THE EMERGENCE OF MAYFLIES, STONEFLIES, AND TRICHOPTERA OF THE LEAF RIVER AS RELATED TO WATER TEMPERATURE AND RIVER DISCHARGE

Paul A. Phillips and Fred G. Howell
Department of Biological Sciences
University of Southern Mississippi

INTRODUCTION

The objectives of this study are to: (1) demonstrate generalized patterns of emergence of the members of each of three aquatic insects orders (mayflies, stoneflies, and caddisflies), and (2) describe the relationship between the emergence of members of these orders, river discharge and seasonal, water temperatures of Leaf River near New Augusta, Perry County, Mississippi. The combination of these three aquatic insect orders are often referred to as the "EPT" group and are often used in the evaluation of the ecologic health of a particular water body. The information presented here will be useful in determining life histories, coordinating more accurate procedures for sampling aquatic insects, and demonstrating the natural variation associated with the biologies of these three insect groups. To our knowledge, a study of this type has never been conducted in south Mississippi.

Emergence of aquatic insects in temperate latitudes is known to be regulated by photoperiod and other environmental factors as such as temperature (Beckett 1982; Masteller 1993). While our larger project is focused on species and their individual emergence patterns as affected by water temperature and other natural variables in this section of the Leaf River, this paper will serve to document the relationships between water temperature, river discharge, and the seasonal emergence of members of these orders in this stretch of the Leaf River. This sampling for this study was begun in May 1994 and ended in September 1995.

MATERIALS AND METHODS

Sampling Method

An incandescent light trap located on the grounds of the Georgia Pacific Corporation, Leaf River Pulp Operations mill in New Augusta, Mississippi, was used to collect the emerging adult insects. The light trap was mounted between two poles on the banks of the Leaf River approximately 1.75 meters above the ground. The trap was positioned six to eight meters from the water. Samples were retrieved every seven days in 120 ml containers and immediately preserved in 75% ethanol. All the containers were stored in the lab at the University of Southern Mississippi.

Sorting

The samples were rinsed in a U.S. Standard No. 30 sieve then placed in a 15 cm X 30 cm pan for sorting. A lighted magnifier was used to aid in the removal of all undesired individuals. Twenty milliliter scintillation vials were used to place the individuals from the target orders when removed from the sample at large. Separate vials were used for each target order for each sample. A label was placed in each vial noting the order, the date the sample was collected, and the location. When the study is concluded, the label will include the family and species name as well.

Analysis

To determine when the emergence of each order takes place and to be able to predict the timing of the emergence, data from each order will be compared with the water temperature, air temperature, river discharge, and rain fall. Thermal units, or degree days, will be computed and then charted against the emergence data so that time intervals between emergencies can be predicted more accurately.

RESULTS AND DISCUSSION

Sampler Performance

The light trap performed as expected over the entire sampling period. Light bulbs were changed monthly to guard against any periods of light outages that could occur from a spent bulb. Vandalism was recorded twice during the sampling period. On one occasion, the collection jar was completely shattered by what appeared to have been pellet gun or small caliber rifle fire. On the

second occasion, the collection jar was struck by an object, likely a rock, which cracked but did not break the jar.

Numbers of Individuals vs. Temperature

Ephemeroptera. Mayflies first appeared in the light trap in March; river water temperature was above 16°C (see Figure 1). The greatest numbers of individuals were seen in May; water temperature was above 20°C (Figure 1). In all, 649 individuals were collected over the seventeen months of the study period.

Trichoptera. Caddisflies first began to emerge in February; average water temperature during this month was 14°C and above (Figure 1). The greatest numbers of individuals emerging and being caught in the light trap occurred in July when the temperature was above 26°C (Figure 2). During the entire sampling program, we collected 1357 caddisflies in the light trap.

Plecoptera. Individuals of this order showed a different timing of emergence than that illustrated by the previous two orders by appearing during the cooler months of November, January, and February (Figure 1). However, the greatest numbers of stoneflies emerged in May as the water temperature was elevated to more that 20°C (Figure 1). Only 44 individuals of stoneflies were collected during the seventeen month sampling period.

Based upon the numbers of individuals collected, stoneflies (plecopterans) were not abundant in that area of the Leaf River. This has been demonstrated in previous work on the Leaf River by Mischuk and Howell (1984, 1985, 1986, and 1987).

Numbers of Insects vs. River Discharge

The time span extended through most of two growing seasons, including the winter portion of 1994 and 1995. While the influence of seasonal temperature is obvious, i.e., the timing of emergence of the EPT groups could be expected to occur mainly during the warmer portions of the year. However, comparison of the total numbers of individuals emerging and being trapped differed greatly between the growing seasons of the two years represented. The data presented in Figure 2 make a compelling argument that the numbers of individuals emerging may be associated with the magnitude of river discharge. Our data suggests that while temperature (and probably photoperiod) represent major influences on the patterns of emergence of the members of these insect orders, river discharge appears to impact either the numbers successfully emerging or the ability of our trap to collect insects.

CONCLUSIONS

It appears obvious that the emergence activities of aquatic insects in the Leaf River are being influenced greatly by the physical nature of the river itself, particularly its temperature with its discharge rate having a modifying influence on the actual numbers successfully emerging. The preliminary results of this study support the findings from other emergence studies (Harvey 1971; Becker 1973; Weiss et al. 1993) that temperature is a major factor in the emergence of aquatic insects. This has been established in a number of insect studies, both aquatic and terrestrial. Also, the results appear to support the findings of other studies that the number of generations of some insect species is dependent on water temperature (Beckett 1982; Mackay 1979). It is our intention to examine these data and relate the information to thermal units. We believe that it will be possible to predict the timing of the emergence of these insects with a high degree of accuracy.

REFERENCES

Becker, C. D. 1973. Development of *Simulium (Psilozia) vittatum* Zet. (Diptera: Simuliidae) from larvae to adults at thermal increments from 17.0 to 27.00C. The American Midland Naturalists. 89:246-251.

Beckett, D. C. 1982. Phenology of *Hydropsyche orris* (Trichoptera: Hydropsychidae) in the Ohio River: Changes in the larval age structure and substrate colonization rates. Env. Ent. 11(6): 1154-1158.

Harvey, R. S. 1971. Temperature effects on the maturation of midges (Tendipedidae) and their sorption of radionuclides. Health Physics. 20:613-616.

Masteller, E. C. 1993. Comparison of tropical and temperature emergence phenology of aquatic insects from Puerto Rico and Pennsylvania. J. Kan. Ent. Soc. 66(2):192-199.

Mackay, R. J. 1979. Life history patterns of some species of Hydropsyche (Trichoptera: Hydropsychidae) in southern Ontario. Can. J. Ent. 57:963-975.

Mischuk, M. W., and F.G. Howell. 1984, 1985, 1986, 1987. An environmental assessment of the Leaf River near New Augusta, Mississippi. Institute of Paper Chemistry, Appleton, Wisconsin. 4 reports, 476 pp.

Weiss, S. B., D. Murphy, P. Ehrlich, C. Metzler. 1993. Adult emergence phenology in checkerspot butterflies: the effects of macroclimate, topoclimate, and population history. Oecologia. 83:261-270.

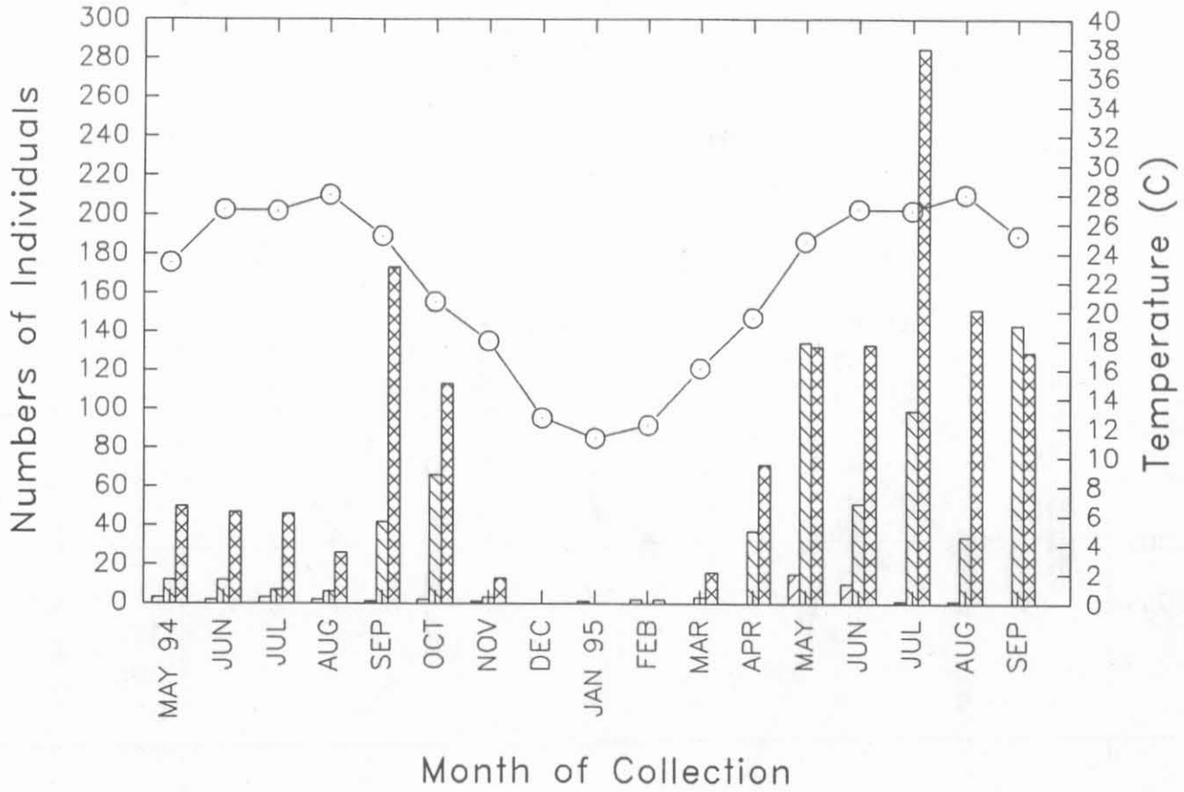

Figure 1. Total numbers of individuals per month caught in light trap vs. river water temperature in degrees C. Circles = monthly average temperature; bars = respectively left to right for each month: stoneflies, mayflies, and caddisflies.

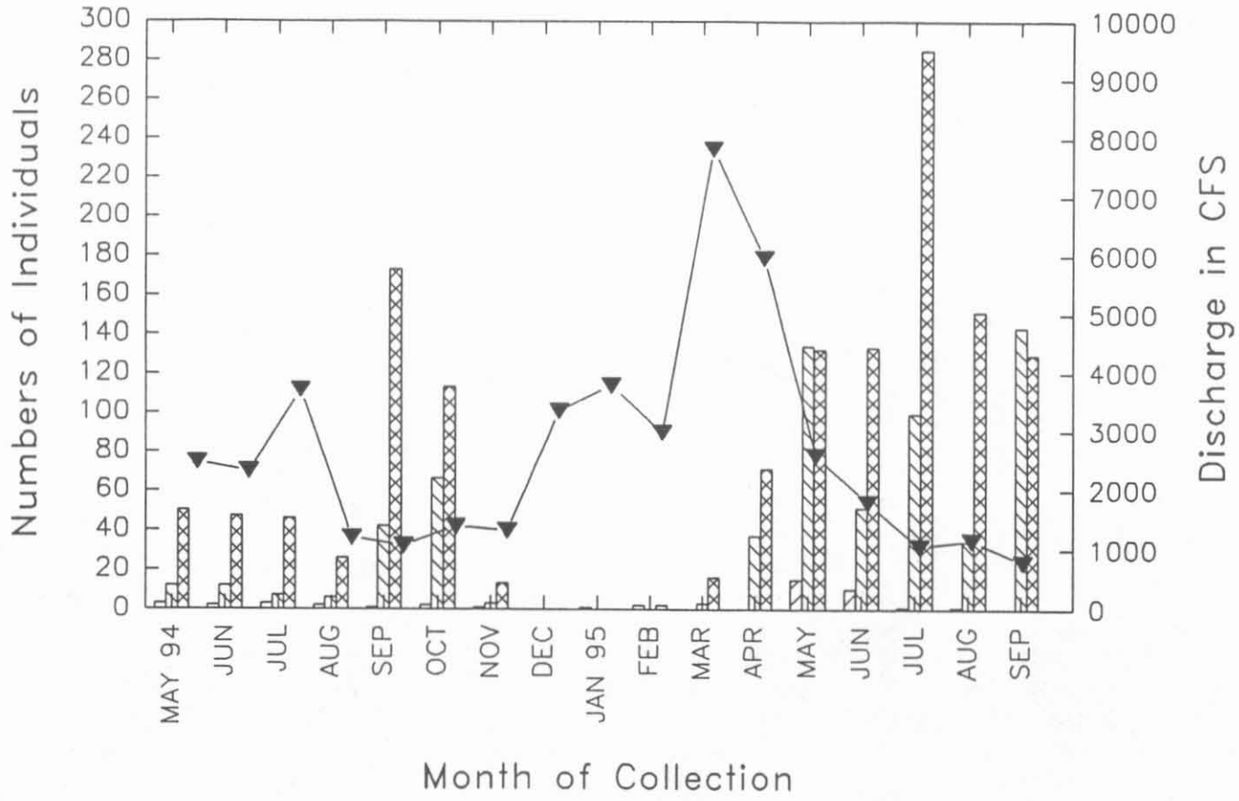

Figure 2. Total numbers of individuals per month caught in light trap vs. river discharge in cubic feet per second (CFS). Triangles = monthly average CFS; bars = respectively from left to right for each month: stoneflies, mayflies, and caddisflies.