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ARTICLE

An Evaluation of Aquatic Macroinvertebrate Diversity of River Achankovil, Kerala

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Abstract

A diversity assessment of aquatic macroinvertebrates of River Achankovil was done. Three sampling sites were selected to comprise highland, midland and lowland along the river. Organisms were collected by adopting multihabitat composite sampling method. Diversity was estimated by calculating indices such as Shannon-Weiner diversity index, Simpson dominance index, species richness and evenness, and abundance index. Diversity was found to be moderate in all regions but comparatively high in lowland with a Shannon – Weiner diversity index of 2.46 and almost similar in the other two sites (2.04 & 2.05). Similarly, Simpson's dominant index value was also high in lowland (9.6) and low at Pandalam segment (5.60) and Achankovil segment (5.66) which revealed that lowland has fairly good diversity than other two regions. At the same time, species richness was greater at midland (4.97) and low in downstream (4.88) and upstream (4.90). Pielou's species evenness index value also proved that Veeyapuram has good diversity (0.75) and moderate in Achankovil (0.63) and Pandalam (0.62).

Keywords: Achankovil river, Macroinvertebrates, Biodiversity, Pollution indicators

Introduction

Most aquatic invertebrates live in the bottom parts of our waters and also called benthic macroinvertebrates, or benthos, and make good indicators of watershed health. Some benthos found more often, and in larger amounts, in waters that are generally clean, or unpolluted by organic wastes. Benthic macroinvertebrates are continuous indicators of environmental quality. The composition of a macroinvertebrate community in a river reflects that river's physical and chemical conditions.

A river ecosystem consists of a wide variety of macroinvertebrates which include, various insect larvae and nymph, (Merritt and Cummins, 1996), although nematodes, oligochaetes, gastropod and bivalve molluscs and various crustaceans are common. Insects are the most dominant among macroinvertebrates. Aquatic insects such as mayflies, stoneflies, caddis flies, midges, beetles etc. Most of them are fed on algae and bacteria and others eat leaves and other organic matter that enters the water.

Macroinvertebrates such as molluscans are now extinct and many more are threatened or endangered due to the biological destruction of their habitats. They occur in nearly all types of unpolluted freshwater habitats. Many species of leeches can able to tolerate a broad range of salinities, temperatures, oxygen concentrations and other environmental conditions due to their physiological plasticity (Yong and Ironmonger, 1982; Sawyer, 1986). Isopods are the most morphologically diverse group of crustaceans. The greatest diversity of free living freshwater isopods is probably to be found in cave waters (Botasaneanu, 1986). Of the estimated 6500 known species of brachyuran or true crabs some 1000 are wholly freshwater crabs- Potamidae, Gecarunucidae and Parathelphusidae (Cranbrook and Furtado 1988; Ng, 1990; Ng and Ambu, 1998). Freshwater crabs are significant organisms playing a key role in recycling nutrients through their scavenging of plants and animal material. Prawns are among the most ubiquitous macroinvertebrates. There are three families of freshwater prawns – Palaemonidae, Atyidae and Alpheidae – all of which belong to the infraorder Caridea. Spiders are arthropods belonging to the class Arachinida which is characterized by the possession of four pairs of legs and two major body regions. There are probably more than 40000 known species of spiders in the world. Insects are characterized by three pairs of legs. These are the most abundant group of organisms among macroinvertebrates.

Macroinvertebrates are stationary and are sensitive to different degrees of pollution. Pollution may adversely affect the diversity of aquatic organisms. Insects are highly sensitive to pollution. Organisms such as May flies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) are more susceptible or intolerants to the effects of physical or chemical changes in a river than other organisms. These organisms act as indicators of the absence of pollut-

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ants. Midges and worms are tolerant to pollution. When a stream becomes polluted, pollution sensitive organisms decrease in number or disappear; pollution tolerant organisms increase in number and variety.

The presence and diversity of freshwater mussels serve as an indicator of river. Freshwater mussels are moderately intolerant to pollution. Gastropods are also intolerant to pollution. So the presence or absence of macroinvertebrates diversity in a river, we can easily predict the water quality of that river.

Benthic macroinvertebrates play a significant role in aquatic food chain. They form a vital link in the food chain connecting aquatic plants, algae, and leaf litter to the fish species in river. The conditions of benthic macroinvertebrates community reflect the stability and diversity of the larger aquatic food web. The number and variety of macroinvertebrate community reflects the biodiversity richness of the river .Some of the macroinvertebrates such as leeches and molluscans (*Bithynia siamensis*) have medicinal value.

Achankovil river, rises south of Devarmala in the Western Ghats in the Pathanamthitta District of Kerala at an elevation of 700m. The river formed from the streams of the Rishimala, Pasukidamettu and the Ramakkaltteri of the southern Western Ghats. The river follows a north westerly course till Kumbazha and in this portion it is joined by Kallar about 1km upstream of Turai forests. The river follows a generally western direction till Edappon. Here it turns North West upto Thazakkara and thereafter flows westwards. The river then splits up in several branches and flows in a north westerly direction to join Pamba river near Veeyapuram. The basin extends over an area of 1484km^2 and lies entirely in Kerala state. The total length of the river is 130 km. Moderate rainfall and a relatively 100% humid atmosphere throughout the year are characterized in the Achankovil river basin.

The present study is an attempt for assessing the aquatic macroinvertebrate biodiversity of the River Achankovil.

Materials and Methods

The study area is selected from Kollam, Pathanamthitta and Alappuzha district. The River Achankovil flows through these districts which are originating from the Pasukidamettu – Ramakkalteri and at altitudes ranging between +700m and +160m. Three sampling sites from highland, midland and lowland were selected and macro invertebrates sample were collected.

The sampling site 1, Achankovil is about 10 km upstream to Achankovil temple and in dense forest area. This station is located at latitude 9^0 07' 39.53 N and longitude 77^0 07' 58.56'E with an elevation of 870 ft. above MSL. The second order stream from which samples were taken is about 2-5m width and 0.5m water depth and crystal clear water during the sampling period. A small beautiful waterfall is there upwards the sampling site.

The second sampling site is near to the bridge on MC road at Pandalam and located at latitude 9^0 13'59.37' N and longitude 76^0 40' 38.4' E with an elevation of 66 ft. above MSL. Width 30-40m and depth varies from 2-10m during monsoon periods.

Samples were taken from the third sampling station where the River Achankovil meets and merges with River Pampa in Alappuzha district and 6km east of Haripad town. It is located at latitude 9^0 19' 29.07 N and longitude 76^0 27' 54.31' E with an elevation of 6ft. above MSL. The width of the river at this station is 40-50m and full depth is around 5-10m.

Macroinvertebrate Sampling

Macroinvertebrate collection were made by cast net, scoop net, D-frame Dip net and kick seine sampling method. Sampling of macroinvertebrates involves sampling of a portion of the organic debris and sediment, from which the macroinvertebrates can be separated.

Kick Seine Sampling

The kick seine is method is a simple procedure for collecting stream dwelling macroinvertebrates. It is used in riffle areas where the majority of the organisms prefer to live. Two to three people work together to perform the method properly. One person placed the net at the downstream edge of the sampling area. The net was held perpendicular to the flow, but at a slight (45^0) downstream angle. Stretched the net approximately three feet, being certain that the bottom edge is lying firmly against the bed. Another person comes upstream of the net stand beside, not within the sampling area. Removed all stones and other objects two inches or more in diameter from the sampling area. Then disturbed the entire sampling area. Tried to disturb the bed to a depth of at least two inches. Carefully removed the net with a forward upstream scooping motion. Carried the seine to a flat area on the stream bank. Placed it on a large white sheet, plastic table cloth, garbage bag, or shower curtain. Removed leaves, rocks, and other debris examined them for any attached organisms. Using fingers or forceps removed organisms from the net and placed in another container with water for later identification. Recorded the number of each type of organisms.

Dip Net Sampling

D-frame dipnet was used for sweeps in riparian zones, pools and for bank oriented sampling in segments of river that exceeded 1m depth. In riparian zones, shook the leaf pack in the water to release organisms, and then quickly scooped up the net, capturing both the organisms and the leaves. Dumped the collected materials in to a white container. The organisms were picked by using forceps. They were also hand picked, if bigger. Macroinvertebrates were preserved in 70% ethyl alcohol, if the organisms are having calcareous shells of exoskeleton.

The organisms collected from the three study sites were identified using standard references and with help of experts and quantified (Morse *et. al.*, 1994). The data from different sites were statistically analyzed using one way

analysis of variance (ANOVA).

Shannon diversity index, Simpson dominance index, species richness and evenness, and abundance index were calculated using the software biodiversity pro.

Results

Most of the macroinvertebrates are continuous indicators of water quality. The increase or decrease in number of such organisms is an indirect measure of water quality. Among the macroinvertebrates, insects are highly useful in water quality assessment. Three study sites in river Achankovil were selected for the macroinvertebrates sampling.

The macroinvertebrates collected from three different study stations were identified family wise and presented in Table 1. The mean abundance of macroinvertebrates fauna from the three deferent stations are graphically represented in figure 1. From the first study site (Achankovil) the abundance in the number of pollution intolerant organisms indicated the purity of water quality. Organisms such as crustaceans, molluscans, mayflies, caddisflies, stoneflies were abundantly obtained from the first study site.

Crabs are present in almost all clean freshwater bodies.

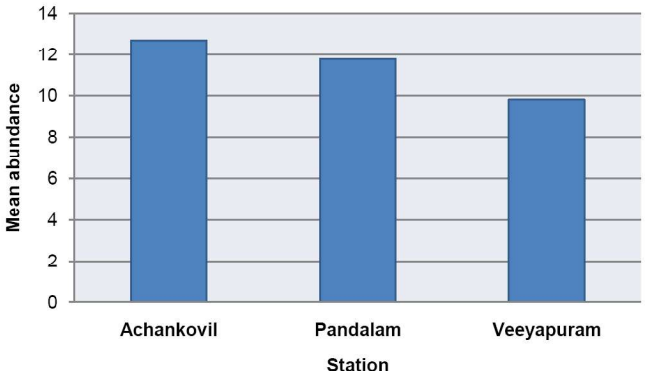
Table 1. Macroinvertebrate fauna collected from the sampling sites

Sl.No.	TAXA				Site 1. Achankovil	Site 2. Pandalam	Site 3. Veeyapuram
	Phylum	Class	Order	Family	(n)	(n)	(n)
1	Annelida	Hirudinida	Rhynchobdellida	Glossiphoniidae	5	-	-
2	Mollusca	Gastropoda			17	-	5
3		Bivalvia			-	9	-
4	Arthropoda	Crustacea	Decapoda	Potamidae	2	-	-
5				Aegidae	-	-	3
6				Atyidae	16	6	35
7				Palaemonidae	-	-	1
8		Insecta	Ephemeroptera	Caenidae	30	54	18
9				Heptageniidae	-	2	-
10				Leptophlebiidae	5	-	-
11			Odonata	Coenagrionidae	5	-	9
12				Chlorocyphidae	-	-	3
13				Platycnemididae	2	1	12
14				Libellulidae	--	-	3
15			Diptera	Chironomidae	15	24	-
16				Chaoboridae	-	2	-
17				Tipulidae	-	15	3
18			Hemiptera	Corixidae	-	-	3
19				Veliidae	-	6	-
20				Nepidae	5	1	18
21				Belostomatidae	-	-	6
22				Naucoridae	5	17	24
23			Coleoptera	Hydrophilidae	2	10	6
24				Dytiscidae	-	6	15
25				Elmidae	-	-	3
26			Trichoptera	Hydropsychidae	56	-	-

Table 2. One way ANOVA comparing the macroinvertebrate fauna at three stations of river Achankovil

Stations	Mean	± SD	F value
Achenkovil	12.69	5.41	
Pandalam	11.77	6.45	0.193
Veeyapuram	9.82	7.39	

Figure 1. Mean abundance of macroinvertebrate fauna at three stations of river Achankovil



Most of the species in family Potamidae live in relatively fast flowing waters and require clear, highly oxygenated waters. Freshwater mussels are present in all types of unpolluted water. Pollution tolerant organisms (Diptera) obtained in lesser number indicate lesser pollution. A number of 165 macroinvertebrates belonging to 13 different families were obtained from the first study site.

Pollution indicator organisms were high in the second study site Pandalam when compared to first site. 153 macroinvertebrates belonging to 13 different families are obtained from the second study site. Caenidae (Ephemeroptera) are quite tolerant to organic pollution. Large number of caenideans were recorded from second study site. Diptera, especially chironomidae is highly tolerant to pollution which were abundantly obtained from the second study site. The abundance of these organisms indicates the severity of pollution.

Third study site is less polluted when compared to second study site. Because pollution intolerant organisms such as stoneflies (Odonata), and coleopterans were abundantly obtained from the third study site Veeyapuram. The diversity of these organisms indicate lesser pollution. 168 macroinvertebrates belonging to 18 different families were obtained from third study site.

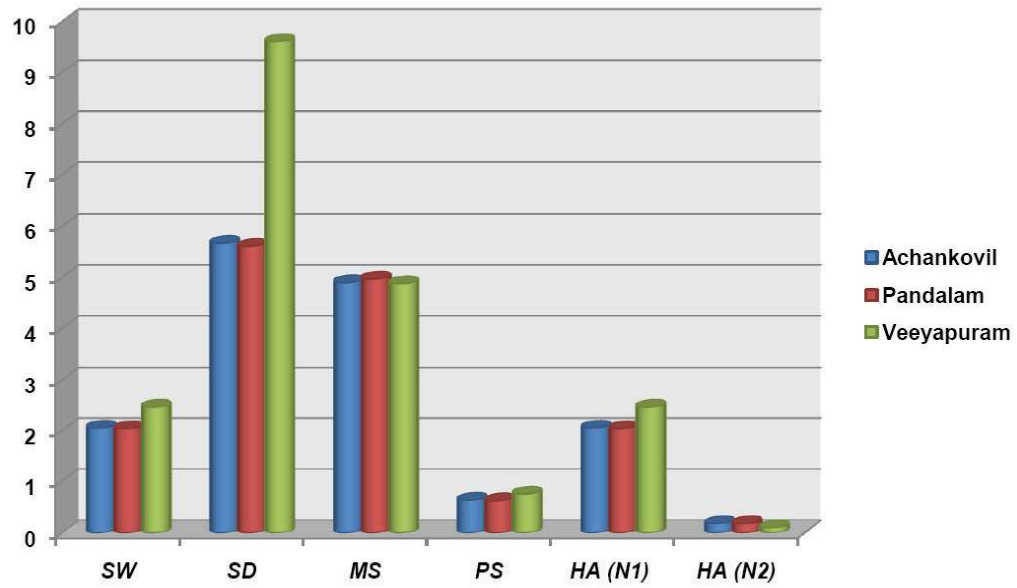
The statistical analysis of the results shows that there is no significant difference between the three study stations. The one way ANOVA comparing the macroinvertebrates fauna at the study stations is presented in Table 2.

Table 3 shows biodiversity indices of macroinvertebrates at three different study stations. The Shannon – Weiner diversity index value is high in Veeyapuram (2.46) and low in Pandalam (2.04) and Achankovil (2.05). In the case of Simpson's dominant index value, Veeyapuram (9.61) show high index value and low in Pandalam (5.60) and Achankovil (5.66). Mergalef's species richness index value is high in Pandalam (4.97) and low in Veeyapuram (4.88) and Achankovil (4.90). Pielou's species evenness index value is high in Veeyapuram (0.75) and low in Achankovil (0.63) and Pandalam (0.62). In the case of species abundance high and low values of Hill's index N1 is 2.46 in Veeyapuram, 2.05 in Achankovil and 2.04 in Pandalam and N2 is high in Pandalam (0.18), low in Veeyapuram (0.10) and Achankovil (0.18). Figure 2 shows the graphical representation of indices of macroinvertebrates at three different study stations.

Table 3. Biodiversity indices of macroinvertebrates at different study sites

Diversity indices		Achankovil	Pandalam	Veeyapuram
Shannon-Weiner diversity index		2.05	2.04	2.46
Simpson's dominant index		5.66	5.60	9.61
Mergalef's species richness index		4.90	4.97	4.88
Pielou's species evenness index		0.63	0.62	0.75
Hill's species abundance index (N1- number of abundant species; N2- number of very abundant species)	N1	2.05	2.04	2.46
	N2	0.18	0.18	0.10

Figure 2. Biodiversity indices of macroinvertebrates at the sampling sites



SW: Shannon-Weiner diversity index; SD: Simpson's dominant index; MS: Mergalef's species richness index; PS: Pielou's species evenness index; HA (N1): Hill's species abundance index -number of abundant species; HA (N2):Hill's species abundance index - number of very abundant species)

Discussion

Macroinvertebrates play a key role in maintaining the water quality. The life cycle process of macroinvertebrates is hindered due to various factors including the fluctuations in the physicochemical parameters that lead to its diversity depletion (Verma and Agarwal, 1993).

The abundance of pollution tolerant organisms indicates the intensity of pollution in site 2 Pandalam. The density of these organisms was very high in study site to indicating the aquatic environment of river Achankovil at Pandalam. The first study site is non polluted because pollution tolerant organisms decrease in number in the first study site Achankovil. According to Washington (1984), an indicator species is the one which is sensitive to pollution. Some macroinvertebrates like stoneflies and mayflies are very sensitive to organic pollution, while on the other hand, pollution tolerant invertebrates like Chironomous larvae and Tubifex etc; have increased their number in organically enriched conditions. As tolerant organisms may be found either in clean or polluted situations, therefore their presence is not definitive. Thus a population of tolerant organisms combined with an absence of intolerant ones is a good indication of the presence of pollution. (APHA, 1998)

Pollution reduces the number of species and destroys the balance of life in streams and is evidenced by the biological indices of community diversity. The number of organisms of some species increase, while other either remains same or decline. The first study site is free from pollution because of the lesser number of pollution tolerant organisms, whereas the pollution intolerant organisms such as caddisfly (Trichoptera) stoneflies (Odonata), crustaceans (Potamidae) are abundantly seen in first study site Achankovil. The first study site is the origin of river, so the water is not polluted therefore only pollution intolerant organisms increase in number and variety.

The second study site, Pandalam is polluted because the pollution tolerant organisms like Chironomidae are abundantly seen in this site these are highly tolerant to organic pollution. Caenidae are also quite tolerant organic pollution, these are largely obtained from second study site indicate the severity of pollution. Third study area is less polluted because pollution intolerant organisms like Coleopterans and stoneflies (Odonata) are abundantly seen in third study site. Odonates have considerable potential as indicators of environmental disturbance following logging or pollution (Yule and Sen 2004). Hemipterans are not useful indicators of water quality because they are less dependent on local stream conditions for habitat requirements. The ecological diversity of caddisfly larvae is extensive, apparently facilitated by their ability to produce silk from labial glands (Mackay and Wiggins, 1979). Water beetles, especially Elmidae are gaining increasing recognition as indicators of water quality, water types (Verdonschot *et. al.*, 1992) and endangered habitats (Jach *et. al.*, 2004). Dytiscidae is the most diverse family of True Water Beetles, because more than 3700 species in about 150 genera are known (Pederzani, 1995; Nilsson, 2001)

The Chironomidae, which are known popularly as non - biting midges, are a species rich family of flies, with over 5000 described species worldwide. Larval Chironomid species track ecological conditions closely, and their distributions have long been used to assess water quality. The high density of Chironomid in second study site indicating the

polluted aquatic environment of river Achankovil at Pandalam site.

Macroinvertebrates are stationary and are sensitive to different degrees of pollution, changes in their abundance and variety vividly illustrate the impact of pollution is having on the stream. Biomonitoring of macroinvertebrates helps in assessing the environmental conditions of the river. Macroinvertebrates plays a major role in maintaining the aquatic food chain. The biodiversity indices obtained from the present study also indicates that even though there is not much significant difference between the stations, the river harbours a rich and diverse macroinvertebrate community.

Conclusion

Aquatic macro invertebrates form a vital component of aquatic food web and thus helps in maintaining the ecosystem health. Any change in the water quality will be reflected in the community assemblage and corresponding distribution pattern of these organisms. Even though river Achankovil holds a good diversity of aquatic macro invertebrates, their pattern has been affected moderately at Pandalam segment due to anthropogenic interventions. Further, biomonitoring protocols using aquatic insects and other macro invertebrates could be considered as an efficient tool for river health assessment.

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