Notes on the Life History of *Potamanthus Myops* in Southeastern Michigan (Ephemeroptera: Potamanthidae)

Philip G. Bartholomae
University of Michigan

Peter G. Meier
University of Michigan

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Philip G. Bartholomae and Peter G. Meier[1]

ABSTRACT

Naiads of the mayfly *Potamanthus myops* were collected six times over a one year period from the Huron River to obtain some information on their natural history. Contrary to other Ephemeroidea, *myops* was never collected below the substrate surface, but was usually found on the underside of stones. The immature mayflies were measured and their length plotted for each collection period. The results support the hypothesis that the majority of *myops* requires two years to mature.

Potamanthus myops (Walsh) is a sprawling Ephemeroidea of the family Potamanthidae. It is an unusual member of this group because unlike its relatives, *myops* has not been found to burrow actively throughout its life cycle. *Potamanthus* has retained many of the morphological characteristics of the fossorial habitat such as large mandibular tusks and feathery filamentous gills which are adaptations of Ephemeroptera for burrowing and feeding in soft substrates. *Potamanthus* has also acquired many morphological characteristics that are adaptive to its own habitat, such as flattened body form, outstretched legs, lateral gills, and mouthparts for scraping rather than filter feeding.

Very little is known of the taxonomy, ecology or life history of the genus *Potamanthus.* It presently consists of six species which are known in the aquatic form. Recent work by McCafferty (1975) and Lord (1975) has helped clarify the confusing taxonomy of the genus. Lord and Meier (1977) demonstrated the intraspecific variations of the species *myops.*

The ecology of *Potamanthus* is even less understood than its taxonomy. The literature offers only brief descriptions of the habitat occupied by *Potamanthus.* A description by Morgan (1913) typifies the early misconception that *Potamanthus* occupied essentially the same habitat as other Ephemeroidea. "It [*Potamanthus sp?*] crawls upon the muddy bottoms in the same locality (as other ephemeroids)." Argo (1927) distinguished *Potamanthus* from another Ephemeroidea (*Polymitarcys*) and described the *Potamanthus* habitat as "found in the sand and gravel at the edges of riffles where current is not too swift." McCafferty (1975) took *myops* from "gravel substrate in a moderate current of medium sized to large rivers, often times under rocks or logs." Lord (1975) described a similar habitat for *myops* in southeastern Michigan.

McCafferty (1975) postulated that naiads of *myops* may burrow throughout their life cycle. He noted that very early instars of this mayfly were taken in the Tippecanoe River in the substrate at a depth of 11 cm.

Nearly all information on the life history of *Potamantyus* is based on the collection of adults. Imagos have been collected from June through August. McCafferty (1975) found that in Indiana, this species develops immediately after oviposition and overwinters as naiads. He took young instars in October and middle instars in May. This information was interpreted by McCafferty to mean that *Potamanthus myops* possesses a one year development cycle. Lord (1975) hypothesized from limited collections that *myops* in southeastern Michigan is univoltine.

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[1]Department of Environmental & Industrial Health, School of Public Health, The University of Michigan, Ann Arbor, Michigan 48109.

Immediate growth of naiads after hatching is substantiated as shown in various laboratory studies. Argo (1927) described the hatching of *Potamanthus* in the laboratory in only 14 days. The effect of environmental factors such as temperature on hatching time should be taken into consideration.

DESCRIPTION OF STUDY AREA

This study was conducted at the Huron River in the vicinity of Zeeb Road Bridge, Washtenaw County, Michigan. The Huron River is a moderately warm, hard water river, which flows through mixed forest and agricultural land. The drainage basin, which is largely glacial till, covers about 1880 km^2. Water temperatures range between a winter minimum of 0°C and an average summer maximum of 25°C. Dissolved oxygen shows diel and seasonal variations. A maximum of 12.0 ppm and a minimum of 6.0 ppm were found during the study year. Discharge is fairly stable with a variability ratio of 0.32 (Velz and Gannon, 1960). The consistantly good water quality of the Huron River supports a diverse benthic fauna as found by Lord (1975).

METHODS

A single population of *Potamanthus myops* delineated by only one 100 m^2 sampling area on the Huron River, was used throughout this entire study. As part of a larger study which dealt with the feeding behavior of *myops*, approximately 950 naiads of this mayfly were taken from the sampling area on the following dates: 29 June, 1976, 22 July, 1976, 12 August, 1976, 9 October, 1976, 23 February, 1977, 6 May, 1977. Hand picking was used to avoid damaging the abdomen or gut during sampling. This precluded the use of more standard or random sampling methods. Attempts were made to assure consistency in sampling so that any animal located in the sampling area had an approximately equal probability of being sampled. This procedure cannot, however, be assumed random as certain rocks and animal size categories (i.e. larger instars) could be picked selectively.

Animals were preserved in 70% ethanol until measurement. The body length was measured using a calibrated ocular micrometer on a dissecting microscope. Body length was defined as the distance between the posterior tip of the 11th abdominal segment and the anterior tip of the labrum. This body length excludes tusk length.

DESCRIPTION OF HABITAT

The population of *myops* in the Huron River is patchy but can be found in locally high concentrations. The preferred substrate of this mayfly is gravel and sand overlain by cobble-sized stones which are seasonally overgrown with filamentous algae. Current velocity seems to be a critical factor affecting the distribution because naiads are found only in shallow (less than 1 m) backwater areas where current velocity does not exceed 0.5 m/sec. In the summer months naiads are never abundant in the faster moving main channel. Thus, like their burrowing ancestors, *myops* prefers very slow current velocities and is not limited to the riffle areas by respiratory stress. However, unlike other ephemeroids, it does not prefer erodable substrates.

An abundant periphyton community was also observed to be a critical requirement for the distribution of *myops*. Naiads were not taken from what otherwise would seem to be a perfectly suited habitat unless a large growth primarily of *Cladophora* was also present. The periphyton community associated with the *myops* habitat was comprised of *Cladophora* (predominant), diatoms, detritus and silt of variable concentrations. Analysis of gut contents has shown all of these materials to be the major food source of this organism.

Potamanthus myops demonstrates a negative phototactic response which is common to most ephemeropterans. During the photophase, naiads were collected almost exclusively from the undersides of stones, with movement to the upper surface of stones periodically to feed on surface accumulations.

Naiads taken on all dates were found on the substrate surface. Even the smallest instars taken on 23 February were found on the benthic surface. Extensive search by digging and coring did not produce any naiads occurring deep in the substrate.

As mentioned above, naiads during the summer months were limited solely to the shallow (less than 1 m) backwater habitats near the river banks. However, during the month of February naiads were not found, or were very scarce in the shallow habitat. At this time the naiads were found to concentrate much farther out towards the main channel of the stream where current velocity and depth were greatly increased. *Cladophora* was found in this area. The benthic community of the near shore habitat had changed from a diverse grouping of different species to a dense population of midges.

LIFE HISTORY

Size distributions of *myops* collected on 29 June, 22 July, 12 August, 9 October, 23 February, and 6 May were made to observe the population dynamics throughout the year. The percentage of individuals occurring in each of 0.32 mm body length intervals (0.2 ocular units), was graphed for each sampling date mentioned above (Fig. 1).

The 29 June collection was characterized by having no peak or modal distribution; rather the population was extended with a nearly equal percentage of individuals throughout the middle size classes. The smallest individuals were 5.3 mm and the largest naiads were 14.9 mm in length. The distribution for this date did show some clumping into two size groups. The division of the two populations occurred approximately at 7.2 mm, which was made from measurements of 102 individuals.

The 22 July date showed evidence for a possible bimodal peak in the population distribution. The mean size of individuals in the smaller group occurred at 8.2 mm while the mean size of the larger group was approximately 13.9 mm. The smaller group distribution was greatly reduced by the distribution of larger individuals. The size range of the 263 naiads taken on this date was from 7.5 mm to 16.5 mm.

The 12 August distribution showed a very strong divergence of the population into two size groups. The smaller group, which contained approximately the same number of individuals as the large group, ranged from 8.2 mm to 11.4 mm. The larger group ranged from 13.6 mm to 16.5 mm. Some individuals of intermediate size between these groups were found. The mean size of the first group was 9.7 mm and the second occurred at 14.9 mm. The sample size for August 12 totaled 90 individuals.

The population of *myops* on 9 October showed an approximately normal distribution about a single mean. The mean value (also the mode) occurred at 12.3 mm. The range of sizes found on this date was from 7.5 mm to 15.2 mm. The sample size on 9 October was 191.

Two very distinct and widely separated size groups of *myops* were found on 23 February. The smaller group included the smallest instars of this population found on any date. These naiads were less than 2.0 mm in length. The mean size of this group was 3.4 mm. The other cohort concurrent with the smaller group had a mean size of 12.0 mm. Individuals of this larger group ranged from 9.1 mm to 14.6 mm in length. A total of 69 naiads were measured for this date.

A less distinct bimodal distribution of this mayfly was found on 6 May, 1977. The smaller group indicated appreciable growth since 23 February while the larger group had shown little or no growth for this time period. The younger cohort ranged in size from 4.2 mm to 9.8 mm with a mean body length equal to 7.3 mm. The older cohort overlapped into the smaller generation, which ranged from 9.6 mm to 15.0 mm with a mean of 12.1 mm. A total of 296 naiads were measured for this date. The distribution of the younger cohort became widely spread at this time. It is possible that a portion of this population achieved a growth rate which enabled some of them to emerge within one year.

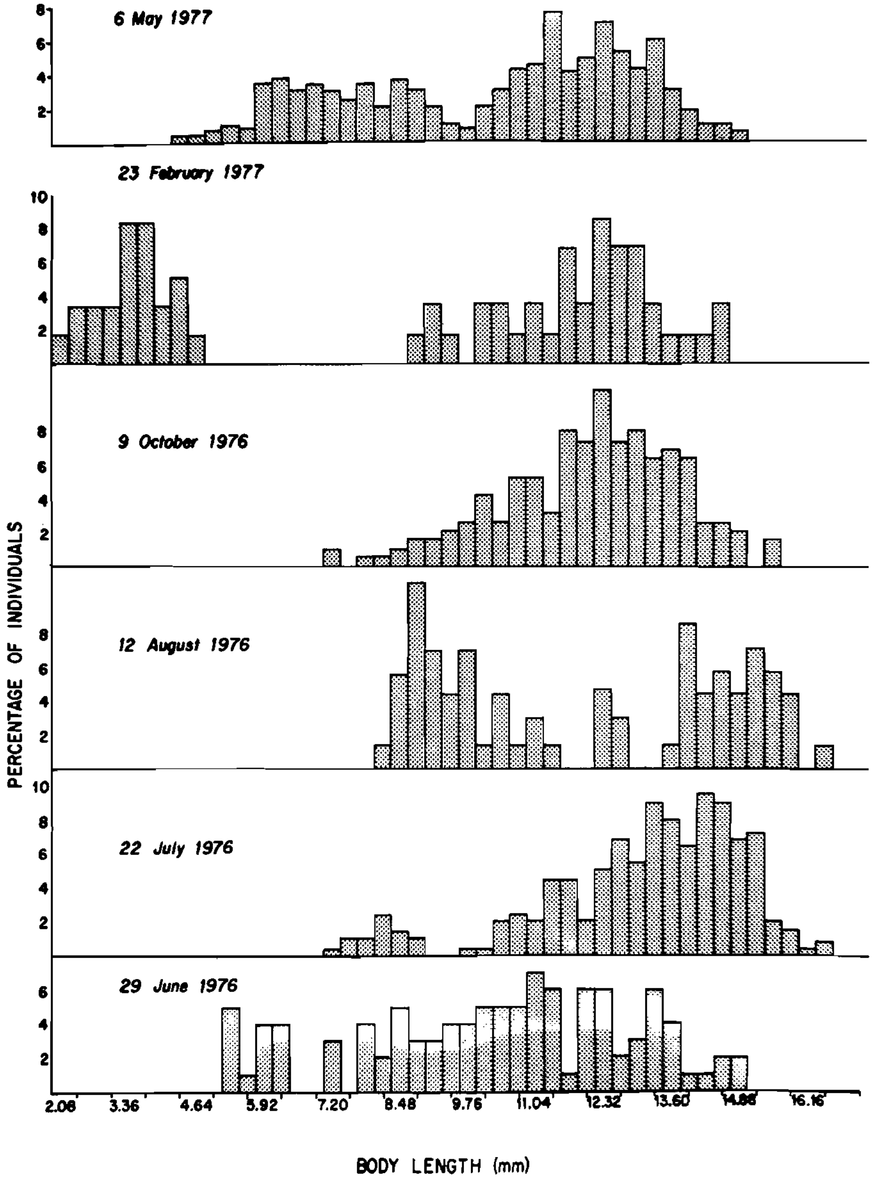

Fig. 1. Size distribution of *Potamanthus myops* for respective collection dates.

DISCUSSION AND CONCLUSION

The size distributions of the population shown here for 1976-1977 support an alternative hypothesis, that *myops* in southeastern Michigan possesses a two year, or C1, development cycle.

The life history results showed evidence of a clumped, extended distribution on 29 June, 1976. A reduced, bimodal distribution occurred on 22 July, 1976, and 6 May, 1977. A distinct, widely separated bimodal distribution was found for both dates of 12 August, 1976, and 23 February, 1977. All of these data substantiate the fact that on these dates there existed, concurrently, two cohorts of the same population of *myops*. Therefore, individuals or a large percentage of the population may require two years to complete their life cycle.

Only the 9 October population shows a normal distribution about a mean body length value. The 9 October date corresponds to the time when the emergence of the older cohort was complete but development of the offspring of the emergent generation had not yet begun. Thus, this single cohort represented the emergent generation of the following summer.

The reduced size of the smaller cohort which is more apparent on the 22 July collection demonstrates the bias of hand pick sampling toward larger individuals. When two size groups were present, the larger naiads were picked preferentially to the smaller. On 12 August, again two cohorts were present, however the larger population was more scarce owing to emergence and the smaller individuals were closer in size to the larger. This caused less size selectivity of the cohort on this date. On 23 February the early instars could not be hand picked; rather they were found by kick-screening with a fine mesh net. Thus, these data do not represent the actual population distributions of *myops* in the Huron River.

The major growth period for both generations appears to be the months from May through the time of emergence. The non-emergent generation continues a rapid growth rate until October when it reaches a mean body length of approximately 12.0 mm. The mean body length of the younger cohort was found to develop 1.5 mm from 22 July through 12 August. This represents the maximum growth rate found for this population. The development of mean body length of the larger cohort was only 1.0 mm for this time period. This reduced growth is owing to emergence of a portion of this population. The smaller cohort continued to increase mean body length at approximately the same rate until October. The time period from 12 August to 9 October showed a 2.6 mm growth. Thus, a similar increase in mean body length of 1.2 mm $month^{-1}$ was found for the younger naiads up through October. The non-emergent naiads were found to diapause at 12.0 mm body length with no appreciable growth during the winter months from October to May, whereas the period from 23 February through 6 May indicated good development for the younger cohort. These animals would only have to continue growth to about 15 mm before reaching the ultimate instar by the month of July.

Because the first instar naiads were not found, the hatching, or egg diapause time cannot be estimated for this species under natural conditions. The first instar of *Potamanthus* was reported by Argo (1927) to be 1.0 mm in length. The naiads found on 23 February were as small as 1.9 mm representing not more than the third instar of this species. There are two possibilities for the development of the early instars. First, that the eggs of *myops* hatch soon after oviposition and develop to about the third instar when they overwinter. Second, the eggs of *myops* are diapaused over the winter and development of first instars does not begin until early February. The fact that Argo (1927) reports hatching times for *Potamanthus* of only 14 days in the laboratory, has no bearing on which type of development does exist because egg hatching is dependent on in situ controls of temperature. Regardless of which type of development does exist the growth of the new cohort is not significant during the winter months.

McCafferty (1975) hypothesized the early instars of *myops* might burrow. However, all naiads of *myops* taken from the Huron River were found sprawling on the undersides of stones located on the substrate surface. Even on 23 February the early instars were found only at the benthic surface and although a search for burrowing naiads was made, none were found. Because the first instar does not seem capable of actively burrowing owing to its small size and lack of tusks, we hypothesize that *myops* has completely lost this ancestral trait and does not burrow throughout any part of its life cycle.

The midstream migration of *myops* during the winter months was a curious phenomenon. Two theories for this change of habitat are possible. The first is that because of physical-environmental factors the near-shore habitat became very unstable causing the naiads to move out to midstream. The winter of 1976-1977 was a cold one as evidenced by the Huron River in this section being frozen over throughout most of the winter. Temperature, the formation of ice, or the accompanied flow reduction could have caused the migration. The second theory relates to the biological competition for available food and space between *myops* and the midge population. The chironomid larvae were extremely dense in this area during the winter months. Their production and numbers could have forced *myops* to the midstream habitat.

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