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Macroinvertebrate diversity indices: A quantitative bioassessment of ecological health status of an oxbow lake in Eastern India

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Original Article

Abstract

Aquatic macroinvertebrates, which play a significant role in the food chain of an ecosystem, are used in fresh water quality assessment to identify the environmental stress resulting from a variety of anthropogenic disturbances. Seasonal surveys of macroinvertebrate communities were conducted from April 2013 to March 2014 in Chhariganga oxbow lake of Nadia District of West Bengal, an eastern state of India. In order to bioassess water quality and aquatic health analysis using diversity indices, viz. Shannon-Wiener and Simpson's diversity index, species richness and evenness, and total abundance with composition trends were carried out. Taxon richness values of 14, 14, and 18, evenness values of 0.80, 0.71, and 0.73, Shannon-Wiener Index values of 2.10, 1.88, and 2.12, and Simpson's index values of 0.15, 0.22, and 0.20 were determined for macroinvertebrates found during pre-monsoon, monsoon, and post-monsoon period, respectively. In the present study, low diversity indices, like the Shannon-Wiener Index, demonstrated clearly that the selected lake is polluted and has high anthropogenic activity which has rendered the lake bad to poor health status especially during monsoon season. Therefore, it is necessary to regulate and prevent the jute retting process, and its intensity and density during the monsoon to enhance biodiversity in order to ensure sustainable management and conservation of aquatic environment of the oxbow lake.

KEYWORDS: Oxbow Lake, Macroinvertebrate, Diversity Index, Aquatic Health, Bioassessment

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Introduction

Macroinvertebrates include those "organisms large enough to be caught with a net or retained on a sieve with a mesh size of 250-1000μ".[1] These organisms can be benthic, inhabiting substrates like sediments, debris, or logs, or pelagic, swimming freely in the water column. They play an essential role in the aquatic habitat and food web. Apart from fishery resources and periphyton, ecological assessment of aquatic systems using macroinvertebrates has been one of the frequently used protocols for indication of water quality in standard water management. Macroinvertebrate abundance, community structure, and ecological function have long been used to characterize water quality in freshwater ecosystems. While many taxa contribute to biodiversity in stream ecosystems, macroinvertebrates play a central ecological role in many stream ecosystems and are among the most ubiquitous and diverse organisms in fresh waters.[2] Because of their cosmopolitan nature, inhabiting all freshwater habitats of the world, macroinvertebrates are not only useful as bioindicators, but helpful in ameliorating polluted water. As they have low mobility (i.e.,

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sedentary, sessile, or nearly sedentary) and life cycles of several weeks and or years, they reflect cumulative effects of the present and past conditions of an aquatic ecosystem. They can often be extremely productive and abundant and are good indicators of environmental conditions, toxic contamination for localized conditions and site specific impacts, and changing water qualities. They make a good study specimen, because they are abundant, readily surveyed, and taxonomically rich[3] and easy to collect and identify.[1,4] Macroinvertebrates usually consist of a heterogeneous collection of evolutionary diverse taxa. For that reason, different species will react to different changes in aquatic environment, natural as well as imposed, and physical as well as chemical.[1] The use of benthic macroinvertebrates to assess the overall health status of aquatic environments remains the most suitable, reliable, and widely acclaimed method globally. The qualitative and quantitative studies of their diversity are of great importance.

Benthic invertebrates were used as bioindicators for studies of the impact of environmental perturbations on the aquatic ecosystems.[5,6] Macroinvertebrates are attractive targets of biological monitoring efforts as they are a diverse group of long-lived, sedentary species that react strongly and often, predictably to human influence on aquatic ecosystems.[7] They are most frequently used in biomonitoring studies as their responses to organic and inorganic pollution have been extensively documented.[8,9] The use of benthic macroinvertebrates has been discussed in the assessment of freshwater bodies.[10] They have sensitive life stages that respond to stress and integrate effects of both short-term and long-term environmental stressors[11] and are important areas for maintaining biodiversity.[12,13] Macroinvertebrates and water quality are interrelated; thus, macroinvertebrates are a potential indicator of water quality.[14] They are more efficient bioindicators in understanding the ecological health of an aquatic ecosystem, compared to chemical and microbiological data, which at least illustrate short-term fluctuations.[15-17] Biomonitoring studies with the use of macroinvertebrates to rate the quality of both lotic and lentic water bodies have been widely reviewed.[18-21]

However, the use of aquatic macroinvertebrate in bioassessment of water quality and aquatic health in India has rather limited documentations.[22-30] Few studies have been carried out on its ecological aspects in oxbow lakes. Greater macroinvertebrate diversity was observed in the lentic system of the Hansadanga Beel oxbow lake, than other biotic communities. The Hansadanga Beel oxbow lake is situated at longitude 88° 33/E, latitude 23° 24/N, in Nadia district of West Bengal, an eastern province of India. Its anthropogenic activities were observed to be influencing the changing of sediment redox potential values for alteration of macroinvertebrate communities in the water body.[31] The diversity analysis of benthic macroinvertebrates of West Bengal oxbow lake ecosystems and their role in the assessment of water quality and aquatic health are not well known. Existing works on the macrobenthic fauna of the oxbow lakes in Nadia District, in particular, and West Bengal, in general, are quite scanty. Therefore, a survey of macroinvertebrate communities and an analysis of macroinvertebrates were performed using diversity indices and structure and composition trends with abundance in an oxbow lake ecosystem in Nadia District, India. They were conducted for the quantitative and biological assessment of aquatic health status of the oxbow lake ecosystem.

Materials and Methods

The Chhariganga oxbow lake, abandoned, fractioned, and derived from the river Ganga is located in Nakashipara development block of

Nadia District, West Bengal, an eastern Indian province. It is situated at 23.5800° N latitude, 88.3500° E longitude, about 90 Km from the Kalyani University Campus, Nadia, and nearly 40 Km from the line of Tropic of Cancer towards the north. It is a fresh water source and semi-open type oxbow lake, and receives water from the river Ganga during monsoon season through a narrow channel at the North East corner of a loop of the river. The oxbow lake is spread over an area of 145.69 acres with an annual average depth of 8.5 ft. It also stores rain water. The catchment area of the oxbow lake is nearly 600 hectares (Figure 1).

In the changed climate of this region, three distinct annual seasons are observed; the monsoon or rainy season generally from July to October, post-monsoon season or winter from November to February, and pre-monsoon or dry season from March to June. There was an occasional inundation of the surrounding banks during the monsoon. The oxbow lake is subjected to all forms of human activities including jute retting during monsoon season, agriculture, and fishing. It is the only source of irrigation water to the immediate agriculture communities.

The methods by which macroinvertebrates are collected in aquatic systems can be diverse, depending on the physical characteristics of the aquatic habitat. In shallow waters, samples can be collected using kick sampling technique with a hand net, whereas deeper waters require larger instruments like grab sampler. In this study, we collected benthic macroinvertebrates from the oxbow lake during the three seasons, viz. pre-monsoon, monsoon, and post-monsoon seasons, from April 2013 to March 2014. We collected the organisms using a D-frame net (0.5 mm mesh) and following hand picking method. We took the samples at 1 × 1 m locations from an area of nearly 100 m^2 in order to include all possible microhabitats. In some areas with the presence of large bushes, we first picked out the bushes and washed them into the net to remove pupae and other attached macro-invertebrates. For the bank-roots and macrophytes, we collected benthic invertebrates using a hand net made of mesh bolting silk of 100 μm. We collected the sediment in a plastic container of 15 l volume. Water was added and stirred vigorously while the floating fauna were sieved using 250 μm size sieve and the un-floated fauna were handpicked. Mud samples of 1 l were collected from the bottom of the lake using an Ekman grab. All the animals collected were immediately fixed in formaldehyde (4%) in the field, and then, transferred to 70% ethyl alcohol for preservation. In general, macroinvertebrates are taxonomically identified using key identification guides, and some samples may require examination under a dissection microscope.[1]

Figure 1. Map showing the study area

Identification can be carried out at two possible levels; family or genus/species. Genus/species level identification provides more accurate information on ecological condition and population sensitivity, but identification at family level awards more precision to the taxonomists, and thus, requires less expertise and time to complete.[4] In this study, macroinvertebrates were sorted and identified to the lowest possible taxon (species/genus or families) and counted under a stereomicroscope in the laboratory with the help of an identification manual and literatures.[32-38]

To understand a particular biotic community, it is very important to attain certain indices for the purpose of community analysis of the macroinvertebrates. Most assessment methods for macroinvertebrates are taxonomical, whereby analysis of a particular species, groups, or population is carried out.[1] The assessment of these groups can further be conducted in either of three approaches; saprobic, diversity, and biotic approaches. Saprobic approach indicates specific tolerance to pollution by a specific indicator species, whereas diversity approach utilizes the community structure as evaluation for ecosystem health. The biotic approach combines both saprobic and diversity approaches in the assessment of water quality. Examples of indices used in macroinvertebrate study are the Shannon-Wiener diversity index (H'), Family Biotic Index (FBI), and Biological Monitoring Work Party (BMWP). The biotic index and score systems are efficient in assessing organic pollution and eutrophication, but poor in assessing toxic and physical pollution. Low diversity indicates low quality and high diversity indicates good quality of water. Therefore, to obtain a fair overall assessment of the quality of a water body, both methods are essential and need to be combined with alternative methods of evaluating biota response.[39] Washington believes diversity measures are useful for describing community structure, but not the pollution level of water bodies.[40] The same author maintains that biotic indices must be limited to environments polluted with easily degradable organic matter (sewage) and not by other types of pollutants.[40] Benthic macroinvertebrate species are differentially sensitive to many biotic and abiotic factors in their environment. Consequently, macroinvertebrate community structure has commonly been used as an indicator of the condition of an aquatic system.[41] Diversity indices are efficient in indicating physical and toxic pollution which stress most species in a community without encouraging replacement species. However, although high diversity does indicate good quality water, low diversity may not necessarily indicate low quality. To evaluate the distribution and diversity between sampling sites, community indices such as abundance, richness, evenness, and the Simpson and Shannon-Wiener diversity indices were used. Statistical analysis of biological indices, such as taxa richness, evenness (E), and the Shannon-Wiener and Simpson's diversity indices was performed using diversity index formulas 1 and 2.

(1) Simpson's index (D)[42]: $D = \Sigma (pi)^2$

where pi is the proportion of important value of the i^{th} taxon (pi = ni/N), ni is the importance value index of i^{th} taxon, and N is the importance value index of all the taxa).

Simpson's index gives relatively little weight to the rare taxa and more weight to the common taxa. It weighs towards the abundance of the most common taxon. It ranges in value from 0 (low diversity) to a maximum of 1-1/s, where s is the number of taxon.

(2) Shannon-Wiener Index (H')[43]: $H' = -\Sigma\, pi \log pi$

where pi is the proportion of importance value of the i^{th} taxon (pi = ni/N, ni is the importance value of i^{th} taxon and N is the importance value of all the taxa).

This diversity index helps in calculation of taxon relative abundance. A large H value indicates greater diversity, as influenced by a greater number and/or a more equitable distribution of taxon. The index values range between 0 and 5, where higher index values demonstrate higher diversity, while low index values are considered to indicate pollution. Diversity and anthropogenic disturbances are inversely related. The Shannon-Wiener index takes account of taxon richness as well as abundance. It is simply the information entropy of the distribution, treating genus as symbols and their relative population sizes as the probability. The advantage of this index is that it takes into account the number of taxon and the evenness of the taxon. The index is increased either by having additional unique taxon, or by having greater taxon evenness. The Evenness Index is the relative distribution of individuals among taxonomic groups within a community and is expressed as:

Evenness Index (E).[44]: $E = H'/\log S$

where H′ is the Shannon–Wiener Diversity Index, and log S is the natural log of the total number of taxon (S defined as taxon richness) recorded. It is used for the degree to which the abundances are equal among the groups present in a sample or community.

Results and Discussion

Macroinvertebrates' seasonal occurrence, compositions, and diversity indices are illustrated in table 1. Phylum Arthropoda (Class Insecta) accounted for 64.34% (83 no/m^2), 94.15% (338 no/m^2), and 82.72% (158 no/m^2) of total macroinvertebrates surveyed during pre-monsoon, monsoon, and post-monsoon periods, respectively. Water scorpion dominated this Class Insecta during all seasons from April 2013 to March 2014. Dragonfly larvae and water strider was found the least during pre-monsoon, dragonfly larvae and damselfly larvae during monsoon, non-biting midge larvae/blood worm during post-monsoon in this class. Phylum Arthropoda (Class Crustacea) accounted for 0.78% (1 no/m^2), 1.39% (5 no/m^2), and 7.33% (14 no/m^2) of total macroinvertebrates surveyed during pre-monsoon, monsoon, and post-monsoon periods, respectively. While prawn dominated the class during pre-monsoon and monsoon periods, freshwater crab dominated the class during post-monsoon period. Fresh water mite (Family: Limnocharidae) representing Phylum Arthropoda (Class Arachnida) was found to be the lone macro-invertebrate during post-monsoon period in 2013-2014 with 0.52% (1 no/m^2) of total macroinvertebrates surveyed. Right handed freshwater gilled snail with 24.81% (32 no/m^2) dominated Phylum Mollusca during pre-monsoon period, when left handed freshwater pouch snail occurred the least with 2.33% (3 no/m^2). Left handed freshwater pouch snail was found (7 no/m^2) to be the single Mollascan with 1.95% of the total macroinvertebrates during monsoon period. It was dominant with 3.14% during post-monsoon period, while freshwater mussel was found to be the least with 1.05% in the oxbow lake. Aquatic segmented earth worm in the Phylum Annelida was dominant during all the seasons. Leeches were present only during post-monsoon period in that phylum. Average abundance of macroinvertebrates was found to be 129, 359, and 191 numbers, while average biomass was weighed at 95.64, 286.65, and 178.56 gm/m^2 of the lake water, respectively, during pre-monsoon, monsoon, and post-monsoon periods. Macroinvertebrates' richness of 14, 14, and 18, taxon evenness values of 0.80, 0.71, and 0.73, Shannon-Wiener Index values of 2.10, 1.88, and 2.12, and Simpson Index values of 0.15, 0.22, and 0.20 were determined for macroinvertebrates found during the three seasons, respectively. Seasonal compositions and diversity indices of macroinvertebrate occurrence in phyla are presented in table 2.

Shannon-Wiener Index values of 0.73, 0.29, and 0.65, evenness values of 0.52, 0.21, and 0.40, and Simpson Index values of 0.53, 0.89, and 0.69 were observed, respectively, during the three seasons for macroinvertebrates when occurred in different phyla. Seasonal occurrence, compositions, and diversity indices of different groups found in each phylum are given in table 3. Shannon-Wiener Index values of 0.99, 0.90, and 1.27, evenness values of 0.71, 0.65, and 0.79, and Simpson Index values of 0.43, 0.51, and 0.33 were obtained during the three seasons for the macroinvertebrate groups when occurred in each phylum. Figure 2 depicts the seasonal variations in occurrence while figure 3 demonstrates seasonal variations in macroinvertebrates' diversity indices. Seasonal variations in phyla diversity indices are illustrated in figure 4. Figure 5 highlights the seasonal variations in group diversity indices while figure 6 accommodates variations in numbers in phyla in a year. Seasonal variations in occurrence of groups in each phylum are shown in figure 7.

Table 1. Seasonal distributions and diversity indices of macroinvertebrates

Macroinvertebrate (Common Name)	Taxa	PRM no	PRM %	MON no	MON %	POM no	POM %
Phylum Arthropoda Class Insecta							
Riffle beetle/larvae and Beetle	Coleoptera (family Elmidae)	11.00	8.53	-	-	5.00	2.62
Dragonfly larvae	Odonata (family Gomphidae)	1.00	0.78	3.00	0.84	2.00	1.05
Non-biting midge larvae/blood worm	Chironomidae (family)	-	-	5.00	1.39	1.00	0.52
Biting midge larvae	Ceratopogonidae (family)	3.00	2.33	19.00	5.29	9.00	4.71
Damselfly larvae	Odonata (order)	-	-	3.00	0.84	-	-
Water boatmen	Corixidae (family)	6.00	4.65	17.00	4.74	15.00	7.85
Water scorpion	Nepidae (family)	32.00	24.81	126.00	35.10	76.00	39.79
Water measurer	Hydrometridae (family)	11.00	8.53	56.00	15.60	22.00	11.52
Water strider	Gerridae (family)	1.00	0.78	13.00	3.62	5.00	2.62
Water scavenger beetle adult/larvae	Hydrophilidae (family)	15.00	11.63	89.00	24.79	21.00	10.99
Mosquito larvae and pupae	Culicidae (family)	3.00	2.33	7.00	1.95	2.00	1.05
Phylum Arthropoda Class Crustacea							
Freshwater prawn	Decapoda (order)	1.00	0.78	3.00	0.84	2.00	1.05
Freshwater crab	Decapoda (order)	-	-	2.00	0.56	12.00	6.28
Phylum Arthropoda Class Arachnida							
Fresh Water mite	Acarina (family Limnocharidae)	-	-	-	-	1.00	0.52
Phylum Mollusca							
Freshwater mussel	Bivalvia (class)	9.00	6.98	-	-	2.00	1.05
Freshwater snail (Right handed gilled)	Gastropoda (class)	32.00	24.81	-	-	6.00	3.14
Freshwater snail (Left handed pouch)	Viviparidae (family)	3.00	2.33	7.00	1.95	6.00	3.14
Phylum Annelida							
Leeches	Hirudinea (class)	-	-	-	-	1.00	0.52
Segmented worm (aquatic earthworm)	Oligochaeta (class)	1.00	0.78	9.00	2.51	3.00	1.57
Average abundance [no/m^2]		129.00	100	359.00	100	191.00	100
Average Biomass (gm/m^2)		95.64		286.65		178.56	
Macroinvertebrate richness		14.00		14.00		18.00	
Shannon-Wiener Index		2.10		1.88		2.12	
Taxon evenness		0.80		0.71		0.73	
Simpson's Index		0.15		0.22		0.20	

PRM: Premonsoon; MON: Monsoon; POM: Postmonsoon

Table 2. Seasonal phyla compositions and diversity indices of macroinvertebrates

Occurrence in Phyla	PRM	PRM	MON	MON	POM	POM
	no	%	no	%	no	%
Phylum Arthropoda Class Insecta	83.00	64.34	338.00	94.15	158.00	82.72
Phylum Arthropoda Class Crustacea	1.00	0.78	5.00	1.39	14.00	7.33
Phylum Arthropoda Class Arachnida	0	0	0	0	1.00	0.52
Phylum Mollusca	44.00	34.11	7.00	1.95	14.00	7.33
Phylum Annelida	1.00	0.78	9.00	2.51	4.00	2.09
Total abundance (no/m^2)	129.00	100	359.00	100	191.00	100
Phyla richness	4.00		4.00		5.00	
Shannon-Wiener Index	0.73		0.29		0.65	
Phyla evenness	0.52		0.21		0.40	
Simpson’s Index	0.53		0.89		0.69	

PRM: Premonsoon; MON: Monsoon; POM: Postmonsoon

Table 3. Taxon frequency distributions and diversity indices of macroinvertebrates

Occurrence of group in each phylum	PRM	PRM	MON	MON	POM	POM
	no	%	no	%	no	%
Phylum Arthropoda Class Insecta	9.00	64.29	10.00	71.43	10.00	55.56
Phylum Arthropoda Class Crustacea	1.00	7.14	2.00	14.29	2.00	11.11
Phylum Arthropoda Class Arachnida	0	0	0	0	1.00	5.56
Phylum Mollusca	3.00	21.43	1.00	7.14	3.00	16.67
Phylum Annelida	1.00	7.14	1.00	7.14	2.00	11.11
Group richness	14.00	100	14.00	100	18.00	100
Phyla richness	4.00		4.00		5.00	
Shannon-Wiener Index	0.99		0.90		1.27	
Group evenness	0.71		0.65		0.79	
Simpson’s Index	0.43		0.51		0.33	

PRM: Premonsoon; MON: Monsoon; POM: Postmonsoon

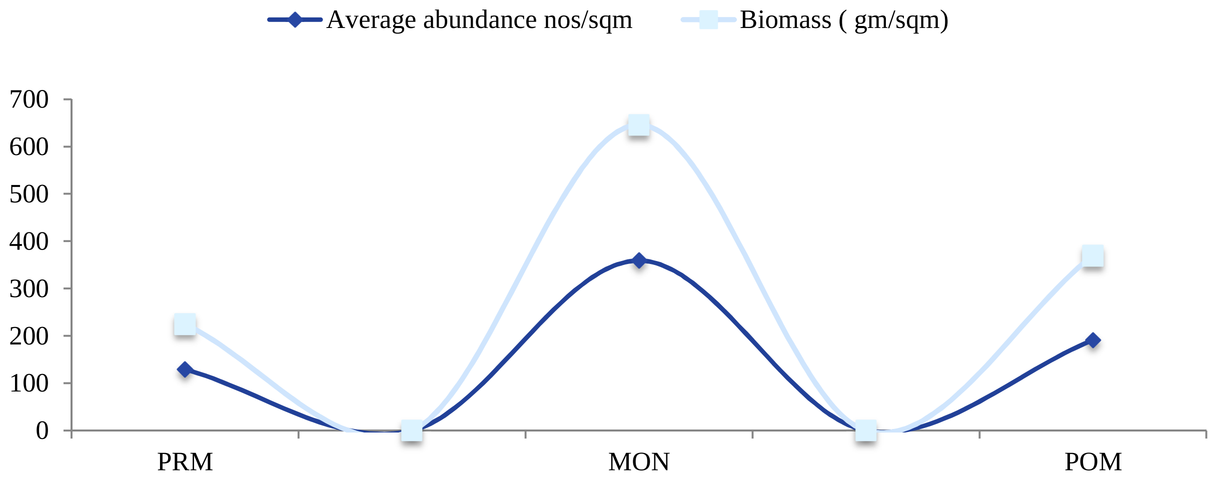

Figure 2. Seasonal variations in occurrence of macroinvertebrates
PRM: Premonsoon; MON: Monsoon; POM: Postmonsoon

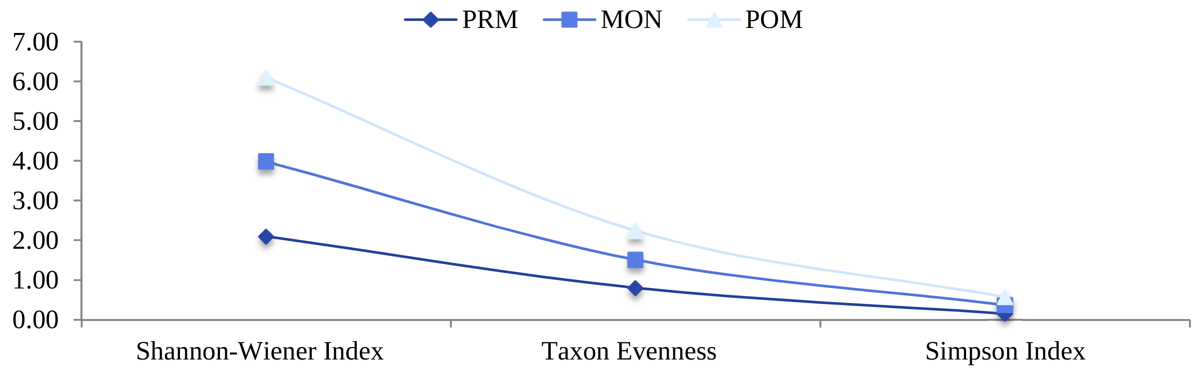

Figure 3. Seasonal variations in macroinvertebrate diversity indices
PRM: Premonsoon; MON: Monsoon; POM: Postmonsoon

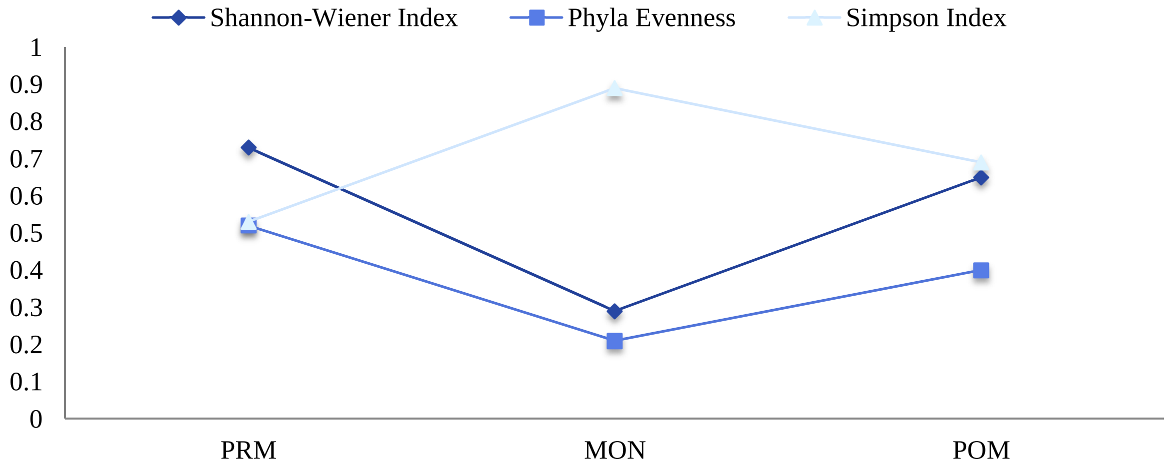

Figure 4. Seasonal variations in phyla diversity indices of macroinvertebrates
PRM: Premonsoon; MON: Monsoon; POM: Postmonsoon

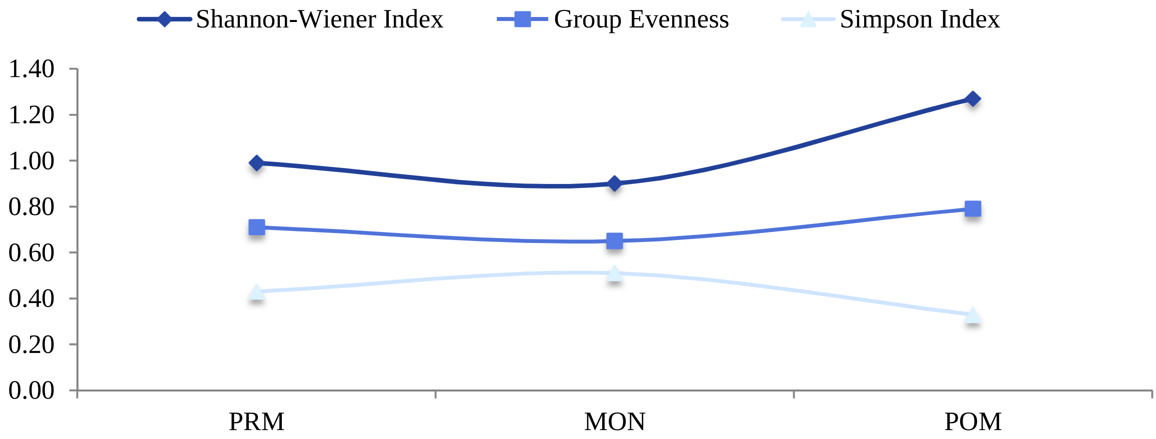

Figure 5. Variations in taxon frequency diversity indices of macroinvertebrates
PRM: Premonsoon; MON: Monsoon; POM: Postmonsoon

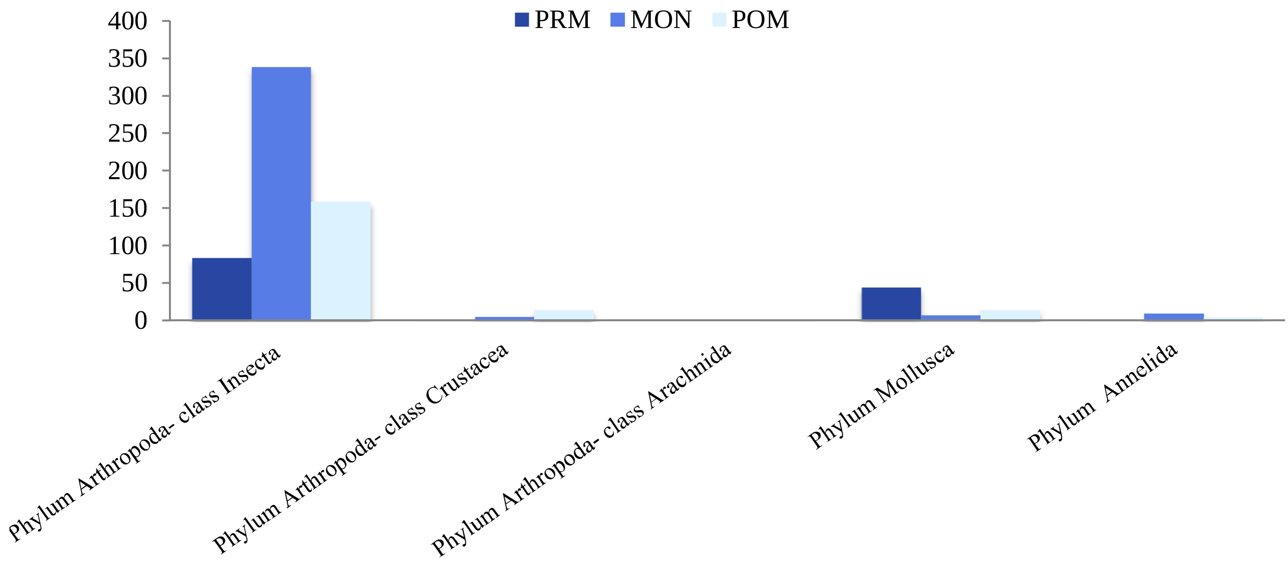

Figure 6. Variations in numbers of macroinvertebrates grouped in phyla in a year
PRM: Premonsoon; MON: Monsoon; POM: Postmonsoon

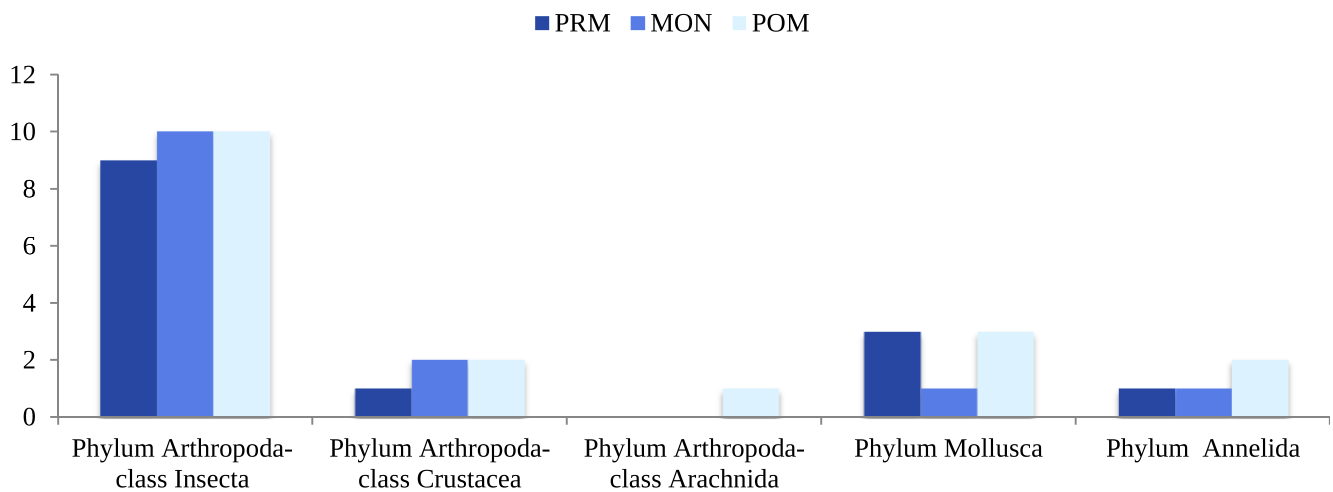

Figure 7. Seasonal variations in taxon frequency distributions
PRM: Premonsoon; MON: Monsoon; POM: Postmonsoon

Lower Shannon-Wiener diversity indices were observed during jute retting during monsoon period. The same decrease in diversity index was reported during October[45] and was attributed to emergence of several groups of aquatic insects prior to sampling or some movement into shallower parts of the lake during the hottest time of the year. Similarly, diversity index for the different species was generally low in the coconut husk retting zones (0.68 to 1.20) when compared to the non-retting zones (0.88 to 2.97) of Kerala backwaters in India.[22] Lower Shannon-Wiener diversity index values were found between 0.67 and 1.77 using macroinvertebrates in Bangalore lakes.[23] Shannon-Wiener diversity index of quite similar patterns were also reported[24] (1.28 to 2.31) with maximum and (0.27 to 1.53) minimum values which are much lower than the present findings. Seasonal change was found; like lowest Shannon-Wiener diversity index during October and highest during July. The change was attributed to poor water exchange insufficient for self-purification. In that study,[24] insecta (Chironomidae and Culicidae) showed higher incidence in the coconut husk retting zones when compared to non-retting zones in lakes. Macroinvertebrate diversity index values from 0.49 to 1.40 and dominance index of between 0.30 and 0.72 are reported in tropical urban wetlands in Bangalore.[25] Shannon-Wiener index values of 1.8-3.07 with macroinvertebrates were found in a lake in Turkey[46], the lower value of which is in agreement with the findings of the present study. Lower Shannon-Wiener diversity values (0.35-1.81) and similar low Simpson's diversity index values (0.20-0.79) were observed in Bangalore inlets.[26] Evenness was found at quite similar range (0.56 to 0.97) in inlets in Bangalore. Much lower values of Shannon-Wiener Index (0.30-0.69) and quite similar evenness index values (0.53-0.97), using aquatic insects, were also reported for oxbow lake water in Assam.[27] Macroinvertebrate fauna species density values of 140–1113 no/m^2, which is quite similar or a little higher than that of the present study (129-359 no/m^2) were observed in mangrove ecosystem in India.[28] Moreover, compared to the present study results, quite similar dominance values of 0.17-0.50, almost similar diversity values of 1.80-2.83, and quite similar evenness values of 0.45-0.72 were observed.[28] Almost similar Shannon-Weiner diversity index values of macroinvertebrates (2.00 to 2.38) were observed in oxbow lakes in Assam. [30] They concluded that there was a good diversity in oxbow lakes in Assam where evenness index values (0.45-0.56) were lower than that of this study.[30] Quite similar Shannon-Wiener diversity (H) values (1.967-2.625), lower evenness (E) values (0.357-0.600), and higher dominance index (C) values (0.776- 0.903) were also observed in south Nigerian rivers.[47] Quite smaller Shannon-Wiener diversity index values of macroinvertebrate community were observed in Hansadanga Beel, an oxbow lake in Nadia District.[31] They were within the range of 0.943-1.551 (with average values of 1.231 in premonsoon, 1.473 in monsoon, and 1.113 in postmonsoon period) which indicates an intermediate scale of pollution.[31]

The Shannon-Wiener Index was found to be the most reliable in assessing river water quality using macrozoobenthos.[48] According to the Water Framework Directive, the relationship between the indices and ecological level is as follows: high status: higher than 4 bits/individual, good status: 4-3 bits/individual, moderate status: 3-2 bits/individual, poor status: 2-1 bits/individual, and bad status: 1-0 bits/individual.[49] Shannon-Wiener Index values of macro-invertebrates in all the cases from April 2013 to March 2014 in this study (showed lowest values during monsoon, unlike the Simpson Index values which were highest, especially during monsoon) ranged from 0.29 to 2.12. The lower index values thus efficiently and reliably suggested the bad to poor state of the aquatic health of this semi-closed oxbow lake ecosystem with an indication to pollution. These findings prove once again that diversity and anthropogenic disturbances are inversely related. This pollution status showed similarity to assessment results of diversity indices of rotifer,[50] zooplankton,[51] phytoplankton,[52] and macrophytes[53] on the same oxbow lake during the same time period as the study.

Conclusion

The purpose of the present investigation was to present a general account of benthic macroinvertebrates' composition and diversity to rate the aquatic health status using the aquatic benthic fauna. Low diversity values of Shannon-Wiener and Simpson indices in the present study clearly show that the selected lake is polluted and has high anthropogenic activity. Hence, this lake is not suitable for growth of fish especially during monsoon season. Therefore, it is necessary to regulate and prevent jute retting processes, and their intensity and density in the lake during the monsoon to enhance biodiversity in order to ensure sustainable management and conservation of aquatic environment of this oxbow lake. It was also proven that biological data are useful for the detection of pollution. To understand the lake ecosystem and its health, understanding about the ecology (life cycle and secondary production) of macroinvertebrates is necessary. Thus, the study would hopefully be a reference archive for future studies on aquatic health of oxbow lake ecosystems in the region. The information obtained is crucial in serving as baseline data for various agencies, including governmental academic, and nongovernmental institutions, to take actions for more efficient sustainable management of this oxbow lake in particular and others in the country in general.

Conflict of Interests

Authors have no conflict of interests.

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