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Macrobenthos Presence in the Estuarine Waters of the Meghna River, Ramghati, Laksmipur, Bangladesh

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Abstract: Study was conducted in the estuarine waters of Meghna River Ramghati, Laxmipur, Bangladesh during the period of December, 2015 to February, 2016 with a view to exploring macrobenthic community structures and relating with water quality parameters. Sediment samples were collected by using Ekmandrege. Eight families were identified under five groups of macrobenthos. Maximum number (3358 indi./m^2) of macrobenthos were found in Nereidae family where minimum (44 indi./m^2) in Echuiridae family. Rest were Capitellidae (310 indi./m^2), Syllidae (400 indi./m^2), Mysidae (177 indi./m^2), Lumbrinereidae (666 indi./m^2), Goniadidae (1021 indi./m^2) and unidentified (2858 indi./m^2) were recorded. Five macrobenthic groups (Taxa) were identified where number of Polychaeta (7819 indi./m^2) was highest in each month and Gatropoda (44 indi./m^2) was lowest. Others were Bivalvia (176 indi./m^2), Crustacea (664 indi./m^2) and Oligochaeta (619 indi./m^2). Water quality parameterswere measured in each stations where the range of temperature,salinity, pH and dissolve oxygen were 22.7±4.0 to 22.6±3.08°C, 7.33 ± 0.58 to 6.50 ± 0.50 ppt, 7.33 ± 0.76 to 6.80 ± 0.20 and 10.5±1.2 to 9.5 ± 0.76 mg L^{-1} respectively.

Key words: Benthos · Water Quality Parameters · Community · Meghna River

INTRODUCTION

Benthos are macro invertebrates benthic organisms of soft mud, sand and bottom habitats in the water as well as the interspersed patches of aquatic vegetation and oyster shell, support the wide variety of fauna and flora and essential part of the coastal ecosystem for the aquatic production [1]. Benthos are found in the bottom of standing water body where the concentration of organic carbon higher than the others or any solid liquid interface [2], those are collected by using sieve of different mesh size from 0.2 to 0.5 mm which includes a heterogeneous assemblage of organisms belonging to various phyla like Arthropod, Annelida, Mollusca and others [3]. They also occupy an important position in the lake ecosystem, performs huge number of ecological roles in the function of aquatic ecosystem, serving as a link between primary producers, decomposers and higher tropic level [4, 5], contribute in the energy pathway and nutrient cycling [6]. For the assessment of the ecological integrity and bio monitoring of aquatic habitats macro zoo benthos has important contribution [7].

Benthos are responsible for the change of aquatic environment by this way they serving as promoting indicators of hydrologic stress and for the development of the health of aquatic ecosystem [8]. The mineralizing capacity of benthos are not same, vary with the change of place and family. The amount of nutrients release at the time of mineralization by the sediments will depend on the mineralizing capacity of the benthic community [9]. There are some important physical and chemical parameters such as depth, water current, organic contents of the sediments and contamination of bed sediments in the environment, toxicity of sediments which are responsible for the abundance, distribution and shifting of macro benthos [10].

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Alteration produced in the physical and chemical status of the riverine ecosystem becomes recognizable through elasticity of the community structure of the organisms by this way benthic micro invertebrates make ideal subject for biological assessment of water quality [11]. Benthic species perform a variety of functions in freshwater food webs. First, benthic invertebrates provide essential ecosystem services by accelerating detritus decomposition [12]. Dead organic matter is one of the main sources of energy for benthic species in shallow-water habitats [13]. Second, benthic invertebrates release bound nutrients into solution by their feeding activities, excretion and burrowing into sediments. Bacteria, fungi, algae and aquatic angiosperms can quickly take up these dissolved nutrients, accelerating microbial and plant growth [12]. This increased growth of benthic microbes, algae and rooted macrophytes is in turn consumed by herbivorous and omnivorous benthic invertebrates [14]. Third, many benthic invertebrates are predators that control the numbers, locations and sizes of their prey [15]. Fourth, benthic invertebrates supply food for both aquatic and terrestrial vertebrate consumers (e.g., fishes, turtles and birds). Finally, benthic organisms accelerate nutrient transfer to overlying open waters of lakes [16] as well as to adjacent riparian zones of streams [17].

The eutrophication and pollution in a lake are reflected in the benthic organisms as the suspended waste immediately sinks to the bottom to decompose and thus cause a change in the benthic organisms [18]. The soft bottom sediments of lakes and wetlands are characterized by annelids either as dominant group or an important contributor to the macro benthic fauna. The oligochaetes which are fresh water annelids display the greatest diversity and have the greatest indicator value [1]. Macro benthos play an remarkable contribution in the mineralization, promoting and mixing of sediments and flux of oxygen into sediments, cycling of organic matter [19, 20] and in effort to assess the quality of inland water [21].

Benthos is the essential component in the bottom sediment of any water body. Adequate knowledge about benthos is essential for the better of the aquatic water bodies and the organisms which live in water. Many scientists studied about the benthos in different area but it is not sufficient. Very little number of researchers has worked about benthos in the Meghna River of Bangladesh. It is essential to know the structure and composition of sediment for the monitoring and observing of productivity in the water bodies. By considering the demand of benthos, present study was about the macrobenthic communities in estuary waters of the Meghna River in Ramghati, Laxmipur. The purposes of the present studywere to measure water quality parameters, estimate abundance and diversity of the macrobenthic communities.

MATERIALS AND METHODS

Sampling Locations: The sediment samples were collected monthly from three stations (Station I: Ramghati near fish landing centre, Station II: Majipara and Station III: east part of the Ramghati) of the Meghna, Ramghati, Laksmipur, Bangladesh from December, 2015 to February, 2016 where distance of one station to another was 0.5 km. The approximate geographical location of this estuary is between 22°35’00” to 22°34’53’’ N latitude and 90°59’41.6’’ to 91°00’0.4’’ E longitude.

Collection of Macrobenthos: For macro benthic fauna, samples were collected by using a small boat. Replicate samples were collected from intertidal area of the stations. Sampling was done using an Ekmandredge having a mouth opening of 0.02 m^2. Samples were sieved through 500 µm mesh screen to retain macrobenthos. The sieved organisms were preserved immediately with 10% formalin solution in the plastic container with other residues and labeled and then transferred to laboratory for further analysis.

Identification and Counting of Benthos: In the laboratory, small amount of “Rose Bengal” was added to increase visibility of organisms. For identification, the samples were taken into a round transparent Petri dish (diameter 15 cm and depth 2 cm) and placed on a white paper background for the easy contrast of vision. Droppers were used to separate the benthos. The organisms were counted and calculated for total amount in m^2. Organisms were sorted and enumerated under major taxa and preserved in small vials by using small brush or forceps. Magnifying glass and microscope were used for identification. Electronic microscope was used to capture the picture of benthos. Identification was done up to possible taxonomic level and results were tabulated.

Water Quality Analysis: During sampling, water quality parameters such as salinity (ppm), temperature (°C), pH, dissolved oxygen (DO) were measured at each sampling site in the each station. Salinity, DO and temperature were determined by using a refractometer (New-100, TANAKA, Japan), DO meter (Lutron DO- 5509, China) and a Celsius thermometer, respectively.

Data Analysis: On the data available after total number of macro-invertebrates counting in a sample, number per square/meter occurrence of macro-invertebrates was then computed using the formula formulated by Welch [22], this formula is,

N= *O*/(*a.s*)*10000

where

N = Number of macro-invertebrates 1 sq. m. of profoundal bottom

O = No. of macro-invertebrate (actually counted) per sampled area,

a = Transverse area of Ekmandredge in sq. cm and

s = Number of sample taken at one sampling site.

Species Richness; Diversity and Evenness Index Calculation: The Margalef's Index of Species Richness (D) is simple ratio between total species (S) and total numbers of individual (N). It can be used to compare one community with another.

The index is

$$D = (S - 1)/\ln N$$

where

D = Margalef's index

S = Number of species in sample

ln = log normal

N = Total number of individuals in sample

During the data analysis diversity of fish assemblage was qualified and then statistical comparison was performed. PA leontological Statistics (PAST) version 3.15, A software package for paleontological data analysis written by P.D. Ryan, D.A.T. Harper and J.S. Wllalley, was run the analysis. PAST has grown into a comprehensive statistical package that is used not only by paleontology, but in many fields of life science, earth science and even engineering and economics.

RESULTS

Water Quality Parameters Analysis: Highest water temperature (24°C) was recorded in the month of February and January in the sample number II where the mean water temperature was 22.6±3.08°C. The water salinity (ppt), pH and DO (mg L^{-1}) were measured highest 7.3±0.58 (ppt), 7.3±0.76 and 10.5±1.2 (mg L^{-1}) respectively in the month of February (Table 1).

Table 1: Water quality parameters were recorded from the estuary of the Meghna River.

Dec.	Sample	Water Tem. (°C)	Salinity (ppt)	PH	DO (mg L^{-1})
	I	21	7	6.6	10
	II	20	6	6.8	11
	III	21	7	7	9
	Mean	20.6.33±3.1	6.67±.8	6.8±20	10±1.3
Jan.	I	22	6.5	6.9	9.5
	II	21	7	6.9	10
	III	24	6	6.7	12
	Mean	22.6±3.08	6.5±50	6.83±.2	10.5±1.2
Feb.	I	22	9	8	11.5
	II	24	8	7.5	8
	III	22	7	6.5	9
	Mean	22.7±4	7.3±58	7.3±76	9.5±76

Group (Taxa) of Macrobenthos: After collecting macro benthos, total area was converted into m^2. The total number of macro benthos 9322 indi./m^2 were identified at the present study where total number of Polychaeta, Oliogochaeta, Crustacea, Bivalve and Gasropoda were 7819, 619, 664, 176 and 44 indi./m^2, respectively. The highest number of macrobenthos were recorded in the group of Polychaete in each station where maximum in the January 3066 indi./m^2 and minimum in the February 2304 indi./m^2. This group is available in the all station of the sampling. Polychaetes occupied 83.89% among the groups of macro benthos. The maximum number of oligochaetes was 486 indi./m^2 in the station I and the minimum was 44 indi./m^2 in the station III. Oligochaetes were recorded 6.67% among the groups of macrobenthos. Crustacea was the second highest number of macrobenthos in this group. The total 664 indi./m^2 crustacea were found in three stations. The maximum number of crustacean 399 indi./m^2 were found in February and minimum 44 indi./m^2 in the December. Bivaves were rare in the study sites. The total numbers of Bivalve were 176 indi./m^2 in the three stations where absence in the station I and maximum found in the station II and III (88 indi./m^2). The percentage of the Bivalve was 1.9% in the present study sites. Gastropodawas absence in January and February but only found in December o (44 indi./m^2). They constituted 0.48% of the total macro benthos (Table 2).

Families of Macrobenthoic Communities: Present study identified eight families from three stations. Among 8 families the 3 most abundant families are Nereidae (36.5%), Goniadidae (11.1%) and Lumbrinereidae (7.2%). Nereidae families were dominant in each sample. Maximum number (1270 indi./m^2) of the macrobenthos were found in the Nereidae family in the month of December. Second

Table 2: Abundance of benthic groups (indi./m^2) found in the study site

Benthos Group	Dec.	Jan.	Feb.	Mean	Total	Percentage (%)
Polychaeta	2532	3066	2304	2634±319.34	7819	83.89
Oliogochaeta	486	89	44	206.33±198.61	619	6.67
Crustacea	44	221	399	221.33±144.93	664	7.14
Bivalve	0	88	88	58.67±41.48	176	1.9
Gastropoda	44	0	0	14.67±20.74	44	0.48

Table 3: Identification of benthos families (indi./m^2) in the present study.

Family	Dec.	Jan.	Feb.	Mean	SD	Total	Percentage (%)
Capitellidae	44	133	133	103.33	41.96	310	3.4
Syllidae	89	0	311	133.33	130.78	400	4.4
Neptydae	133	0	44	59	55.32	177	1.9
Mysidae	89	44	222	118.33	75.57	355	3.9
Nereidae	1270	1066	1022	1119.33	108.04	3358	36.5
Lumbrinereidae	89	444	133	222	158	666	7.2
Goniadidae	0	888	133	340.33	391.05	1021	11.1
Echiuridae	0	44	0	14.67	20.74	44	0.5
Unidentified	1392	845	621	952.67	323.84	2858	31.1
Total	3106	3464	2619	3063	346.31	9189	100

Table 4: Pearson correlation analysis.

Temperature	Temperature	Salinity	pH	DO	Benthos
Salinity	1	.699*	0.129	0.302	0.007
pH			0.444	0.188	-0.019
DO			1	0.499	0.321
Benthos				1	0.196
					1

highest macrobenthos found in the Goniadidae family. Goniadidae family absent in the month of December where highest in the January (888 indi./m^2) (Table 3).

Minimum number of macrobenthos found in the Echiuridae familifies. Echiuridae only found (44 indi./m^2) in the January where absence in the December and February (Table 4). In the present study 2858 indi./m^2 were unidentified which constituted 31.1%. The most dominant families among 14 are Nereidae, Goniadidae and Lumdrinereidae. These three families are highly available in every station. The number (indi./m^2) of macrobenthos present in the Nereidae family is 1270, 1066, 1022 respectively in December, January and February (Table 3).

Pearson Correlation Analysis: Pearson correlation analysis was conducted in the present study with the significant level of $p \geq 0.5$ between the water quality parameters and macrobenthos. The correlation between temperature and salinity was moderately significant ($r=.669$, $p \geq .05$). The correlation between pH and DO was no significant ($r=.499$, $p \geq .05$). Salinity has a negative correlation with benthos ($r=-.019$, $p \geq .05$) (Table 4).

Diversity analysis

Margalef's Diversity: The equation of Margalef's is used for the determination of the diversity. Present study has shown the diversity of the microbenthos within December to February. Margalef's value is highest in the month of February which value is 0.254. The lowest Margalef's value has found in the month of January. The lowest Margalef's value is 0.245 among three months (Figure 1).

Dominance Diversity: The dominance value was recorded in December, January and February 0.46, 0.35 and 0.38 respectively where the macrobenthos dominance was highest in December and lowest in January (Figure 2).

Analysis Evenness of the Diversity: In the present study highest Evenness of the diversity was in January where lowest in December (Figure 3)

Analysis Diversity Profile: In Diversity Analysis profile, it is shown that Diversity highest in January where lowest in Decmber (Figure 4).

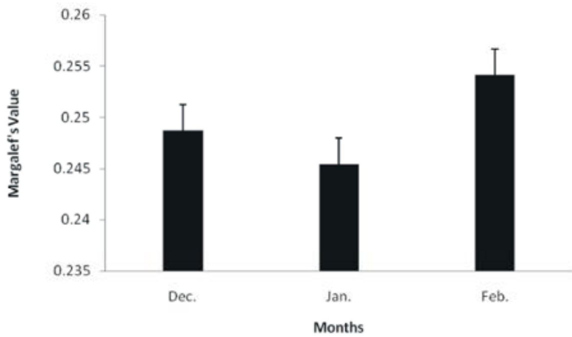

Fig. 1: Analysis of the Margalef's diversity.

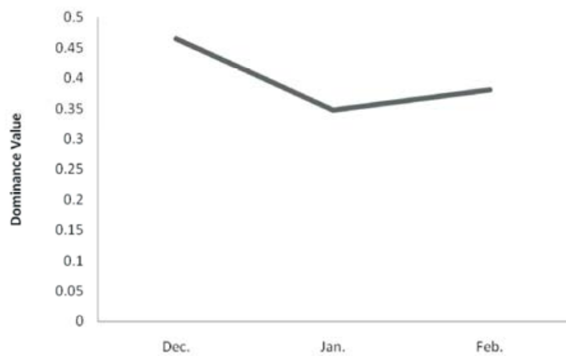

Fig. 2: Analysis of Dominance diversity

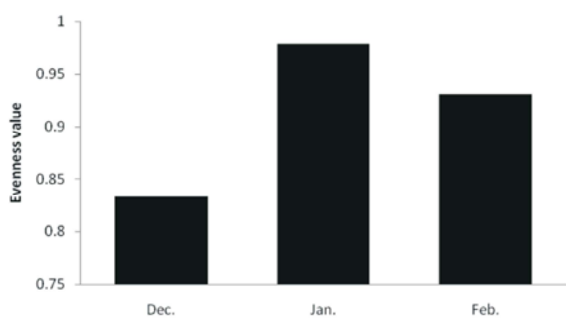

Fig. 3: Analysis Evenness value of the diversity.

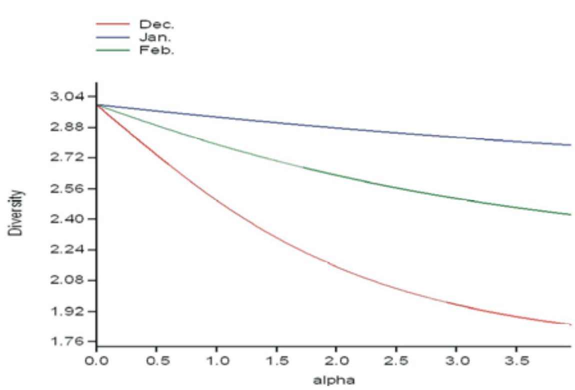

Fig. 4: Analysis Diversity profile.

DISCUSSION

In the present study, total number of macrobenthos 9322 indi./m^{2}was found.Total number of polychaeta 7819, Oliogochaeta 619, crustacea 664, Bivalve 176 and Gasropoda 44 indi./m^{2}were identified which are more coincides with findings of Sakri [23]. The number of macrobenthos was higher than the findings of Khan [1] where the Polychaeta showed it maximum density 305 indi./m^2 and minimum 125 indi./m^2. Maximum abundance of Oligochaeta, Insecta and Bivalvea were 340 indi./m^2, 219 indi./m^2 and 150 indi./m^2 and minimum 250 indi./m^2, 70 indi./m^2 and 10 indi./m^{2}recorded, respectively.. Another study by Sivadas [24] observed that benthic Polychaetes as good indicators of anthropogenic impact. A total of 71 Polychaete taxa were identified from the area. They found that Polychaete abundance, biomass and species number was highest during post monsoon mainly due to new recruitment.

In the present study the highest number of macrobenthos was recorded in the group of Polychaete in each station. The present study was shown that the presence of Polychaetaes were maximum in the January 3066 indi./m^2 and minimum in the February 2304 indi./m^2. This group is available in the all months. The composition of the Polychaetes, Oligochaetes,Crustacea, Bivalve and Gastropoda were recorded 83.89%, 6.67%, 7.14%, 1.9% and 0.48%, respectively which are more or less coincides with the study of Bamakole [25] where they recorded Polychaeta was highest and constituted 82.8%. The others were Bivalvia (4.6%), Crustacea (4.5%) and Oligochaeta (3.9%), Gastropoda (2.1%) and Insecta (2.0%).

In addition, Mutschke and Gorny [26] investigated in four areas in the Magellan region (South Patagonian Ice-Field, Strait of Magellan, Beagle Channel and Continental Shelf) about the distribution of abundance, biomass, productivity and production of macro zoo benthos. The average abundance, biomass and production of the whole Magellan region are lower (2318 ind./ m^2) than in the high Antarctic Weddell Sea. In the Magellan region, macrozoobenthos composition of abundance is mainly dominated by Polychaetes (56%), followed by Arthropods (16%), Echinoderms (10%) and Molluscs (11%). In the present study, the identified groups are Polychaetes, oligochaetes, Crustacea, Bivalve and Gastropoda. In December, the number of macrobenthos were identified 2532, 486,44, 0 44 Indi./m^{2}as Polychaetes, Oligochaetes, Crustacea, Bivalve and Gastropoda, respectively. Polychaetes, Oligochaetes, Crustacea, Bivalve and Gastropoda were found 3066, 89, 221, 88 and 0indi. /m^2, respectively in the month of

January. The Polychaetes, Oligochaetes, Crustacea, Bivalve and Gastropodawere found 2304, 44, 399, 88 and 0 indi./m^2at the end of the study. In the present study, the percentage of polychaetes was higher (83.89%) compared to the study Mutschke and Gorny [26] found polychaetes (56%).

In the present study, the composition of the Polychaetes, Oligochaetes, Crustacea, Bivalve and Gastropoda were recorded 83.89%, 6.67%, 7.14%, 1.9% and 0.48%, respectively. Polychaetes has increased but other taxas has deceased in the present study compare to the previous study conducted by Belal [27] about the occurrence and abundance of Macrobenthos of Hatiya and Nijhum Dweep Islands, Bangladesh during pre-monsoon (January-June, 2010). The maximum density (4511 individual/m^2) was found at Nijhum Dweep, Namar Bazar and the minimum (433 individual /m^2) at Nalchira Ghat. The macrobenthos included Polychaetes (45.03 %), Oligochaetes (16.65 %) and Shrimp larvae (13.93 %), Crab (9.63 %), Gastropods (3.56 %), Isopods (1.15 %), Bivalves (1.15 %), Copepods (0.73 %), Annelids (0.42 %), Amphipods (0.63 %) and others (7.12 %). Polychaetea, Oligochaetea, Shrimp larvae and Crab contributed 85.24 % of total population. Polychaete was dominant by contributing 45.03 % of total macrobenthos. Other study recorded the density of Polychaeta 50-585 indi./m^2in the polluted portion of Ganga river, India [28] which supported the result of present investigation.

CONCLUSION

Present study identified that macrobenthos abundance was high in the estuarine waters of the Meghna River, Ramghati, Laksmipur, Bangladesh. Huge number of benthos in the bottom mud influence water quality of this river.

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