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Diversity of Macro Benthic Fauna of Two Freshwater Pisciculture Ponds of West Bengal

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Abstract

Macro benthos diversity of one managed and one unmanaged freshwater fish pond was studied. Frequency distribution of benthic organisms was higher in the managed pond than the unmanaged one. The diversity of the macro benthic fauna in both the fluctuated ecosystem is calculated with the use of diversity indices, to show the variation of the abiotic and biotic factors on the species diversity. The Shannon-Wiener diversity index was higher in the managed pond, which had less organic matter. The production of benthic invertebrate population showed strong positive relation with the soil parameters like temperature, available phosphorus, available nitrogen and organic carbon. The production of benthic invertebrate population showed a strong positive correlation with the water parameters. However, there was a negative correlation between *Bellamya* sp. and DO in the managed pond *Tubifex* sp. also showed a negative correlation with pH in the unmanaged pond. In the unmanaged pond, the Tubificidae were recorded more than Chironomidae. In the managed pond Tubificidae was recorded to be relatively less in number whereas larvae of Chironomidae were recorded high. This observation suggests that unmanaged pond had high organic load, which also depicted from the soil study of unmanaged pond. Thus the ratio *Tubifex* sp. and Chironomid larvae may be a useful index of sewage pollution.

Key words : Macro benthos, *Bellamya* sp., *Tubifex* sp., Managed pond, Unmanaged pond.

The study of biotic and abiotic components of the pond ecosystem has received increased attention because of their functional role in the tropic dynamics. The macro fauna is important for enhancing the aquatic resource and is also important in food chain leading to fishes and play an important link in energy transfers in pond ecosystem and take part in biological purification of water. They are therefore important and useful for the management of fish and water flow, and even used to demonstrate the condition of the pond. Species composition diversity and abundance of macro zoo-benthic fauna are greatly related to oxygen concentration and oxygen status of water (1—3). The benthic macro invertebrate population have been investigated since 18th century (4) because of their importance in aquatic food chain, significance in the natural purification of the polluted waters and usefulness as bioindicators of different types of pollution (5, 6). The chemical status of soil seems to influence the production of bottom fauna. The increase in the nutrient level and organic carbon towards the lentic waters in attributed to the transport of sediments from the fluviatile zone to lacustrine zone through inflow. The variation in the temperature and physio-chemical properties of water may also contribute to the unpredictability of its environment (7). Garray and David (8) and Wilhm and Dorris (9) have studied macro invertebrate community to ascertain species diversity under polluted conditions. In the present study, macrobenthic community has been studied to determine the community conditions of two ponds located in different areas because of significant position occupied by the benthos as a link in the flow of energy from primary producers to further tropic levels and to determine organic load in terma of pollution in the ponds.

Methods

Two ponds were selected for the study. One pond was selected (area 1.97 ha) at Naihati (24 Parganas North, West Bengal), which is well managed as fish culture is done scientifically. Another pond which is unmanaged (area 1.80 ha) was selected

at Mahestala (Kolkata), which is randomly used by the local people. Water samples were collected from surface, column and bottom of the ponds. The physico-chemical parameters like water temperature, pH, DO, free carbon dioxide, total alkalinity were tested. Soil parameters like available phosphorus, available nitrogen and organic carbon were determined. Five soil samples were collected in separate polythene bags on each sampling occasion from each pond. All the parameters were analyzed following the standard methods (10—12). To study the macro benthic community regular weekly sampling of water was done during April and May 2007. The sample was collected with the help of Ekman grab method 15.2 cm × 15.2 cm) from six different areas of both the ponds. The sample was then sieved through a no. 40 standard sieve and the organisms retained were preserved in 70% alcohol. Benthic organisms were identified, counted and analyzed.

Percentage frequency is the percent of quadrate in which a given species is found and was determined as follows

$$\text{Percentage frequency} = \frac{\text{No. of quadrates in which the species occurred}}{\text{Total no. of quadrates}} \times 100$$

The different statistical indices used were Index of diversity (13), Evenness index (14), Index of dominance (15), Index of density, Pearson's correlation and Student *t*-test.

Results and Discussion

In the both the ponds, the community was dominated by Mulluscs. Among the molluscan group *Bellamya* sp. was found abundantly, in both the ponds (Fig. 1 and Fig. 2). The other molluscs found were *Marisa* sp. (more in unmanaged pond) and *Lymnaea* sp. (more in managed pond).

The number of *Tubifex* sp. was high in unmanaged pond while the *Limnodrilus* sp. was only found in the managed pond. The only macrobenthic arthropod found was Chironomid larvae. The number of Chironomid larvae was however higher in managed pond.

The physiochemical parameters of the soil and water like temperature available phosphorus, available nitrogen, concentration of soil and organic carbon was done, and they showed strong influence on the production of benthic fauna. In the present study, diversity of macro zoo benthic species of two pond ecosystems is calculated with the use of diversity indices to show the influence of abiotic and biotic factor on the species diversity.

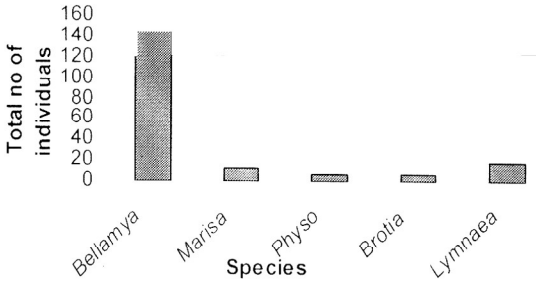

Figure 1. Comparison of different species of molluses in managed pond.

Correlation Between Soil Parameters and Benthos. The correlation between soil parameters and the benthos of both the managed and unmanaged ponds were done. The correlation between available nitrogen and total benthic organisms ($r = 0.491$, $P < 0.01$) and between available phosphorus and total benthic organisms ($r = 0.469$, $P < 0.02$) were strongly positive. Total benthic organisms also showed a strong positive correlation with organic carbon ($r = 0.471$, $P < 0.02$).

Correlation Between Water Parameters and Benthos. The total benthic organisms were positively

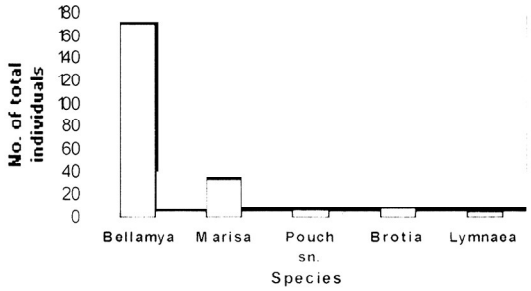

Figure 2. Comparison of different species of molluscs in unmanaged pond.

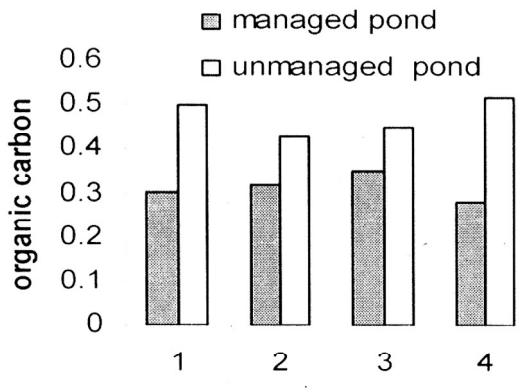

Figure 3. The values of organic carbon in managed and unmanaged pond.

correlated with the total nitrogen (r =0.137) and phosphorus (r = 0.176) values of surface water. In the managed pond the correlation was found between *Limnodrilus* and DO (r =0.39) and *Limnodrilus* and pH (r = 0.04). There was also a positive correlation between Bellamya and DO (r =0.49) and *Bellamya* and pH (r =0.4). In the unmanaged pond a positive correlation existed between *Tubifex* and DO (r = 0.5) and *Tubifex* with CO_2 (r = 0.61). *Bellamya* with pH (r = 0.11) and *Bellamya* with CO_2 (r = 0.94). However there a negative correlation was found between *Tubifex* and pH (r = -0.5) and *Bellamya* with DO (r = -0.75) (Table 1).

Table 1. Correlations between the benthos and the different water parameters.

	r	t-value	Correlation
Managed Pond			
Between *Limnodrilus* vs DO	0.39	0.59	Positive
Between *Limnodrilus* vs pH	0.04	0.056	,,
Between *Bellamya* vs DO	0.49	0.795	,,
Between *Bellamya* vs pH	0.40	0.617	,,
Unmanaged Pond			
Between *Tubifes* vs DO	0.05	0.07	Positive
Between *Tubifex* vs pH	-0.3	0.44	Negative
Between *Tubifex* vs CO_2	0.61	1.09	Positive
Between *Bellamya* vs DO	-0.75	1.603	Negative
Between *Bellamya* vs pH	0.11	0.158	Positive
Between *Bellamya* vs CO_2	0.94	3.84	,,

Macrobenthic Community Structure, Species Diversity Index (H). Evenness Index (J). Index of Dominance (C) and Density. The Shannon Wiener diversity index has a higher value in pollution free environment. The value of the Shannon Wiener diversity, index was slightly higher in managed pond whereas the value was relatively low in unmanaged pond (Table 2). Thus the level of pollution in the managed pond was relatively less than that of the unmanaged pond. The sources of pollution in the unmanaged pond were domestic sewage, which resulted in high organic pollution. The less variation found in the managed and unmanaged ponds may be due to the reason that the sources of pollution was restricted in the unmanaged pond, as it had no inland drainage channel, thus it was not highly polluted.

Frequency Distribution. The macro benthic community found in the ponds of two different areas was important for determining the condition of the ponds (Table 3). The macro benthos is important link in the flow of energy from primary producer to further tropic levels. Benthos include organism that migrate to the bottom for their activities and hence known as bottom dwellers. They are categorized depending upon their size as macro benthos and micro benthos. The present study is related to the macro benthic fauna.

The production of the benthic invertebrate population showed a strong positive correlation with the weater parameters. However, there was a negative correlation between *Bellamya* sp. and DO in the unmanaged pond. This could have resulted due to the silt accumulation at bottom of the pond which causes the BOD level to rise. Thus *Bellamya* can be regarded as a bio-indicator species of fresh water. *Tubifex* also showed negative correlation with pH in the unmanaged pond.

The quality of organic matter on the sediment is more important in determining the tubificid preference than the quantity of organic matter (16). The increase input of organic matter results in the increase in the macro zoo-benthic invertebrate population due to enrichment of nutrients.

The Tubificidae were recorded more in the unmanaged pond, which was enriched with organic matter receiving the domestic sewage from different sources which might increased BOD value (0.49 organic carbon value). However, it recorded less num-

Table 2. Different indices in the managed and unmanaged ponds.

Species	Ni	Ni/N	Species diversity index (H)	Evenness index (J)	Index of dominance (C)	Index of density
		Managed Pond				
1. *Limnodrilus* sp.	66	0.452				
2. *Tubifex* sp.	17	0.116				
3. *Nereis* sp.	8	0.055				
4. *Bellamya* sp.	146	0.764				
5. *Marisa* sp.	12	0.063	-2.399	-0.757	0.0732	0.2345
6. Pouch snail	8	0.042				
7. *Brotia* sp.	7	0.037				
8. *Lymnea* sp.	18	0.094				
9. *Chrionomid larvae*	55	0.163				
		Unmanaged Pond				
1. Earthworm	4	0.026				
2. *Tubifes* sp.	103	0.678				
3. *Bellamya* sp.	170	0.762				
4. *Marisa* sp.	5	0.022	-2.422	-0.807	0.3242	0.2832
5. Pouch snail	33	0.148				
6. *Brotia* sp.	7	0.031				
7. *Lymnea* sp.	8	0.036				
8. Chrionomid larvae	45	0.296				

ber of larvae of Chironomidae group. Conversely, the number of Tubificidae was recorded relatively less in the managed pond where the number of larvae of Chironomidae group was high. Thus the result suggests that the unmanaged pond had high organic pollution.

It was found that the frequency distribution of benthic organisms was higher in the managed pond than the unmanaged pond. There was a rich population of molluscs found in both the ponds. The poor growth of the bottom fauna is due to the frequent water level fluctuations. Extensive areas are suddenly exposed when the level goes down as a result of water draw down, killing the bottom fauna especially the insect larvae, nymphs and oligochaetes which are not capable of moving down with the reducing level of water. Molluscs are capable of withstanding this to some extend.

Table 3. Frequency distribution of different species in managed and unmanaged ponds.

Species	Managed pond	Unmanaged pond
Earthworm	-	12.5
Limnodrilus sp.	95.83	-
Tubifex	37.5	75
Nereis	29.17	-
Bellamya	100	100
Marisa	33.33	83.33
Pouch snail	20.83	25
Brotia	20.83	16.67
Lymnaea	37.5	16.67
Chrinomid sp.	83.33	58.33

We conclude that the proper management of a pond keeps the species composition almost similar and greater abundance of zoo-benthic population occurs which ultimately makes the pond eutrophic and as a result the maximum production of fish will occur.

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