



Life cycle studies of Heptageniidae (Insecta: Ephemeroptera) in Kumbakarai Stream of Western Ghats, Tamil Nadu, India

T. Sivaruban¹, S. Barathy², K. Venkataraman³ & M. Arunachalam⁴

^{1,2,4} Sri Paramakalyani Centre for Environmental Sciences, Manonmaniam Sundaranar University, Alwarkurichi, Tamil Nadu 627412, India

³ Centre for Research in Aquatic Entomology, Department of Zoology, Madura College, Madurai, Tamil Nadu 625011, India
Email: rooban2002@yahoo.com

Abstract: Life cycle studies of *Epeorus* sp., *Afronurus kumbakkaraiensis* and *Thalerosphyrus flowersi* of the family Heptageniidae were conducted in the Kumbakarai stream of Western Ghats, southern India. *Epeorus* sp. may have more than one univoltine brood since part of the eggs hatch in northeast monsoon period and the rest in the following summer. Life cycle of *Afronurus kumbakkaraiensis* and *Thalerosphyrus flowersi* is basically multivoltine with asynchronous, overlapping genera. However, this study reveals the possible influence of summer in numerical reduction of *Afronurus kumbakkaraiensis* and *Thalerosphyrus flowersi*.

Keywords: Ephemeroptera, Heptageniidae, life cycles.

Mayflies (Ephemeroptera) are abundant and diverse in most tropical Asian streams. They represent 30% of benthic populations (Dudgeon 1992) but little is known about their life history. Rawlinson (1939) gave a detailed account of breeding and life history of *Ecdyonurus venosus*. Harker (1952) studied the life histories of *Ecdyonurus torrentis*, *Heptagenia lateralis* and *Rhithrogenia semicolorata* and found that the last two

forms have univoltine life cycle. *Epeorus pleuralis* was also found to have univoltine life cycle (Minshall 1967). McCafferty & Huff (1978) have given an account of the life cycle of *Stenacron interpunctatum*.

Bengtsson (1981) and Olechowska (1981) described the life cycles of *Heptagenia fuscogrisea* and *Rhithrogena loyolaea* respectively. Dudgeon (1996), Salas & Dudgeon (2003) described the life cycles of Heptageniidae, Baetidae and Leptophlebiidae. This short communication deals with the life cycle pattern of Heptageniidae found in Kumbakarai Stream of Western Ghats (11°N & 77°50'E) situated about 100km west of Madurai, on the eastern side of Palni Hills at an altitude of 400m. A perennial hill stream cascades as Kumbakarai falls and water temperature ranges from 25° to 35° C. This area receives 175 to 210 cm rainfall per year.

Materials and Methods

Quantitative samples were collected bimonthly during January - December 2006 randomly from ten cobbles of uniform size, in a stratified manner across the stream habitats. Individual cobbles were transferred from the stream bed to a hand net (200µm mesh) positioned immediately downstream, washed inside the net. Larvae collected from all cobbles were pooled and preserved in 70% alcohol.

Clifford (1969) method was followed and in the classification of stages, nymphs were grouped into four arbitrarily chosen developmental stages by appearance and development of the mesothoracic wing pads. Stage I nymphs lacked wing pads; stage II nymphs had wing pads but the lengths was shorter than the distance separating the two wing pads. Stage III nymphs had their wing pad length greater than the distance separating the two wing pads. Stage IV nymphs had darkened wing pads. Every stage is represented by several instars with the exception of stage IV, the last nymphal instar, where the tanned wing pads indicate impending emergence. Male and female nymphs were separated by looking at the genitalia and the nature of eyes. Eyes are very close in male; in female they are widely apart.

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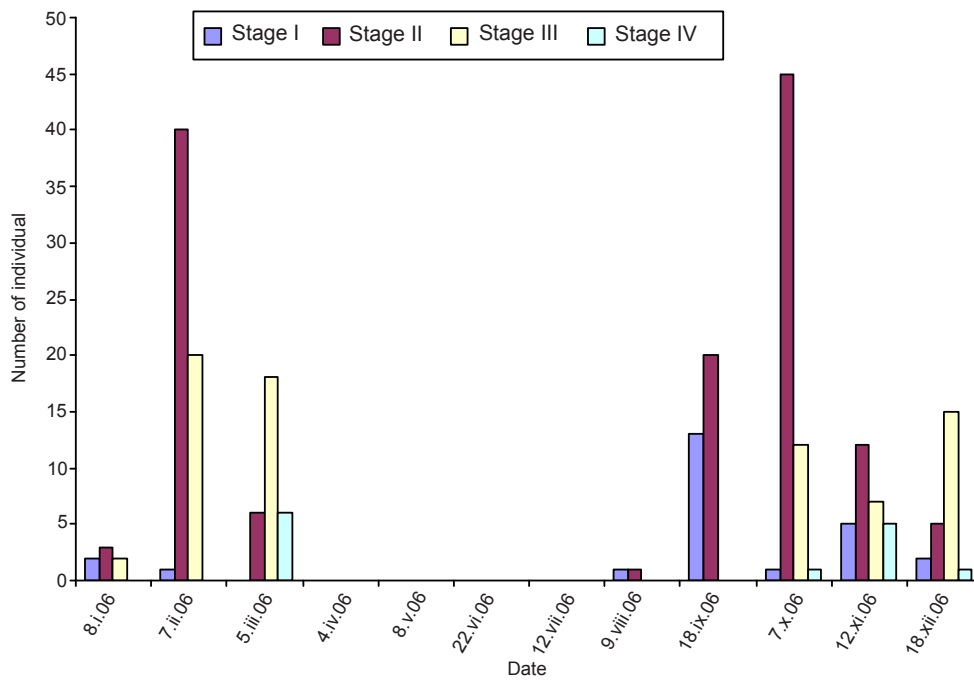


Figure 1. Life cycle of *Epeorus sp.*

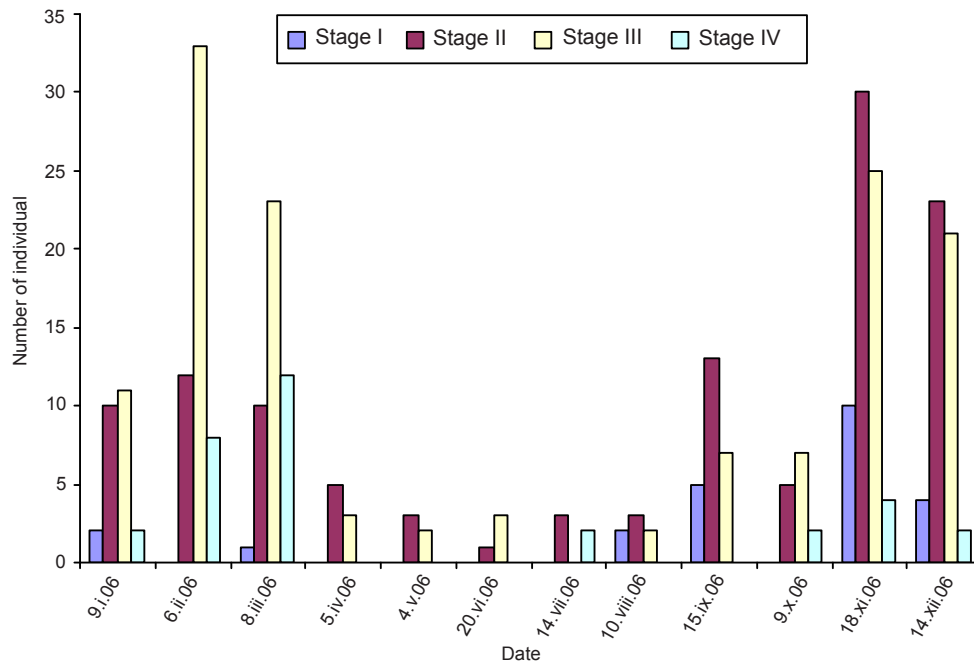


Figure 2. Life cycle of *Afronurus kumbakkaraensis*

Results and Discussion

Hynes (1961) and Landa (1968) proposed a classification of life cycles of the European mayflies and that has been used by Clifford et al. (1973) to classify life cycles of some Canadian mayflies as follows:

A₁ (Winter species): Nymphs hatch in summer and autumn, continue to grow throughout the winter and

emerge the following spring or summer.

A₂ (Summer species): Nymphs hatch, grow and emerge during a short period of summer, the eggs being in a supposedly diapause state for most of the year.

A₃ (Winter species): Nymphs hatch and grow in summer and autumn only. Growth occurs in the following spring.

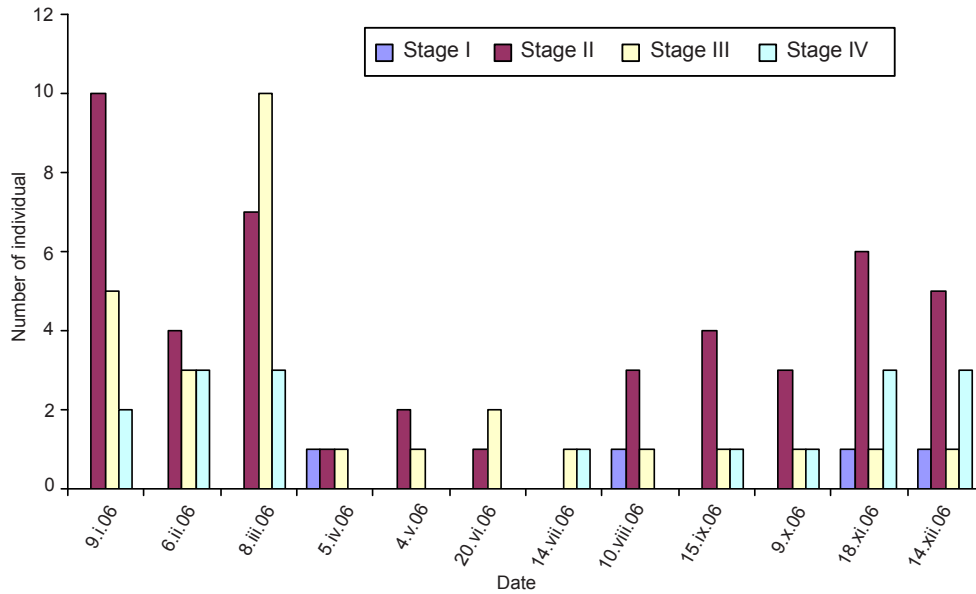


Figure 3. Life cycle of *Thalerosphyrus flowersi*

- B. Two or more generations in a year.
- C. One generation in two or more years.
- D. Others.

Going from the equator to the arctic, the Life cycle patterns of mayfly fauna change from equator to arctic. Species with multivoltine cycles (tropics), to species having one-year cycles with growth during most of the year (moderate-temperate regions) to species having one-year cycles with most of the growth restricted to a short period of the year (cold-temperate and subarctic regions) and finally to one-year cycles with hatching, growth and emergence restricted to a very short part of the year (arctic) (Clifford et al. 1973).

Life cycle patterns of *Epeorus* sp., *Afronurus kumbakkaraiensis* and *Thalerosphyrus flowersi* in Kumbakkarai stream are interpreted from the developmental stage frequency histograms (Figs. 1-3). There is probably a preponderance of species with multivoltine cycles (B-species according to Landa's classification) in tropics (Clifford et al. 1973). The life cycle pattern of the two species *Afronurus kumbakkaraiensis* and *Thalerosphyrus flowersi* are basically multivoltine with asynchronous, overlapping generations and continuous emergence. It is of interest to compare the investigations of Sivaramakrishnan & Job (1981) on the life cycle patterns of *Petersula courtallensis* and *Notophlebia jobi* in Courtallam with the present investigated species. In these species also, hatching was continuous and development asynchronous and independent of any cyclical pattern. Dwindling of *Afronurus kumbakkaraiensis* and *Thalerosphyrus flowersi*. Ide (1935) believed that eggs of certain mayfly species remain dormant during summer and those that hatch early are killed by high

temperature. Also low oxygen level in the stream water in summer may be detrimental to the early instar nymphs (Pescador & Peters 1974). The temperature of the Kumbakkarai Stream water temperature climbed up to 31°C during summer and oxygen level was 5mg/l. Clifford et al. (1973) found that temperature independently or along with photoperiod can influence mayfly life cycle patterns predictably. Temperate Heptageniids normally have univoltine life histories (Clifford 1982) although some species have been reported to complete two generations in a year (Benke & Jacobi 1986; Jacobi & Benke 1991).

The life cycle pattern of *Epeorus* sp. differs from the other two Heptageniids. Adults emerged from October to December. Hatching of nymphs apparently occurs during monsoon periods. Eggs laid by females emerging early in the flight period, hatch in the same year. These nymphs grow and emerge during early summer explaining the appearance of a few large and many tiny nymphs in summer. Field investigations reveal that *Epeorus* sp. takes two to three months to complete life cycle.

The life cycle of *Epeorus* sp. may have more than one univoltine brood since part of the eggs hatch in north-east monsoon period and the rest hatch the following summer. Similar type of life cycle is met within *Heptagenia diabasia*, *Heptagenia hebe* and *Stenacron interpunctatum* in Wisconsin which have more than one univoltine brood since part of the eggs hatch in fall and the rest hatch the following spring. Life history studies of Dobbrin & Giberson (2003) on *Epeorus pleuralis* and *Epeorus fragilis* showed that both are univoltine species. *Epeorus* sp. is classified into A₃ group as per Landa's classification. Complete absence of *Epeorus* sp. in late summer and early southwest monsoon period may be due to the following reasons:

(a) During these periods the mean current velocity at the sampling site was only 0.1m/sec. *Epeorus* sp. being a rheotactic form may not have tolerated a low current velocity, possibly migrated upstream where the current velocity was bearable. Minshall (1967) also found that very slow current velocities unfavourable to *Epeorus pleuralis* nymphs. The cooler upstream conditions with increased current velocity may be a preferred condition.

(b) Egg diapause has been studied in detail in *Ephemerella ignita* and *Baetis vernus* (Bohle 1969, 1972). *Epeorus* sp. being basically a temperate form may have the genetic capacity to enter diapauses, not necessarily, every year. There is a possibility of egg diapause, but the absence of small nymphs in field but as Brittain (1982) observes, need not be the indicator of it.

(c) Normal sampling method allowing free movement of small nymphs, might not have been suitable.

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