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Temporal variation of mayfly community (Ephemeroptera) in response to ecological attributes in Gadana river, Tamilnadu, India

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ABSTRACT: In the study of diversity and distribution of Ephemeroptera in Gadana River and relationship between Ephemeropteran community and ecological factors, revealed a total of 2056 specimens belonging to 25 genera and 7 families. The diversity and distribution of Ephemeroptera were higher during the rainy season, contrasted with non-rainy period. The high scores of Shannon index and Simpson's index indicate that Gadana River is hale and healthy and it bolsters more diverse taxa. The pH values accomplish greatest range in the months of January and August; it legitimately impacts on diversity of mayflies. Leptophlebiidae and Baetidae were the most ubiquitous families present in the Gadana River. Canonical Correspondence Analysis (CCA) shows that rainfall, pH, DO and water temperature were to be the significant stressor in altering the community structure of mayflies.

Keywords: Ephemeropteran community, rainfall, pH, Canonical Correspondence Analysis, Simpsons Index, Shannon Index

INTRODUCTION

Ephemeropterans also called as mayflies, serves as a bioindicators of water quality. The aquatic larval stages, namely the naiads undergo a series of moults as they grow, the precise number being variable within a species, depending on external factors, such as temperature, food availability and current velocity. They are important components of aquatic assemblages in freshwater environments due to their high abundance and richness and therefore have an important role in nutrient cycling, since they process large amounts of organic matter from the riparian vegetation and periphyton in the aquatic environment (Moulton *et al*., 2004). So they serve as very good indicators of conservation importance and of centres of endemicity and they can be used to identify significant localities at much smaller scale than those identified by studies on vertebrates. Mayflies are very touchy to contamination and can accordingly just be discovered near water that is of a high calibre. The diversity and distribution of aquatic invertebrates in fresh water ecosystem are determined by environmental variables such as

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rainfall (Kim *et al*., 2013), current velocity, water temperature, dissolved oxygen (Bueno *et al*., 2003), rainfall (Bispo *et al*., 2004), conductivity (Scheibler and Debandi, 2008), depth (Mollozzi *et al*., 2011) and the type of substrate (Buss *et al*., 2004). These variables show spatial and temporal variability and are consequently expected to drive auxiliary changes in lotic invertebrate communities.

Gadana river which resides in southern Western Ghats has already been explored to biomonitoring studies. It is based on the diversity and distribution of family Baetidae (Kubendran *et al.,* 2017 a). Aim of the study was on the diversity and distribution of all families of Ephemeroptera present in Gadana river and to assess the relationship between Ephemeropteran community and environmental variables.

MATERIALS AND METHODS

Study area: Gadana River originates from Agasthyamalai Biosphere Reserve in southern Tamil Nadu part of Western Ghats of India. Three tributaries such as Pambar, Kallar and Iluppaiyar join to form the Gadana River. It is a 33 km long, drains about 7112 acres which gets together witha Major River called Tamiraparani near Thiruppudai Marudur village in Ambasamudram taluk, Tirunelveli district, south Tamil Nadu. It has its origin in the Sivasailam peak of Western Ghats at an elevation of 1564 m above M.S.L. at a Lat. 81°48' N and Long. 77° 19' E and flows down the eastern slopes of Western Ghats. The stream has well developed riffles, pools, cascades and runs. Channel substrates are bedrock, boulder, gravel, cobble and sand covered with leaf litter. Banks of this stream are exceptionally unstabilised by coconut farms and agricultural lands. Random sampling was carried out in three study sites of Gadana river. Site I is upstream of river, site II is near temple path way and site III is near Dam outlet which are closely associated with cultivated land and polluted human inhabiting area. Samplings were done from August 2018 to January 2019.

Measuring water quality parameters: The physicochemical parameters of stream water such as pH, water temperature, air temperature, dissolved oxygen and water flow were analysed for every month by using the guidelines of APHA (2005). The mean rainfall data of different months were collected from meteorological data.

Ephemeroptera collection: The Mayflies were quantitatively sampled by using 1m wide Kick-net (Burton and Sivaramakrishnan, 1993) and surber sampling. The organisms were then carefully picked from the net surface and were preserved immediately in 70% ethyl alcohol. These samples were transported to the laboratory for further processing and identification was done using stereomicroscope (Magnus MSZ-TR).

Laboratory sorting, identification and enumeration: All samples from the river were identified with the help of field guide by Sivaramakrishnan *et al*. (1998) and by other taxonomic literatures (Balachandran and Ramachandra, 2011; Sivaramakrishnan *et al.,* 2009).

Shannon and Simpson indices and Canonical Correspondence Analysis (CCA) were calculated with the help of PAST software (Hammer *et al.,* 2001).

RESULTS AND DISCUSSION

Sampling of larva of Ephemeroptera in Gadana river from August 2018 to January 2019 resulted in a total of 2056 specimens belonging to 25 genera and 7 families (Table 1). The genera are listed in table 1 which includes maximum of 25 genera in the months of September, October, November and December, whereas in the month of January only 20 genera were noted.

Species richness and Abundance were higher in the month of November followed by October and December it coincides with North East Monsoon period and it yields about 641.4mm rainfall. This shows that during the rainy seasons, the diversity and distribution of Ephemeroptera were higher compared to non-rainy period (January which has low abundance). It is likewise clear that South West Monsoon yields only less diversity and distribution compared to North East Monsoon (October to December), since Western Ghats regularly receives higher rainfall during the North East Monsoon

period as opposed to to South West Monsoon. So this study revealed that Ephemeropteran community is directly in relationship with the high amount of rainfall, as their diversity and distribution continues expanding during the rainy period.

The Shannon index value normally lies between 0.0 – 5.0 and it exceeds 4.5 very rarely. Indices values above 3.0 indicate that structure of habitat is stable or balanced. The values under 1.5 indicate that ecosystem is broken or degradation in structure of habitat. Shannon index (Fig. 2) was highest in October 2018 (3.095) and lowest in January 2018 (2.614). Simpson's index (Fig. 1) was also supports the results of Shannon index and the index was highest in October 2018 (0.951) and lowest in August (0.905). Both the index values which show that Gadana river which have more stable ecosystem in the months of September to December and it have less diversity in the months

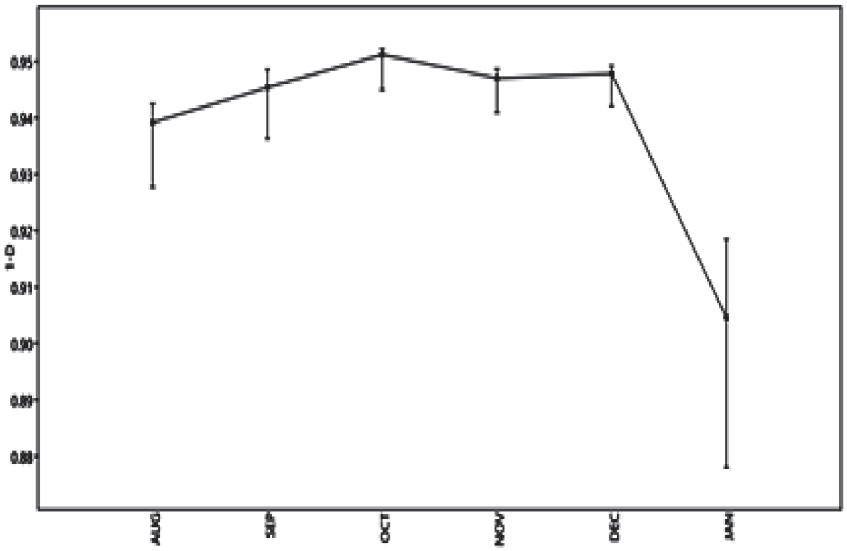

Fig. 1: Simpson index of mayflies in different months

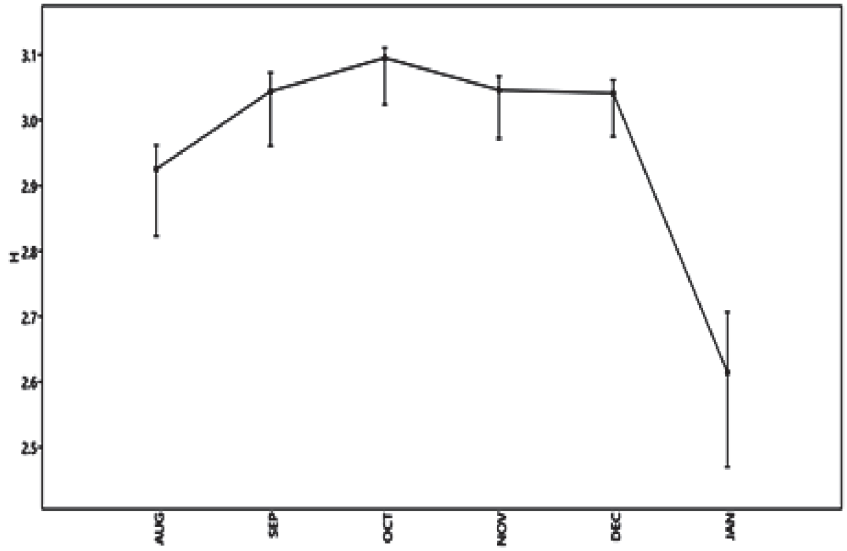

Fig. 2: Shannon index of mayflies in different months

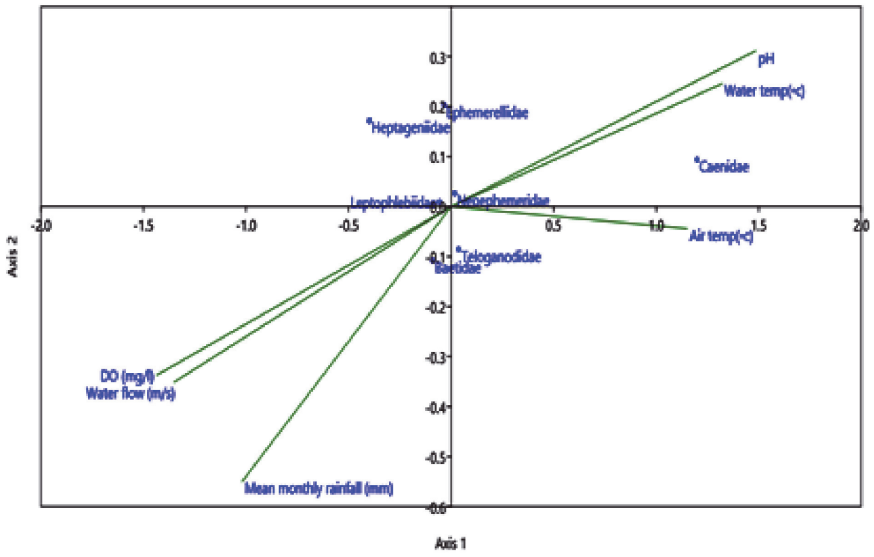

Fig. 3 Canonical Correspondence Analysis (CCA) of mayfly community and ecological attributes in Gadana river

of low rainfall months like August and January but that it also of less concern. The high scores of Shannon index and Simpson's index, indicate that Gadana river is healthy, clean or unpolluted river and it supports more diverse taxa

Water temperature and air temperature varied moderately among months and it was higher in the month of January (22æ%c and 24æ%c). The water flow in the month of January was found to be 0.21 m/s which were very much less compared to other months. During November, the water flow was high which supported more diverse taxa. Normal dissolved oxygen (DO) level in the running water was 4.6 – 8.6 mg/l (Srinivasan *et al.,* 2019) and in all the months it falls in the normal range. The pH values attain maximum range in the months of January (7.9) and August (7.4) and found to be alkaline in these months and this is due to anthropogenic activity during that months (Table 2). Due to this the Ephemeropteran community gets affected and which supports only more tolerant species like Caenis sp.

Leptophlebiidae and Baetidae were the most numerous and ubiquitous families, comprising seven and eight species respectively(Table 1).

Canonical Correspondence Analysis (CCA) predicts relationships between Ephemeropteran communities and environmental variables and it allows integrated analysis of taxa and environmental attributes (Ter Braak and Smilauer, 2002). From the CCA results (Fig. 3), it is clear that family Caenidae which shows positive relationship with high levels of pH and water temperature and it is adversely associated with high levels Dissolved Oxygen, rainfall and water flow though other families' shows negative correlation with elevated levels of pH and water temperature. High rainfall in the months of October, November and December which underpins families like Heptageniidae, Ephemerellidae and Baetidae whereas it have negative correlation with family Caenidae. From the previous investigations in southern India (Selvakumar *et al.,* 2014), it is apparent that family Caenidae is a poor indicator of water quality. Our outcomes also substantiates with that. So CCA results showed that mayflies were significantly associated with ecological attributes in Gadana River. Results additionally anticipated that rainfall, pH, DO, water flow and water temperature turns into the significant components in administering the community structure of mayflies. The prior investigations in Western Ghats uncover that pH

Table 1. List of Ephemeroptera collected in Gadana river

FAMILY	GENUS/ SPECIES	Number of individuals collected in different months					
		AUG	SEP	OCT	NOV	DEC	JAN
Baetidae	*Baetis acceptus*	12	14	22	27	26	05
	Centroptella similis	11	11	14	13	18	03
	Cloen bimaculatum	13	10	16	09	15	04
	Indobaetis michaelohubbardi	08	11	16	14	17	02
	Labiobaetis pulchellus	01	01	07	04	03	00
	Acentrella (Liebebiella) vera	01	01	01	03	03	00
	Tenuibaetis frequentus	05	08	14	15	16	00
Caenidae	*Caenis sp*	24	15	07	04	02	29
	Clypeocaenis bisetosa	13	11	09	08	02	18
Ephemerellidae	*Torleya nepalica*	08	09	04	09	11	01
Heptageniidae	*Afronurus kumbakkaraiensis*	04	22	17	23	34	01
	Epeorus petersi	00	12	10	15	29	00
	Thalerosphyrus flowersi	00	24	18	29	24	00
Leptophlebiidae	*Choroterpes (Euthraulus) alagarensis*	21	34	28	37	34	12
	Choroterpes (Euthraulus) nambiyarensis	12	39	25	31	33	11
	Edmundsula lotica	03	12	11	11	07	01
	Indialis badia	12	11	20	23	18	02
	Isca purpurea	11	17	23	33	19	05
	Nathanella saraswathiae	07	12	15	19	19	02
	Notophlebia jobi	03	10	16	17	21	04
	Thraulus gopalani	08	08	18	24	23	07
Neoephemeridae	*Potamanthellus caenoides*	02	09	10	08	09	04
Teloganodidae	*Teloganodes sartorii*	19	23	31	37	21	10
	Teloganodes indica	11	15	28	39	37	09
	Dudgeodes palnius	10	14	21	26	21	13
	Total number of individuals	219	353	401	478	462	143

and DO turn into the crucial component in controlling the population dynamics of mayflies (Selvakumar *et al.,* 2012; Kubendran *et al.,* 2017 b). Our outcomes additionally validates with that as well. Beyene *et al.* (2008) found that rainfall turns into the significant part in mayfly diversity and they recorded richer diversity of macroinvertebrates in the wet season in an Ethiopian highland river and this work additionally records a similar outcome. This work provides stable information on the present status of water quality and temporal variations in reference to community structure of mayflies in Gadana river and serves as a model ecosystem for the biomonitoring studies.

Table 2. Physico-chemical parameters of the Gadana river

PARAMETERS (Mean Values)	AUG	SEP	OCT	NOV	DEC	JAN
Water flow (m/s)	0.34±0.09	0.53±0.11	0.68±0.17	0.76±0.16	0.57±0.07	0.21±0.04
pH	7.4±0.1	7.2±0.2	7.1±0.1	7.0±0.0	7.0±0.3	7.9±0.2
Air temp(æ%c)	24±1.2	23±0.8	23±0.7	21±0.8	22±1	24±1.2
Water temp(æ%c)	21±1	20±0.6	19±0.8	17±0.8	18±0.9	22±0.9
DO (mg/l)	8.2± 0.1	8.6± 0.2	8.9± 0.1	8.7± 0.1	8.7± 0.2	7.8± 0.2
Mean monthly rainfall (mm)	17.32	92.1	254.3	283.7	103.4	12.6

Table 3. Correlations of environmental gradients with the axes of canonical correspondence analysis (CCA) in Gadana river

VARIABLES	AXIS 1	AXIS 2
Eigenvalue	0.0779	0.0178
Water flow	**0.0329**	**0.1012**
pH	2.2732	1.9390
Air temp	2.2797	1.8036
Water temp	2.5323	2.1199
DO	1.8165	1.3216
Rainfall	**-1.5381**	1.1417

(Bold values indicates significant differences)

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