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Biomonitoring status and contribution to the knowledge of benthic macro invertebrates for river Manimala, Southern Kerala, India

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Abstract

The diversity patterns and occurrence of benthic macro invertebrate families encountered in river Manimala which originates from the Muthavara hills near Peermade in Idukki district of the Kerala state was an approach conceded based on the knowledge of benthic macro invertebrates. The primary objective of this study was to identify the fresh water benthic macro invertebrates and to find out the biological water quality using BWQC developed by Central Pollution Control Board (New Delhi). The study also emphasizes the anthropogenic influences especially of pollution-sensitive organisms belonging to the order Ephemeroptera, Plecoptera and Tricoptera. A total of 163 individuals of aquatic insects belonging to 51 genera, 43 families were collected from the five stations of the River Manimala during pre monsoon and monsoon period. The highest species richness and abundance was observed in Elamkaadu top (Station 1) followed by Andayaar (Station 2) during monsoon and premonsoon respectively. The most dominant taxa found in this river were Cheumatopsyche. The rivers in Kerala is undergoing serious anthropogenic effects, the need to conserve the pollution sensitive organisms bears prime significance. Temporal/biological factors could have conceivably diminished the density of benthic communities, however the ever increasing population load, wetland filling, sand mining, encroachment of river banks have adversely affected the diversity of life forms.

Keywords: River Manimala, Benthic macro invertebrates, Saprobic and diversity score, Sand mining, Wetland filling, Encroachment, BWQC.

Introduction

Biomonitoring is generally used to examine existing stream condition and instant insights into changes in stream water and habitat quality (Rosenberg and Resh, 1993). Historically, invertebrates have received considerable attention in the study of running water ecosystems, in particular relationships between macro invertebrate community structures and environmental variables have been the subject of numerous investigations (Cummins, 1992; Thorner, 1997; Kazancig, 1998; Metcalfe, 1998; Bunns, 1999). Biological assessments are being developed worldwide. Evaluating changes in genetic composition of specific populations, bioaccumulation of toxins and related occurrence of morphological deformities, changes in community composition and ecosystem functioning (Marques and Barbosa, 2001). Water pollution is a serious problem in India and many other parts of the world. Modern techniques for monitoring pollution involve the use of pollution-sensitive insects, especially benthic macro invertebrates as biological indicators or "sentinels" has become wide spread only over the last two decades (Morse et al., 1994). Since benthic aquatic insects are sensitive indicators of environmental changes they can be

employed to express long-term changes in water and habitat quality rather than instantaneous conditions (Johnson et al., 1993).

The Kerala state has an area of 38,863 km^2 and is bordered by Karnataka to the north and northeast, Tamil Nadu to the south and southeast and the Arabian Sea towards the west. This land is blessed with 44 Rivers, however many of these are under the threat due to anthropological activities like Wet land filling, sand mining, deepening of lands along the river banks, construction of large dams across the rivers, encroachment of river banks and pollution. Sand mining which is a major threat for rivers in Kerala, has ultimately pushed the water table down, reduced the water holding capacity and adversely affected the diversity of life forms. Construction of large dams across the rivers has adversely affected the flow pattern, extent and nature of sediment formation and deposition, riverine biodiversity and the quality of water

Manimala river originates from the Muthavara Hills near Peermade in Idukki district; the river passes through the districts of Kottayam, Pathanamthitta and finally joins the Pamba river at Muttar in Alapuzha district. It has a length of 92 km. It is an important water way of Central Travancore. Erumeli, Manimala, Mallapally, Thuruthicad, Vennikkulam, Kaviyoor, Kalloppara, Thalavadi, Kozhimukku, Mundakkayam, Kanjirapally and Champakkulam lies on the banks of Manimala river. Major objective of the study was to identify the fresh water Benthic Macro invertebrates including aquatic insects, crustaceans, molluscs, platyhelminthes etc and to find out the biological water quality using BWQC developed by Central Pollution Control Board (New Delhi), India. This study is all about the biomonitoring of water quality using the benthic macro invertebrates of Manimala river.

Study area

Station 1 (Elamkaadu top) is the origin site of Manimala river. The average width is about 10 mts. The place is surrounded by rocky boulders, gravel, sand and clay. People use water for drinking, washing bathing and cattle wading. Station 2 (Aendayar) is situated ata distance of 12 kms from the Elamkaadu top. The average width is about 20 – 25 mts. The place is surrounded by rocky boulders, gravel, sand and clay. People use water for drinking, washing, bathing and cattle wading. Station 3 (Mundakkayam) is situated at a distance of about 25kms from Aendayar. The average width is about 20 mts. The place is surrounded by gravel, sand and clay. This site is found to be disturbed by human influence. Station 4 (Mallapally) is situated at a distance of about 10 kms from Mundakkayam. The average width is about 20 mts. The place is surrounded by sand, gravel and clay. People uses water for drinking, washing and bathing. The site is found to be disturbed by human influence. Station 5 (Valanjavattom) is the discharge site situated at a distance of about 12 kms from Mallapally. The average width is about 20 mts. The place is surrounded by gavel, sand and clay. People use the water for drinking, washing and bathing. This site is being used for religious ceremony.

Materials and Methods

Benthic Sampling

The Procedures employed for sampling of biological parameters were developed by Central pollution Control Board (CPCB, New Delhi, India). Sampling was made from stations of the river Achankovil. Various measurements such as latitude, longitude, altitude, temperature, average depth, approximate width and main stream flow of sampling sites were congregated during the collection. Sampling should be conducted during availability of ample amount of sunlight in the field. Benthic (bottom dwelling) larvae were collected and identified from the origin of the river to the discharge site. Sampling was made from tributaries and from a variety of upland headwaters as well as lowland rivers. Collection methods include the use of benthic nets (D net) and kick screens. The stream current was used to wash the specimens physically from substrates, and the aquatic insects were surveyed on cobbles, rock, large woody debris, decaying leaves and dislodgable boulders to find the attached larvae and pupae. Identification of specimens to the most refined taxonomic level possible will commence immediately after the collection with the help of keys for identification.

To assess the actual health of water bodies, CPCB has derived a Biological Water Quality Criteria (BWQC) for water quality evaluation (Table 3). This system is based on the range of saprobic values and diversity of the

benthic macro invertebrate families with respect to water quality. Saprobic score method involves a quantitative inventory of the presence of Macro-Invertebrate benthic fauna up to family level of taxonomic precision**.** All possible families having saprobic indicator value are classified on a score scale of 1 to 10 according to the preference for saprobic water quality. The families which are more sensitive to pollution are getting a score of 10 while the most pollution tolerant families are getting a score of 1 and 2.

Fig 1. Map showing location of river Manimala

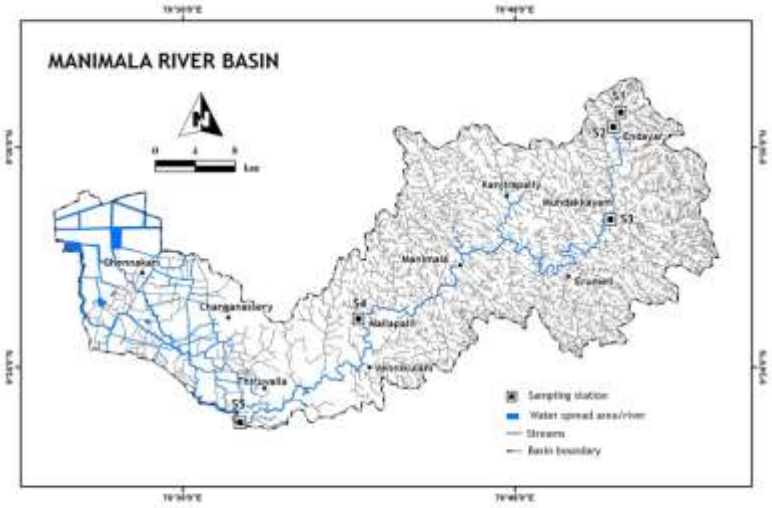

Table 1. Showing geological position of stations for river Manimala

Stations	Latitude	Longitude	Altitude (Ft)
Elamkadu Top	$09^0$41.598’	$76^0$46.423’	850
Aendayaar	$09^0$37.819’	$76^0$54.471’	465
Mundakayam	$09^0$37.919’	$76^0$54.424’	120
Mallapally	$09^0$37.919’	$76^0$54.424’	94
Valanjavattam	$08^0$21.019’	$76^0$33.005’	22

Table 2. Physical characteristics of river Manimala during premonsoon and monsoon.

Stations	River Flow (m/sec)		River Width (m)		Water temperature (°C)	
	Monsoon	Pre monsoon	Monsoon	Pre monsoon	Monsoon	Pre monsoon
Elamkadu Top	0.50	0.38	5	3	23	25
Aendayaar	0.90	0.50	10	8.0	20	25
Mundakayam	0.95	0.35	15.0	13.0	24	27
Mallapally	0.83	0.25	12	10	27	28
Valanjavattam	0.80	0.42	20	19	24	27

Table 3. Biological Water Quality Criteria (BWQC).

Range of Saprobic Score	Range of Diversity Score	Water Quality	Water Quality Class	Indicator Colour
6 - 7	0.5 - 1.0	Slight pollution	B	Light Blue
3 - 6	0.3 - 0.9	Moderate Pollution	C	Green
2 - 5	0.4 - less	Heavy Pollution	D	Orange
0 - 2	0 - 0.2	Severe Pollution	E	Red

Table 4. Taxonomical distribution of benthic macro invertebrates during pre monsoon and monsoon

Sl.No	Order	family	Genus
1	Ephemeroptera	Leptophlebiidae	*Traulus*
		Baetidae	*Platybaetis* *Pseudocioeon* *Baetis*
		Heptageniidae	*Thalerospyrus*
2	Coleoptera	Hydrophilidae	*Amphiops*
3	Crustacea	Atyidae	*Caridina typus*
4	Hemiptera	Naucoridae	*Ctenipocoris asiaticus*
5	Tricoptera	Philopotamidae	*Chimarra*
		Hydropsychidae	*Cheumatopsyche* *Macrostemum*
6	Placoptera	Perlidae	*Phanoperla*

Table 5. Biological Water Quality of river Manimala during pre-monsoon and monsoon.

Location	Period	Saprobic score	Diversity score	Water quality	Water quality class
Elamkadu Top	Pre monsoon	6.25	0.6	B	Slight Pollution
	Monsoon	7.41	0.68	A	Clean
Aendayaar	Pre monsoon	5.0	1.0	C	Moderate Pollution
	Monsoon	6.75	0.325	B	Slight Pollution
Mundakayam	Pre monsoon	5.0	1.0	C	Moderate Pollution
	Monsoon	7.25	0.11	A	Clean
Mallapally	Pre monsoon	6.7	0.8	B	Slight Pollution
	Monsoon	4.50	0.85	C	Moderate Pollution
Valanjavattam	Pre monsoon	7.0	1	B	Slight Pollution
	Monsoon	8.00	50	A	Clean

Result and Discussion

A total of 163 individuals of aquatic insects belonging to 51 genera, 43 families were collected from the five stations of the River Manimala during pre monsoon and monsoon (2010) period. The highest species richness and abundance was observed in Elamkaadu top (Station 1) followed by Aandayaar (Station 2) during monsoon and pre monsoon respectively. This shows that the water bodies of these stations are in healthy biological condition. The highest diversity of benthic macro invertebrates were noticed in station 1 and station 2 (Elamkaadu top and Aandayaar) and the lowest diversity were collected from the station 4 (Mallappally) and Station 5 (Valanjavattom). This shows that the water bodies of these stations are not in a healthy biological condition. A total of 43 families of

macro invertebrates belonging to orders Ephemeroptera, Coleoptera, Crustacea, Hemiptera, Tricoptera, and Placoptera were encountered. During the present study, Ephemeroptera were the most diverse with 3 families. The numbers of families for the other orders were: Crustacea(1), Hemiptera (1), Tricoptera (2), Placoptera (1) (Table 4).

Manimala river originates from the Muthavara Hills near Peermade in Idukki district, the river passes through the districts of Kottayam, Pathanamthitta and finally joins the Pamba river at Muttar in Alapuzha district. It has a length of 92 km. It is an important water way of Central Travancore. Erumeli, Manimala, Mallapally, Thuruthicad, Vennikkulam, Kaviyoor, Kalloppara, Thalavadi, Kozhimukku, Mundakkayam, Kanjirapally and Champakkulam lies on the banks of Manimala river. The presence of, *Thalerospyrus*, *Traulus*, *Platybaetis*, *Pseudocioeon* (Ephemeroptera), *Cheumatopsyche*, *Macrostemum*, *Chimarra* (Tricoptera), *Amphiops (Coleoptera) and Phanoperla* (Plecoptera) were quite predominant, since many species of Ephemeroptera, Tricoptera and Placoptera find it vital to cling to coarse substrate or behavioral adaptation for attachment to surfaces of stones or other substrates between short bursts of swimming (Merritt and Cummins, 1996). Elamkaadu top (Station 1) displayed high values of taxonomic richness, followed by Aandayaar (Station 2) during the monsoon and premonsoon respectively. During the Monsoon season, During the monsoon season, the stations 1, 3 and 5 Elamkaadu top, Mundakkayam and Valajavattom were seen clean and Moderate pollution was seen on station 4 Mallapally and the Station 2 Andayaar was seen slightly polluted. During the premonsoon season, the Stations 1,4 and 5 were seen slightly polluted and Stations 2 and 3 Aandayaar and Mundakkayam were seen moderately polluted.

The differences found on the density values between monsoon and pre monsoon can be explained by temporal changes that occur on the water level and flux affecting some abiotic parameters such as temperature, dissolved oxygen and nutrients availability/ biological factors like predation risk, temporal changes on macrophytes community during growth period and trophic resources availability that vary along the year (De Paula et al., 1997; Barbosa et al., 1997).

The input of organic matter into rivers modifies the bottom substrate characteristics. Roy et al. (2003) and Brabec et al. (2004) pointed out that effects of organic pollution and eutrophication on stream benthic fauna are linked to each other by organic matter and nutrients transformation processes. Beisel et al. (2000) pointed out intense relationships between macro invertebrate assemblages and substrate heterogeneity.

Human impacts, can determine a shift in the benthic organisms and a gradual replacement of species. Changes in species composition and dominance of pollution tolerant species are some of the scenarios commonly observed (Marques et al., 1999, 2003). *Elmidae* (Coleoptera) and *Baetidae* (Ephemeroptera) being present in some of the sampling stations suggested these taxa as tolerant to some level of environmental contamination, caused by inputs of domestic untreated sewage (Goulart and Callisto, 2003). *Perlidae* (Plecoptera) suggests that these organisms are indicators of good water quality. Moreover, the low diversity of habitats affected the distribution of this taxon (Galdean et al., 2000; Goulart and Callisto, 2003.

Since the tolerant species of Tricoptera are mostly associated with the animals of highly polluted waters. They are besides the most commonly encountered family of Tricoptera in Asian streams (Morse et al., 1994). Caddisfly occur in most type of fresh water habitats: spring streams and seepage areas, rivers, lakes, marshes and temporary pools (Betten, 1934). The Tricoptera and Diptera have the capability to adapt to varied aquatic habitats due to their extra ordinary structural organization (Tyagi, 2006; Needham and Needham, 1969; Tonapi, 1980). Lenat and Barbour (1994) reported that Ephemeroptera, Plecoptera and Tricoptera taxa (EPT taxa) are a reliable index sensitive to changes in stream water and/ or substrate quality.

In conclusion biomonitoring is used to document the condition of the aquatic resource and detecting subtle problems. It is a key companion for water quality standards and criteria. Since the river water in Kerala is undergoing serious anthropogenic effects, the need to conserve the pollution sensitive organisms bears prime significance. Temporal/biological factors could have conceivably diminished the density of benthic communities, however the ever increasing population load, wetland filling, sand mining, encroachment of river banks have adversely affected the diversity of life forms.

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