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# Diversity and trophic categorization of aquatic insects of Courtallam hills of Western Ghats

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ABSTRACT: Diversity and trophic categorization of aquatic insects of five falls stream of Courtallam hills of Western Ghats were investigated. A total of 2570 individuals of aquatic insects belonging to 23 genera, 19 families and 9 orders were collected in 4 stations in one second order streams for 6 months in Courtallam hills of Western Ghats. Diversity values of aquatic insects of five falls stream of Courtallam hills were calculated. Shannon index ($H$) and Simpson index ($S$) is highest in altitude 445 msl and lowest in altitude 310 msl. In five falls stream, there is a preponderance of genera of Ephemeroptera followed by Trichoptera and Plecoptera. The life cycle patterns of all the investigated seven species of mayflies are basically multivoltine with asynchronous, overlapping generations and continuous emergence. Trophic studies reveal that all sites in five falls stream show collector dominance followed by grazers and predators. Shredders were conspicuous by their absence. In terms of abundance of trophic categories, collectors were most abundant followed by grazers and predators.


KEYWORDS: Diversity, trophic categorization, aquatic insects, Western Ghats

## INTRODUCTION

As a part of Post-Rio efforts to inventorize and monitor aquatic biodiversity, the study of diversity of aquatic insects of hill streams has gained lot of momentum in the past decade in our country. Aquatic insects form a dominant component of zoobenthos in montane lotic ecosystems (Dudgeon, 1999). They form vital links in fish food chain and are sensitive bioindicators of aquatic pollution. Some taxa are sensitive to global climatic change and are indicators of habitat health (Vinson and Hawkins, 1998). Western Ghats is one of the twenty five biodiversity hot spots in the world with over two third of its species of its amphibians and about a third of its angiosperms unique to that region. Endemism is hardly studied in insects except butterflies and a tenth

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of that are endemic to the Western Ghats (Myers *et al.*, 2000). There have been a few valuable contributions on community-level investigations highlighting variation at local to regional scales, variation from headwater to the tail end in a river basin, as well as diversity studies restricted to a hill or a valley (Burton and Sivaramakrishnan, 1993). The objectives of the present investigation include the study of diversity and trophic categorizations of aquatic insects of Courtallam hills of Western Ghats.

## MATERIALS AND METHODS

### Study area

Courtallam is situated in the Western Ghats lying in the northern half of Tirunelveli District, Tamilnadu between 8° 50′ and 9° 0′ northern latitudes and 77° 10′ and 77° 20′ eastern longitudes. Courtallam is a hilly region whose height varies from 150 meters to 1500 meters with narrow valleys endowed with sleep slopes. Four stations were selected from one of these tributaries, of which three are located above the five falls and one below the five falls. During the monsoon, rains may be torrential, at time gentle and it may last for several days. The total amount rainfalls of Courtallam generally ranges from 175–210 cms per year. Rainfall is not evenly distributed throughout the year. Maximum rainfall is from September and October to December, during Southwest monsoon and Northeast monsoon respectively. The study was conducted from July 2002 to December 2002. The basic habitat consists of a series of rocky edges overlain with large boulders and rubble. The substratum is pebble and gravel integrated with coarse sand in quieter water at the edges. The stream averages 15 m wide with a maximum depth of 2 m. Along the banks of the stream are thick stands of trees and shrubs whose leaves are the stream's principal source of organic detritus. Among the taller plants are *Pongamia* sp., *Artocarpus* and *Terminalia* sp. Because of the leaf canopy over the stream formed by branched and leaning trees there is feeble exposure to direct sunlight even in mid day. So fluctuation in day and night temperature is minimized.

### Sampling methods

The aquatic insects were quantitatively sampled using a 1 m wide Kick-net (Burton and Sivaramakrishnan, 1993) with mesh size of about 1mm. Riffle/run areas of stream were selected for sampling, since Kick-net sampling works best in these areas. One person held the Kick-net while the other person systematically sampled the 1 $m^2$ area. Every large boulder or cobble in this area was picked up if it could be lifted and organisms were vigorously washed by hand into the net. The specimens were then carefully picked form the net surface and were preserved immediately in 70% ethyl alcohol. These samples were transported to the laboratory for further processing. All specimens from each of the 4 sites in one stream were sorted and identified with the help of field guide (Sivaramakrishnan *et al.*, 1998). Further identification of the aquatic insect taxa were confirmed by specialists working in respective groups. Physico-

chemical parameters (atmospheric and water temperature, current velocity and pH) were recorded during collection time.

Mouth part morphology and gut content analysis of the more common taxa were used to categorize the functional feeding groups based on Cummins and Wilzbach (1985).

Primarily two-diversity indices *viz.*, Shannon-Weiner index (alpha diversity) and Simpson index (alpha diversity) were worked out.

The Shannon index of diversity ($H$) was calculated using the following formula,

$$\mathbf{H}' = \sum_{i}^{s} = 1(p_i/N)\log_2(p_i/N).$$

Where, $N$ is the total number of individuals, pi is the number of individuals in the $i$th species and the information content or diversity is expressed as a number of bits (Ludwig and Reynolds, 1988).

Simpson index of diversity was calculated using the equation,

$$D = \sum_{i=1}^{s} P_i^2.$$

Where, $P_i$ is the proportion of the $i$th species (Ludwig and Reynolds, 1988).

Developmental stages of may fly nymphs were classified following, the plan of Clifford (1969). Nymphs were counted. Each nymph was grouped into one of the four arbitrarily chosen developmental stages on the basis of the appearance and development of the mesothoracic wing pads. Stage I nymphs lacked wing pads, stage II nymphs had wing pads but their lengths were shorter than the distance separating the two wing pads; the wing pad length of stage III nymph was greater than the distance separating the two wing pads. Stage IV nymphs had darkened wing pads. Each stage represents several instars with the exception of stage IV, which is the last nymphal instar, the tan wing pads indicating impending emergence.

## RESULTS AND DISCUSSION

A total of 2570 individuals of aquatic insects belonging to 23 genera, 19 families and 9 orders were collected by semi-quantitative kick-net sampling (3 in each) and limited opportunistic collections were made in four stations in one second order streams for 6 months (from July, 2002 to December, 2002) in Courtallam hills of Western Ghats (Table 1). Shannon index is 2.493 in altitude, 445 msl and 1.883 in altitude, 310 msl. Simpson's index is 6.620 in altitude, 445 msl and 4.077 in altitude, 310 msl. It is interesting to compare the aquatic insects assemblage pattern of the five falls stream with other hill streams in South India. In fact, studies of broad scale pattern of aquatic insect composition in all continents have revealed the remarkable worldwide similarity among stream insect assemblages. Indeed, many of the same families and genera of aquatic insects are found worldwide (Vinson and Hawkins, 1998). At the macroscale level, when a comparison is made with similar second order streams in temperate

TABLE 1. Taxonomic inventory and trophic categorization of aquatic insects of five falls stream of Courtallam

| Order | Family | Genus | Trophic category |
|---|---|---|---|
| Ephemeroptera | Heptageniidae | *Epeorus* sp. | Collector |
| | Heptageniidae | *Cinygmina* sp. | Collector |
| | Heptageniidae | *Thalerosphyrus* sp. | Grazer |
| | Leptophlebiidae | *Indialis* sp. | Collector |
| | Leptophlebiidae | *Isca* sp. | Collector |
| | Ephemerellidae | *Teloganodes* sp. | Collector |
| | Baetidae | *Baetis* sp. | Grazer |
| Trichoptera | Hydropsychidae | *Potamyia* sp. | Collector |
| | Hydropsychidae | *Hydropsyche* sp. | Collector |
| | Polycentropodidae | *Polycentropus* sp. | Collector |
| | Rhycophilidae | *Atoposyche* sp. | Predator |
| | Philopotamidae | *Wormaldia* sp. | Collector |
| Plecoptera | Perlidae | *Neoperla* sp. | Predator |
| Megaloptera | Corydalidae | *Corydaleus* sp. | Predator |
| Odonata | Gomphydae | Progomphus sp. | Predator |
| | Coenagryonidae | *Coennagryon* sp. | Predator |
| | Libellulidae | *Pantala* sp. | Predator |
| Coleoptera | Psephenida | *Psephenoides* sp. | Grazer |
| Diptera | Simulidae | *Simulium* sp. | Collector |
| Hemiptera | Naucoridae | *Naucoris* sp. | Predator |
| | Gerridae | *Gerris* sp. | Predator |
| Orthoptera | Gryllotalpidae | *Grylloptalpa* sp. | Predator |
| | Tetrigidae | *Tridatylus* sp. | Collector |
| 9 Orders | 19 Families | 23 genera | |

ecosystems, there is less diversity or at least comparable diversity with temperate counterparts. Yet another factor while making such a temperate tropical comparison depend on the group of insects compared. For instance riffle beetles are more diverse in the tropics (Brown, 1981) while others, like Plecoptera, area more diverse in temperate streams (Zwick, 1986). In the present investigation, 7 out of 23 genera of aquatic insects collected belong to Ephemeroptera.

At the microscale level, factors like substrate, habitat type, light, food, water, temperature, stream size and flow pattern exert major influences in structuring benthic insect diversity. Physico-chemical parameters (atmospheric and water temperature, current velocity and pH) recorded at four stations of five falls stream is presented in Table 2. In present investigation 13 genera of Ephemeroptera, Plecoptera and Trichoptera were recorded. South Indian hill streams, in general, usually have

TABLE 2. Physicochemical features, water quality parameters and diversity index for individual sites

| Site | Altitude (msl) | pH | Water temperature | Current speed (sec $m^{-1}$) | Substrate | Diversity index | |
|---|---|---|---|---|---|---|---|
| | | | | | | Shannon –Wiener index | Simpson index |
| 1 | 445 | 7.2 | 22 | 0.4 m/sec | Bed rock with pebbles and 20–40 diameter sandy | 2.493 | 6.620 |
| 2 | 425 | 7.3 | 22 | 0.5 m/sec | Bed rock with boulders and pebbles | 2.330 | 5.992 |
| 3 | 380 | 7.0 | 22 | 0.2 m/sec | Bed rock, large boulders and pebbles | 2.050 | 5.081 |
| 4 | 310 | 8.2 | 23 | 0.2 m/sec | Rock and sand mixed with silt | 1.883 | 4.077 |

preponderance of Trichoptera followed by ephemeropteran and plecopteran genera. This pattern is exhibited by most of the Western Ghats streams, whereas in five falls there is a preponderance of the genera of Ephemeroptera followed by Trichoptera and Plecoptera. The list of trophic categories of aquatic insects collected in sampling sites for six months in four sites in five falls stream is presented in Table 1. All sites in five falls stream show collector (60%) dominance followed by grazers (20%) and predators (20%). Shredders were conspicuous by their absence. In terms of abundance of trophic categories, collectors were most abundant, followed by grazers and predators. The functional feeding group analysis in five falls streams showed considerable similarity with studies on the Western Ghats stream in peninsular India (Burton and Sivaramakrishnan, 1993). The preponderance of collectors in tropical streams may be due to the fact that leaves are decomposed to detrital particles by the microbial community in matter of days leaving little for shredder to feed as pointed out by Burton and Sivaramakrishnan (1993).

Life cycle patterns of seven species namely *Epeorus petersi*, *Cinygmina kumbakkariensis*, *Thalerosphyrus flowersi*, *Indialis* sp., *Isca* sp., *Teloganodes* sp., and *Baetis* sp. In five falls stream indicate them to be basically multivoltine with asynchronous, overlapping generations and continuous emergence. It is of interest to compare the investigations of Sivaramakrishnan and Job (1981) on the life cycle patterns of *Petersula Courtallensis* and *Notophlebia jobi* in Courtallam with the present investigated species. However, the local influence of the two monsoons is especially felt in abruptly terminating the cycles at the end of the monsoons due to the dwindling discharge from the headwaters. Similar life cycle patterns were recorded in heptagenid mayflies of Kumbakkari stream of the Western Ghats by Venkataraman (1984).

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