals will adhere to the non-drying, non-volatile, sticky surface (Southwood, 1966). The trap (Figs. 1 and 2) is constructed as follows. Clear acrylic plates, 2 mm thick with .1 m² exposed sticky surface (Fig. 1) are arranged end to end in a linear series. Each acrylic plate measures 30.00 X 35.35 cm and is made slightly rectangular so that minimum wastage of acrylic takes place during construction. The sheets are held on two sides by 2 X 2 X 34 cm wooden support frames. A centered groove 1 cm deep is cut the entire length of the support frames allowing the acrylic sheets to be inserted, centered, and fastened with brads. Quarter inch holes are drilled into the ends of the support bars so that bolts with wing nuts can be added to both ends of the frames. The support frames strengthen the acrylic, and the bolts and wing nuts

¹Purdue Agricultural Experiment Station Journal No. 6731.

²Department of Entomology, Purdue University, West Lafayette, Indiana 47907.

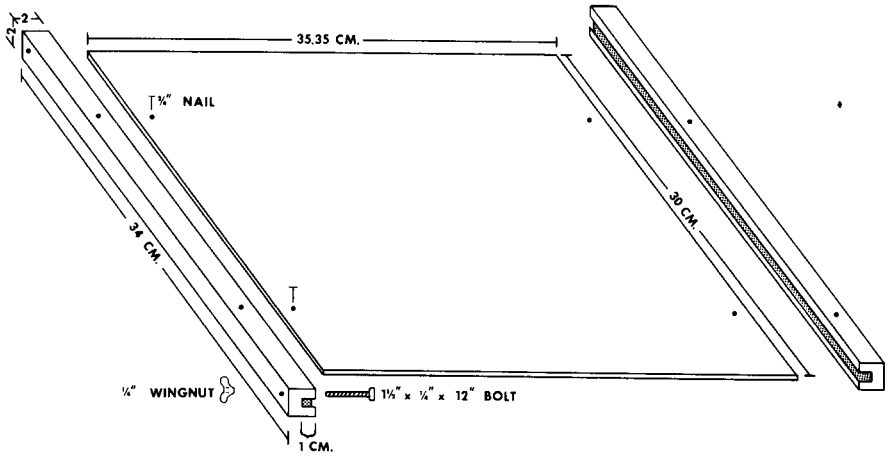


Fig. 1. Diagram of reusable sticky trap plate.

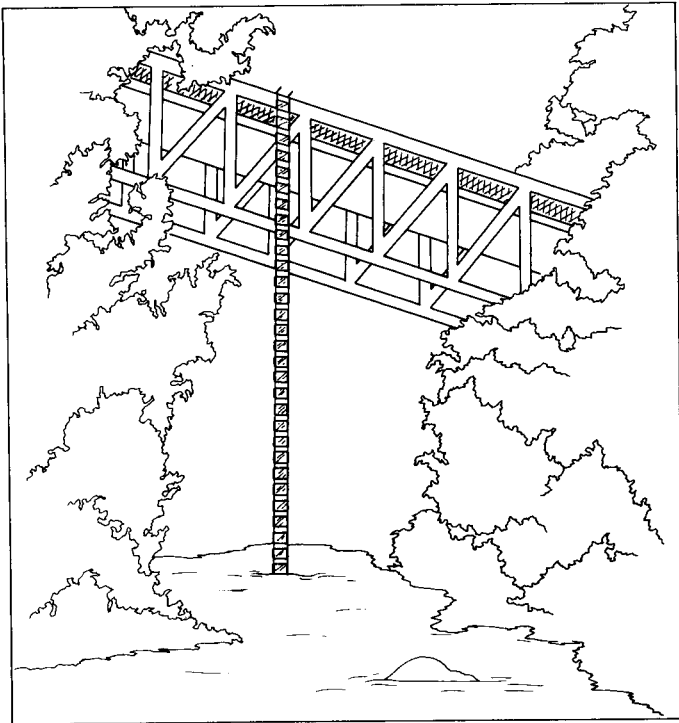


Fig. 2. Sticky trap suspended from High Bridge to monitor upstream flight over Little Pine Creek, Warren County, Indiana.

enable the traps to be attached to chains or a fixed support. The support frames also keep the trap surfaces from sticking together during transport.

An adhesive that may be used is Tack-Trap[®]. This adhesive when applied in a thin layer is nearly transparent. The application of adhesive can be a tedious and messy process. In order to avoid this and also attain a light uniform coat, adhesive should be painted on the trap with a seven inch paint roller with short nap. When utilizing this procedure, approximately 60 plates can be covered with an even coat of Tack-Trap[®] in less than 10 minutes.

Adhesive materials employed in sticky traps may pose problems when working with small and fragile specimens. These specimens when removed from the adhesive often sustain mechanical injury which could make specific determination difficult. This problem can be overcome by the use of the solvent oleum, which does not damage the acrylic sampling plates, but does dissolve the adhesive. Insect laden plates, when removed, should be submerged in oleum in a large, shallow pan. Usually, the insects will float free in the oleum in less than 10 minutes. The mixture may then be funneled through a standard sieve to filter the insects. Although the oleum wash allows speedy specimen removal, it is not miscible in ethanol. The specimens can be placed in a container of 1,4 Dioxane momentarily before placement in ethanol. Specimens retained in the oleum for more than a week become very brittle.

Traps may be attached by chains via the support bars and suspended (for example, from a bridge) above the water (Fig. 2). Adhesive can be placed on one or both sides of the acrylic plates and the traps suspended perpendicular to the stream flow. For retrieval, traps may be stacked in sequence, placed in a carrying case, and transported to the lab for processing. Although adhesive will not deteriorate quickly, caution should be taken since insects may begin desiccation within 24 hours. Heavy dew and light rain do not seem to diminish the adhesive properties of Tack-Trap[®]. If the lower part of the trap becomes partially submerged, insects may still be retained.

TEST APPLICATION AND RESULTS

The above described sticky trap has potential for improving investigation techniques for studying adult flight behavior, monitoring, and life history studies of many aquatic insects. For example, although much has been written about downstream drift of aquatic insects (Müller, 1974; Waters, 1972), little is known of how the upstream fauna is reestablished. The few observations on upstream migration of adult aquatic insects have usually reported the movements of a single species and/or are based solely on visual observation (Elliott, 1967).

In our preliminary testing during the summer of 1975, sticky traps were used to evaluate the fauna of a small third order stream in central Indiana, and to assess the adult flight activity of Odonata, Plecoptera, Ephemeroptera, and Trichoptera. Two traps were suspended from a bridge over a narrow gorge 18.3 m deep (Fig. 2). Each trap consisted of 30 acrylic plates spaced 30 cm apart and was suspended off the side of the high bridge, (one with the sticky surface facing upstream, the other with the sticky surface facing downstream). This procedure permitted the assessment of a) numbers and kinds of insects present, b) comparative directional movements both upstream and downstream, and c) the vertical distance above the water surface at which species flight most often occurs.

Initial samples gave some very interesting results. The number of insects captured moving upstream (caught in the trap with sticky surface facing downstream) were markedly greater than those encountered in the trap which faced upstream. Three 24 hour collections by this trap during July, August and September of 1975 collected 1,359 specimens of Trichoptera, Plecoptera, Ephemeroptera, and Odonata; of these, 1,046 were retained by the trap facing downstream, 313 by the trap facing upstream. Samples of all identified insects verified suspected upstream migration of adults.

Identifiable species of Trichoptera, Ephemeroptera, Odonata and Plecoptera indicated an additional apparent trend. In each of these orders, the greatest percentage of insects captured were females. In some species, such as the caddisfly *Cheumatopsyche pettiti* Banks, females comprised over 90% of the total catch. However, when upstream and down-

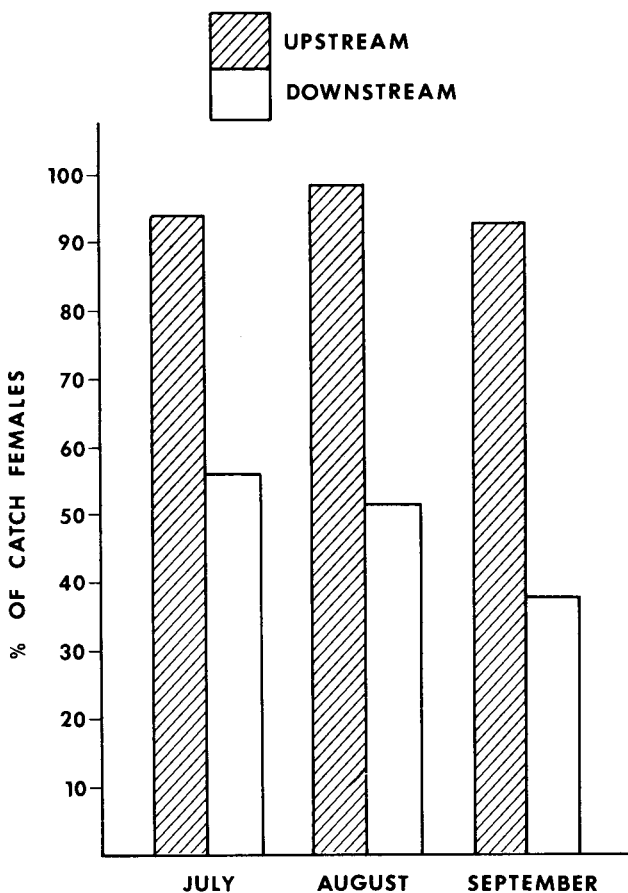


Fig. 3. Percentage of females of *C. ~~sp.~~* retained moving upstream and downstream for three 24 hour samples.

stream samples were compared (Fig. 3), the ratio of females to males retained by the upstream side of the trap (indicating downstream movements) was nearly 1:1, while the ratio of those retained by the downstream trap (indicating movements upstream) was 9:1. Results indicated that the males were not preferably moving upstream, and that upstream migration of females alone may be responsible for recolonization of previously displaced drifting larvae. These data are credible from an evolutionary standpoint, assuming it would be a wasteful strategy for males to migrate upstream after mating has taken place near the emergence site.

The distribution of insects that were obtained at different heights above the stream surface (Fig. 4) provided a plausible explanation for the inadequacy of many standard collecting techniques. The lowest level sticky trap (that placed just above the air water interface) collected the greatest numbers of insects. Only a few of the species sampled were not found at this low level. Many of the species were seldom found more than 30 cm above the air water interface. Some were most commonly retained at 2 m above the water's surface, and still others were most commonly found 9 m or more above the water surface.

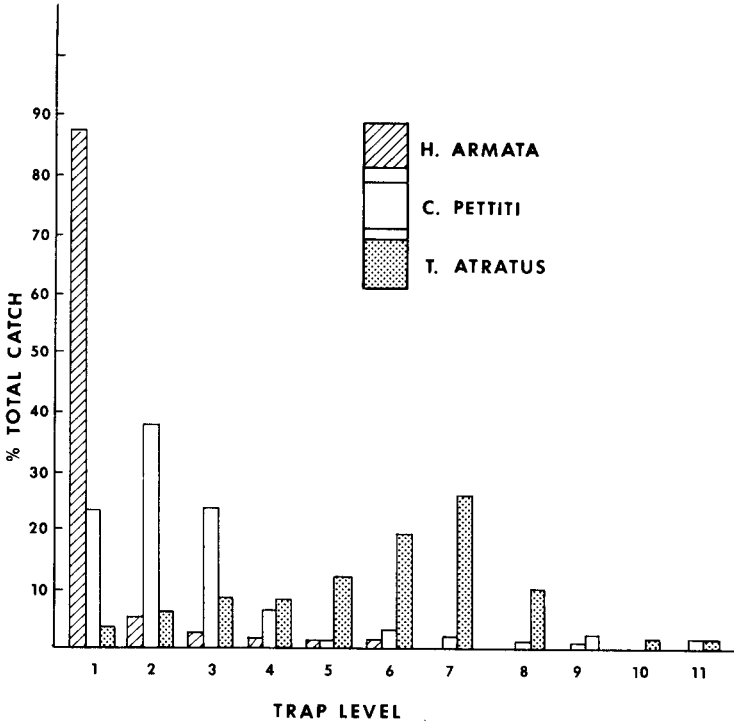


Fig. 4. Percentage of total catch of *H. armata*, *C. pettiti*, and *T. atratus* at different elevations for three 24 hour samples.

The Hydroptilidae, [for example, *Hydroptila armata* Ross (Fig. 4)] were primarily limited to flight within 1 m of the air water interface. Interestingly, this is one of the poorest known and least sampled families of Trichoptera. Other caddisfly species such as *Cheumatopsyche pettiti* were most often collected 2 m above the stream surface. Most mayfly species were collected in greatest numbers at relatively high elevations. Plates from the water level to 13.3 m above the stream retained large numbers of *Tricorythodes atratus* McDunnough; most were collected over 10 m. This flight level corresponded to the canopy level at the collection site, and the characteristic swarming height for this species (Hall, et al., 1975).

Other traps that may normally be placed more than a meter above the water surface may theoretically not be as effective for collecting hydroptilid caddisflies. This was demonstrated by both Malaise and light traps that were used to collect hydroptilids at the study site (Fig. 5). Also extensive collections utilizing aerial nets at the sample site did not contain many *Tricorythodes atratus* adults although the larvae were present in large numbers. The apparent "out of arms reach" flight behavior monitored by the sticky trap would, however, account for this situation.

Effectiveness of the sticky trap for monitoring studies was demonstrated by a trap which we suspended in a culvert over a small stream. This single plate trap collected in 24 hours: two mayfly species, three caddisfly species, and one stonefly species not obtained in a 2 hour light trap sample and extensive sweeping the day before at the same site.

In conclusion, the described sticky trap appears to be well adapted for monitoring stream flying aquatic insects. Most flying insects were retained, the only insects which noticeably avoided capture being aeshnid dragonflies. With the exception of these dragonflies, light trap and sweep net collections of insects at the sample sites failed to turn up any

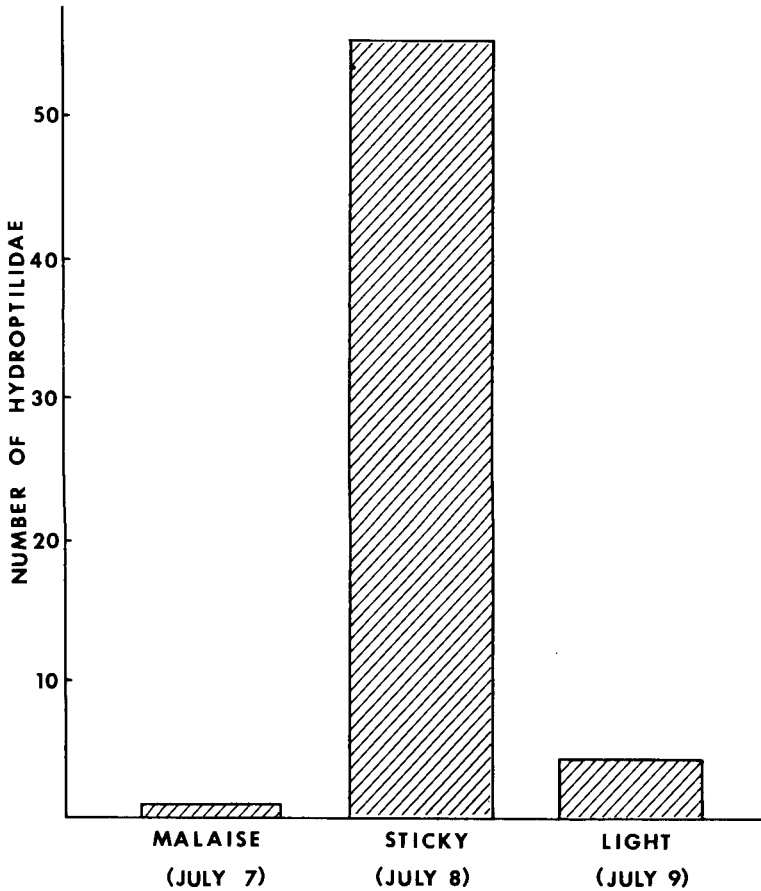


Fig. 5. Numbers of Hydroptilidae retained by light, malaise, and sticky trap. The malaise trap was suspended directly above the water surface, the light trap was located on the bank ca. 1.5 m above water level. Weather conditions were similar each day of comparison.

aquatic species that were not collected by the sticky traps. For life history, faunistic, and behavioral studies, this sticky trap should provide a constant monitor of most aquatic insects flying above the stream and emerging or active during particular times of the day or season.

LITERATURE CITED

- Elliott, J. M. 1967. Invertebrate drift in a Dartmoor stream. *Arch. Hydrobiol.* 63:202-37.
 Hall, R. J., L. Berner and E. F. Cook. 1975. Observations on the biology of *Tricorythodes atratus* McDunnough (Ephemeroptera: Tricorythidae). *Proc. Entomol. Soc. Wash.* 77:34-49.
 Lattin, J. D. 1968. Equipment and Technique, p. 50-51, in: R. L. Usinger, *Aquatic Insects of California*. Univ. Calif. Press. Berkeley.

- Madson, B. L., J. Bengtson, and I. Butz. 1973. Observation on upstream migration by imagines of some Plecoptera and Ephemeroptera. *Limnol. Oceanogr.* 18:678-81.
- Müller, K. 1974. Stream drift as a chronobiological phenomenon in running water ecosystems. *Ann. Rev. Ecol. System.* 5:309-23.
- Provonsa, A. V. and W. P. McCafferty. 1975. New techniques for associating the stages of aquatic insects. *Great Lakes Entomol.* 8:105-9.
- Southwood, T. R. E. 1966. *Ecological methods with particular reference to the study of insect populations.* Methuen, London.
- Waters, T. F. 1972. The drift of stream insects. *Ann. Rev. Entomol.* 17:253-72.