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Species

Diversity and abundance of Macrobenthos in a subtropical estuary, Bangladesh

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Authors' contribution:
AM conceived, designed and performed the experiments. **MBH** conceived, designed the experiment and supervised the research. **MMI** analyzed the data set and revised the manuscript and improved the English language. **MMB** revised the manuscript and improved the English language. **AAA** revised the manuscript. **MMB** revised the manuscript and improved the English language.

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RESEARCH ARTICLE

ABSTRACT

Soft bottom macrobenthos are important component of the marine and coastal trophic chain. There has been sparse information regarding the distribution of soft bottom macrobenthos form the coastal water of Bangladesh. Consequently, the present study was an effort to reveal the diversity and abundance of macrobenthos in the Feni Estuary in a seasonal pattern together with the hydrological factors. A total of 17 taxa families of soft-bottom invertebrates were found over the two sampling seasons. The current study yielded a total number of 34,726 ind./m^2 (mean 2480ind./m^2) including 18,909ind./m^2 in wet season (mean 2682ind./m^2) and 15,817 ind./m^2 in dry season (2259ind./m^2). The highest density of soft-bottom invertebrates was in the wet season while the lowest number in the dry season. A total of 5 groups of macrobenthos were found over the two sampling seasons. The dominant group was Polychaeta that contributed 43.60% of the total soft-bottom invertebrates. The values of biodiversity indices were higher in dry season compare to the wet season in most of the sampling station during the study period.

Key words: Macrobenthos, taxonomic composition, Polychaeta, subtropical estuary.

1. INTRODUCTION

Because of their sessile and sedentary behavior macrobenthos are known to be the common indicators of time integrated environmental conditions (McLusky and Elliot, 2006). The community of benthic organisms is strongly affected by its environment, including sediment and water quality, and hydrological factors that influence the physical habitat. Because the macrobenthos are dependent on its surroundings, it serves as a biological indicator that reflects the overall condition of the aquatic environment (RAMP, 2017). The variety and abundance of macrobenthos also vary with latitude, depth, water temperature, salinity, locally determined conditions such as the nature of the substrates, and ecological circumstances such as predation and competition. Physical, chemical and biological qualities of water are some of the factors that influence species composition, diversity, productivity and physiological conditions of local populations of a body of water (Boyd, 1979). Macrobenthos are mostly found in the standing water body where the concentration of organic carbon higher than the others. Environmental condition is mostly responsible for the variation of benthos in different area those are substratum type, food availability and predation (Dance and Hynes, 1980). Fabry et al., (2008) reported that one of the causes of global warming and ocean acidification is the rising of atmospheric carbon dioxide (CO_2) which is considered as important drivers of change in biological systems.

Soft-bottom macrobenthos are good sources of food of fish and their availability in a certain area enhances high fish production (Longhurst, 1957). They are organisms serve as direct food for higher trophic organisms (*e.g.,* fin and shell fishes) and act as ecological engineer recycling the organic matter and other debris (Assadujjaman et al., 2012). Soft bottom macro-benthos play an important role in aquatic community which is also involved in mineralization, promotion and mixing of sediments and flux of oxygen into sediments, cycling of organic matter (Lind, 1979) and in effort to assess the quality of inland water (Milbrink, 1983; Walag and Canencia, 2016). In addition, a number of benthic invertebrates, particularly clams, are consumed by humans and others, such as worms, are used for recreational purposes as fishing bait (Tagliapietra et al., 2010).

Macrobenthos communities are considered as a pollution index into the water body where they live and the quantity of macro invertebrates vary with the change of physiochemical factors and available habitats. Soft-bottom macrobenthos are used as the tools of bio assessment due to some special characteristics such as limited mobility, comparatively long life cycles and differential sensitivity to pollution of various types and they reflect the impact of cultural eutrophication on aquatic habitats quite satisfactorily (Liebmann, 1942; Gordon, 2000).

Several research had been conducted using soft-bottom macro-invertebrates as indicators of pollution of invertebrate community response to changes in physicochemical factors and available habitats globally (Manoharan et al., 2011; Habib and Yousuf, 2012; Mandal and Harkantra, 2013; Walag and Canencia, 2016). In Bangladesh, in particular, very less is known for the intertidal macrobenthos (Hossain et al., 2009; Abu Hena et al., 2012; Islam et al., 2013).

The study area Feni River Estuary, a typical subtropical estuary is playing a very significant role in the socio-economic development and progress of the country by providing and ensuring high fish supplies to the local and national markets as well as a source of livelihood for a large number of peoples especially the local inhabitants. The estuary is also subjected to tourism activities, high fisheries resources, overexploitation and deterioration. Nevertheless, destruction of natural habitats through various industrial processes, agricultural waste, and sewage among others. This make the river areas vulnerable to pollution and cause great harms to the environment. The present study was designed to evaluate the abundance, diversity, distribution, composition and community structure along the Feni River estuary, Bangladesh.

2. MATERIALS AND METHODS

Study area

Feni River estuary (also known as Little Feni River estuary; Latitude 22°46′44″ N and Longitude 91°22′42″ E) located in the central coast of Bangladesh. Feni River originates in the south Tripura district (India) and flows a distance of 116 km through different cities and municipalities in India and Bangladesh, and finally empties into the Bay of Bengal. The Feni River estuary is heavily used for irrigation, fishing, agriculture, aquaculture, washing, livestock farming, recreation, dumping domestic waste, sewage disposal and water based transport (Islam et al., 2018). The present study was conducted in two seasons; wet season (June-September, 2016) and dry season (October-December, 2016). Seven sampling stations were selected from the mouth to head region of the Feni River estuary (Figure 1).

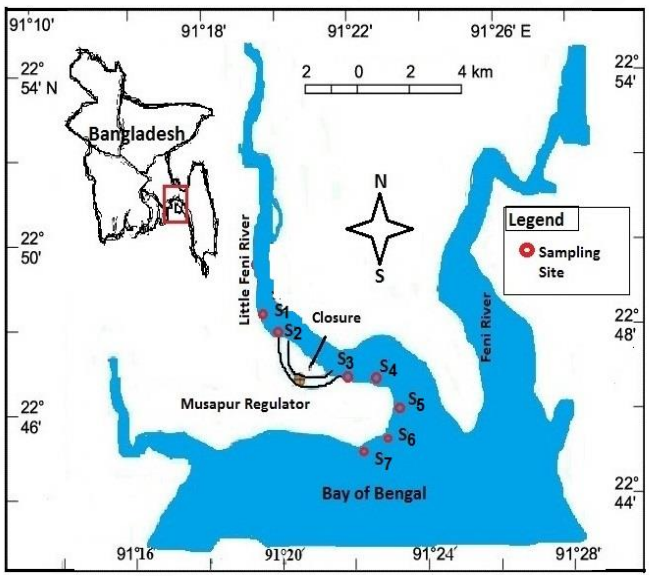

Figure 1 Locations of the sampling stations in the Feni River estuary

Sample collection and laboratory treatments

The sediment samples were collected from the sampling sites during the low tide. Sediment sample were taken from the intertidal zone of the stations using an Ekman Dredge having a mouth opening of 0.0225 m^2. From each station, three replicate samples were collected. The collected sediment samples were sieved through a 500μm mesh screen to get the benthic macro-fauna. The sieved organisms were immediately preserved with 10% formalin solution in the plastic container with other residues and labeled for further analysis.

To increase the visibility of benthic macro-fauna, a small amount of "Rose Bengal" was added within the formalin solution of the plastic container in the laboratory. Benthic fauna were sorted out manually from the other residues on a tray under enough light availability. Then the sorted organisms were preserved in in 70% ethanol solution in small vials using small forceps. Electronic Microscope (Model No. XSZ 21-05DN, China) was used to identify the macrobenthic organisms.

Physicochemical variables measurement

Water parameter and the sediment samples used for benthic macro-faunal analysis were collected simultaneously. Determination of in situ water characteristics such as water temperature, salinity, pH, dissolved oxygen (DO) and transparency were carried out using a centigrade thermometer, refractometer (INDEX, Model No. REF201), digital pen pH meter (HANNA Instrument, Model No. H-196107), DO meter (LUTRON, Model No. DO 5509) and Secchi disc respectively.

Data analysis

On the data, available after total number of macrobenthos counting in a sample, number per square meter occurrence of macro-benthic organisms were estimated by using the following formula formulated by Welch (1948),

$$N = \frac{O}{a.s} \times 10000$$

Where,

N = Number of soft-bottom invertebrates 1 sq. m. of profound bottom
O = Number of soft-bottom invertebrates (actually counted) per sampled area
a = Transverse area of Ekman dredge in sq. cm, and
s = Number of sample taken at one sampling site

The data harvested from seasonal (Wet season and Dry season) samples were blended to provide the value of Shannon-Wiener index. The Shannon-Wiener index of species diversity (H') (Wilhm and Dorris, 1966) is defined as,

$$H' = -\sum_{i=1}^{s} Pi\ Ln\ Pi$$

Where,

S = Total number of species in a sample,
Pi = *ni*/N = Proportion of individuals of the total sample belonging to the i^{th} species,
N = Total number of individual of all the species,
ni = Number of individual belonging to the i^{th} species.

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 by the following index,

$$D = \frac{s-1}{\ln N}$$

Where,

D = Margalef's index
S = Number of species in sample
N = Total number of individuals in sample

The Shannon equitability (or evenness) index was obtained from Shannon-Wiener index. Evenness is referred to the absolute distribution of relative abundance of species at a site, is computed by the following index,

$$J = \frac{H}{\ln S}$$

Where,

J = Evenness index
H = Shannon-Wiener index value
S = Total number of species in sample

Multivariate species analysis

Non-multidimensional Scaling (nMDS) was used to visualize the level of differences of the assemblage's structures between two dry and wet season. Macrobenthos assemblages data obtained in the different sampling stations in two seasons were used for this analysis

3. RESULTS

Physicochemical variables:

All environmental parameters of the sampling area are shown in Table 1. The water temperature showed a similar fluctuation pattern among those sampling station, however showed a different fluctuation pattern among sampling season (Table: 1). Temperature varied from 22.8-24.8°C in the wet season and 30.5-31.4°C in the dry season. The highest water temperature was 31.4°C at station S1 in the dry season and the lowest temperature was 22.80°C at station S7 in the wet season.

The salinity ranges were 4.9-7.5PSU in the wet season and 4.30-7.5 PSU in the dry season. The maximum water salinity was 7.5PSUat station S1 for both dry and wet season (Table. 1). In general, salinity showed only minor change from wet to dry season during the two sampling seasons.

The range of pH was 7.8-8.7 in the wet season and 7.0-7.9 in the dry season. The maximum pH was 8.7station S7 recorded in the wet season and minimum was 7.0 at station S1 in the dry season (Table 1). The range of DO was 5.7-6.8ppm in the wet season and 6.8-9.1ppm in the dry season. The maximum DO was 9.1ppm at station S7 recorded in the wet season and the minimum was 5.7 ppm for both station S1 and S2 in the dry season (Table 1).

The value of transparency was almost alike in the most stations. The range of transparency was 5.0-5.8cm in the wet season and 6.0-6.9cm in the dry season. The maximum value of transparency was 6.9cm at station S4 in the dry season and the minimum value was 5.0cmat station S3 in the wet season (Table 1).

Table 1 Values of different physicochemical factors recorded in different seasons during the study period (n=3 at each sampling station and mean of each observation is reported)

Season	Wet season							Dry season						
Station	S1	S2	S3	S4	S5	S6	S7	S1	S2	S3	S4	S5	S6	S7
Temperature (°C)	24.8	24.7	24.7	24.1	23.8	23.2	22.8	31.4	31.3	31.2	30.9	30.8	30.6	30.5
Salinity (PSU)	7.5	7.4	6.8	6.7	6.2	5.6	4.3	7.5	7.4	7.2	6.8	6.2	5.7	4.9
pH	7.8	7.9	8.1	81	8.2	8.6	8.7	7.0	7.1	7.2	7.3	7.6	7.7	7.9
DO (ppm)	6.8	6.9	7.1	7.5	7.8	8.2	9.1	5.7	5.7	5.8	6.1	6.1	6.2	6.8
Transparency (cm)	6.0	6.2	6.8	6.9	6.5	6.7	6.4	5.8	5.6	5.0	5.2	5.5	5.1	5.3

Table 2 Abundance of macrobanthos family (ind./m^2) during the wet season.

Family	Stations							Total	Mean±SD
	S1	S2	S3	S4	S5	S6	S7		
Ampelisidae	356	756	534	0	1600	0	400	3646	520±548
Anthuroidae	45	89	0	0	0	267	0	401	57±99
Apseudidae	0	89	0	0	0	45	0	134	19±35
Capitellidae	0	0	45	45	0	45	0	135	19±24
Glyceridae	89	45	89	0	0	89	0	312	45±45
Isaeidae	0	45	0	45	267	0	0	357	51±98
Lumbrineridae	178	0	0	0	89	0	0	267	38±70
Megascolecidae	0	89	0	0	45	0	0	134	19±35
Mysidae	178	889	222	889	178	444	533	3333	476±312
Mytilidae	0	45	0	89	45	0	0	268	25±35
Namanereidinae	0	0	45	0	0	45	0	90	13±22
Naticidae	0	0	0	45	0	0	0	45	6±17
Nereididae	578	756	711	579	667	444	356	4091	584±143
Nephthys	223	89	178	45	267	312	356	1470	210±114
Nephtyidae	0	89	89	0	133	0	0	311	44±57
Portunidae	90	889	400	311	89	134	267	2180	311±280
Insecta	267	890	0	444	0	134	0	1735	247±328

Total	2004	4760	2313	2447	3380	1959	1912	18909	2682±1046
Family taxa	9	13	9	9	10	10	5		

Table 3 Abundance of macrobanthosfamily (ind./m^2) during the dry season

	Stations								
Family	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**Total**	**Mean±SD**
Ampelisidae	0	45	0	0	89	0	0	134	19±35
Anthuroidae	0	0	0	0	45	0	0	45	6±17
Apseudidae	45	89	0	45	0	45	0	224	32±33
Capitellidae	0	45	0	0	45	0	0	90	12±21
Glyceridae	222	89	0	0	89	45	0	445	63±80
Isaeidae	0	0	45	45	0	89	0	179	25±35
Lumbrineridae	45	178	0	178	222	133	89	845	120±79
Megascolecidae	578	0	178	0	0	0	45	801	114±214
Mysidae	89	45	89	0	267	227	183	900	128±98
Mytilidae	133	267	45	356	89	133	89	1112	158±11
Namanereidinae	0	45	0	89	0	0	0	134	19±35
Naticidae	400	489	178	400	0	0	89	1556	222±205
Nereididae	222	178	89	178	489	444	400	2000	285±156
Nephthys	622	444	756	578	444	507	400	3751	535.86±12
Nephtyidae	400	444	311	0	45	0	0	1200	171±204
Portunidae	311	89	222	178	89	267	312	1468	209±95
Insecta	222	0	311	178	133	0	89	933	133±114
Total	3289	2447	2224	2225	2046	1890	1696	15817	2259±516
Family taxa	12	13	10	10	12	9	9		

Biological analysis

A total of 17 taxa (families) of soft-bottom macrobenthos were found over the two sampling seasons. The current study yielded a total number of 34,726 ind./m^2 with a mean of (2480±781) including 18,909 ind./m^2 in wet season with a mean density of (2682±1046) from all stations and 15,817 ind./m^2 in dry season with a mean density of (2259±516) from all stations. The highest density of macrobenthos were 4760 ind./m^2 at station S2 in the wet season while the lowest number 1696 ind./m^2 at station S7 in the dry season (Table 2 & 3).

In wet season, Nereididae, Ampelisidae and Mysidae were obtained the top position with a total of 4,091ind./m^2, 3,646 ind./m^2 and 3,333 ind./m^2 and Naticidae, Namanereidinae, Apseudidae and Megascolecidae were obtained the least position with a total of 45 ind./m^2, 90 ind./m^2, 134 ind./m^2 and 134 ind./m^2 respectively. But in dry season, Nephthys, Nereididae and Naticidae were obtained the top position with a total of 3,751 ind./m^2, 2,000 ind./m^2 and 1,556 ind./m^2 and Anthuridae, Capitellidae and Ampelisidae were obtained the least position with a total of 45 ind./m^2, 90 ind./m^2, and 134 ind./m^2 (Table 2 & 3).

Nereididae and Nephthys were dominant during the both seasons bearing a mean of 3,046±1478 and 2,611±1612 while Mysidae, Portunidae and Nephtyidae were also abundant in both of the wet and dry season bearing a mean of 2,117±1720ind./m^2, 1,824±503 ind./m^{2}and 756±628 ind./m^2 respectively (Table 2 & 3). But in regarding of the rest ten families, their attendance was scattered at different stations in both sampling seasons. The dominant taxon was Nereididae that contributes 32.28% of the total soft-bottom invertebrates. Nereididae showed dominance in all stations during each season of the current study.

We also analyzed the major groups of macrobenthos and their contribution. A total of five groups of macrobenthos were found over the two sampling seasons. In the wet season, most dominant group was Crustacea (53%) followed by polychaeta (35%), Insecta (9%), Bivalvia (2%), and Oligochaeta (1%), (Figure 2a).

However, in dry season, most dominant group was polychaeta (53%) followed by Crustacea (19%), Bivalvia (17%), Insecta (6%) and Oligochaeta (5%), (Figure 2b). In a total, among the five major groups of macrobenthos Polychaeta and Crustacea were contributed >70% in each sampling seasons.

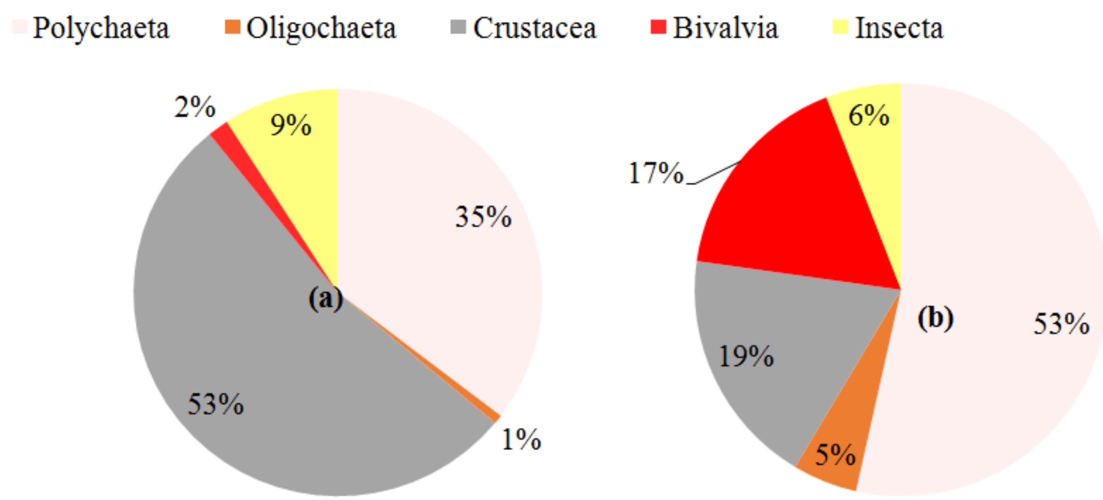

Figure 2 Total composition of the five major groups of macrobenthos found in the a) wet season b) dry season.

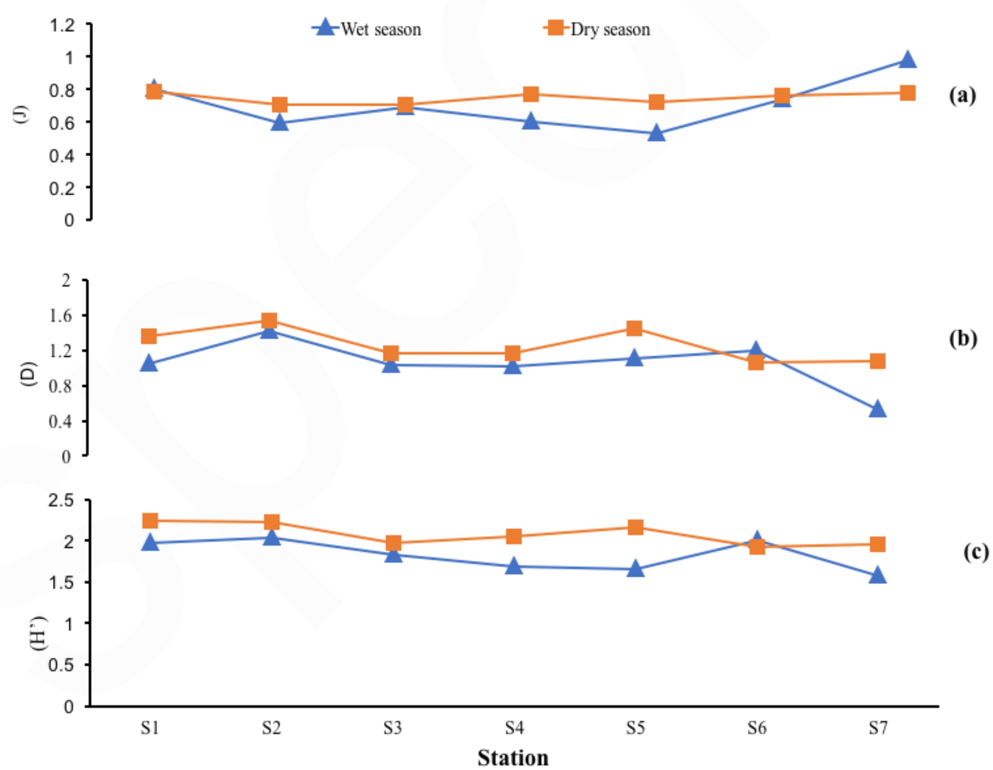

Figure 3 Diversity indices of macrobenthos in two seasons at studied area a) Evenness index (J), b) Margalef richness index (D), and c) Shannon-Weiner diversity index (H')

The value of Shannon-Weiner diversity index (H') ranged from 1.92 to 2.25 during dry season and 1.58 to 2.03 during wet season. The highest value was 2.25 recorded at station S1 in dry season and the lowest value 1.58 was recorded at station S7 in wet season during the period of investigation (Figure 3c). The value of Shannon-Weiner diversity index (H') were higher in dry season compare to the wet season in all sampling station except station S6. The value of Margalef richness index (D) ranged from 1.06 to 1.54 during dry season and 0.53 to 1.42 during wet season. The highest value 1.54 was recorded from the station S2 in dry season and the lowest value 0.53 was recorded at the station S7 in wet season during the period of observation (Figure 3b). Like Shannon-Weiner diversity, the value of species richness index (D) were higher in dry season compare to the wet season in all sampling station except station S6 (Figure 3b).

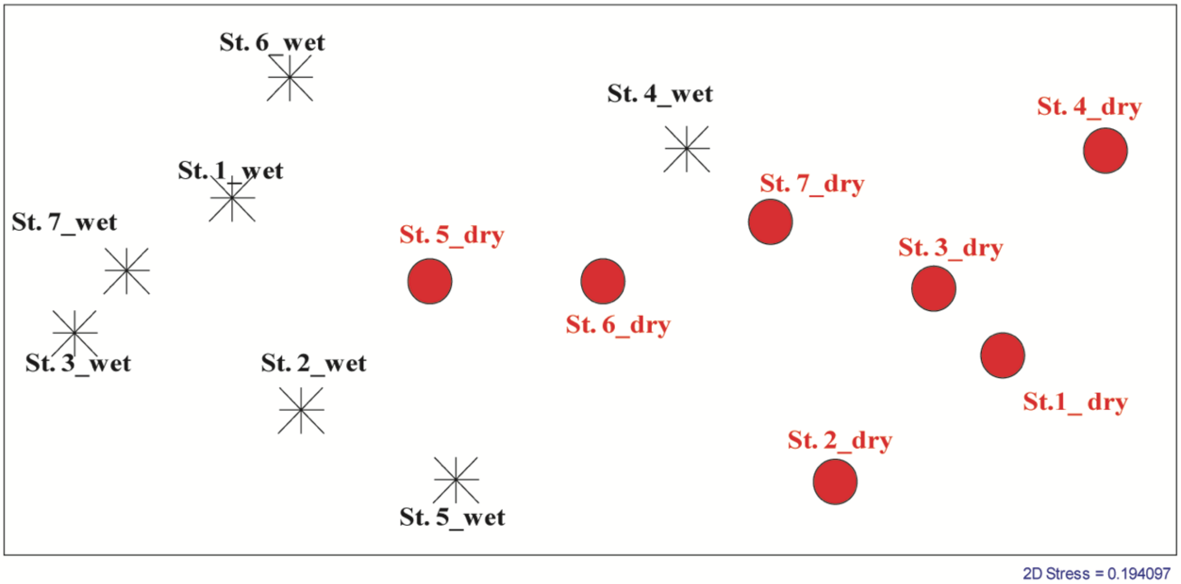

Figure 4 Non-metric Multidimensional Scaling showing the clustering of the assemblages on dry and wet seasons at different stations

The value of the Evenness index (J) ranged from 0.71 to 0.79 during dry season and 0.53 to 0.98 during wet season. The highest value 0.98 was recorded from the station S7 in wet season and also the lowest value 0.53 was recorded at the station S5 in the same season (Figure 3a). The value of the Evenness index (J) were higher in dry season compare to the wet season in all sampling station except station S1 and S7 (Figure 3a). Based on the non-metric multi-dimensional scaling (nMDS) plots marked seasonal differences were observed between the assemblages of the dry and wet season (Figure 4).

4. DISCUSSION

A slightly changes were noticed for water parameters in the present study which with time may certainly affect the assemblage structure. The diversity, distribution, abundance and composition of macrobenthos in a subtropical estuary are linked with favorable environmental parameters such as temperature, pH, salinity and dissolved oxygen (Cyrus and Mclean, 1996; Blaber, 2000; Chowdhury et al., 2011). These differences could be due to seasonal changes in rainfall, salinity and temperature. Generally, most of the macrobenthos have the tolerance to survive salinity fluctuations (Blaber, 2000). Moreover, changes in salinity may influence the biological resources of the estuarine waters (Rozengurt and Hedgpeth, 1989; McAllister et al., 2001; Chowdhury et al., 2011). A slightly change in salinity was noticed during the present study, which may have significant effect on the macrobenthos abundance and distribution with time. It was also reported changes in species abundance due to a salinity increase according to Maes et al. (2004), furthermore, McAllister et al. (2001) reported changes in natural recruitment and species abundance in the Caspian Sea due to an increase in salinity. The water pH in the study area was slightly alkaline with values ranging from 7 to 8.7. The pH value was aligned with the previous study conducted in subtropical estuary of Bangladesh (Iqbal et al., 2014; Iqbal et al., 2017) and water with slightly alkaline is suitable for macrobenthos(Gandaseca et al., 2011). Usually, water with a pH lower than 6.5 and higher than 9 are not suitable for aquatic life (Boyd, 2000).

However, no significant difference in water transparency was observed though, lower transparency was observed in dry compared to wet season. This may be due to the higher water turbulence downstream at some stations in dry season due to strong tidal fluctuation and anthropogenic causes such as the presence of the fish harbor, jetty, etc., in the mouth of the river. Fluctuations in water transparency influence the primary productivity which ultimately affects the fish distribution (Arthington and Welcome, 1995; McAllisteret al., 2001). Temperature and dissolved oxygen during the study period were also different among the seasons and this is in agreement with the findings by Blaber (2000) in other tropical regions. Comparatively lower dissolved oxygen was observed at both stations. Abu Henaand Khan (2009) reported a lower level of DO in the same estuary (1.89-5.37 mg/l), also from another subtropical estuary (3-5ml/L) in Bangladesh (Iqbal et al., 2014; Iqbal et al., 2017). This may be due to the nearby domestic, agricultural and industrial waste water discharges which affect the water and sediment quality and lead to a hypoxic condition, as stated by previous study (Eck van et al., 1991). Dissolved oxygen is one of the most important factors for fish abundance and distribution. Fish communities are highly affected by temperature within estuaries (Cyrus and Mclean, 1996). A sudden increase or decrease in water temperature may cause fish mortality (Blaber, 2000). Environmental parameters such as temperature, salinity, dissolved oxygen, water transparency and pH play an important role for species abundance and diversity (Whitfield, 1999), especially for the tropical regions where the fluctuation of these parameters are frequently due to seasonal changes (Blaber, 2000) Feni River Estuary, Bangladesh is no exception.

Despite relatively limited time and shore perimeter covered, Feni River Bangladesh shows a wide heterogeneity in the composition of soft-bottom invertebrates. This heterogeneity may be lost due to seasonal changes or environmental pollution or both. A total of 17 taxa of soft-bottom invertebrates were found in the study area during the period from June-September (wet season) to October-December, (dry season). The current study yielded a total number of 34,726 ind./m^2 from all sampling stations. In the present study, macrobenthos abundance ranged from 1,696 ind./m^2 and 4,760 ind./m^2. The highest density of macrobenthos was found 4,760 ind./m^2 in station S2 during the dry season while the lowest number was 1,696 ind./m^2 at station S7 during the wet season. Khan et al. (2007) recorded the average density of benthos of Mouri river, Khulna was 630-1040 ind./m^2 and in India, Mishra (1996) recorded the average density of macro benthic organisms in the polluted portion of Ganga river was 119-4053 ind./m^2 which supported the present investigation. Mavrič et al., (2010) carried out a faunistic, biocoenotic and ecological survey of soft-bottom macrozoobenthic communities for the southern part of the Gulf of Trieste on the basis of samplings in 2005 and 2006. At 28 sampled stations, a total of 14595 specimens belonging to 306 animal taxa were identified.

Quantitative distribution of macrobenthos of Feni River estuary comprised of 5 major taxa comprising Polychaeta, Crustacea, Bivalvia, Insecta and Oligochaeta. These have more or less similarity with the findings of Khan et al. (2007), the composition of the soft-bottom invertebrate groups was recorded: Polychaeta (43.60%), Oligochaeta (2.69%), Crustacea (37.44%), Bivalvia (8.58%), and Insecta (7.68%). Abu Henaet al., (2012) found five major groups of macro benthos namely Polychaeta (9.966-30.31%), Oligochaeta (3.68-30.310%), Crustacea (0.02-58.40%), Bivalvia (1.40-82.09%) and Gastropoda (0.08-4.25%) in Bakkhali river of Cox's Bazar, Chittagong. This difference was mainly due to the environmental and ecological condition as the sampling stations was an estuarine area. In the present study, Polychaeta and Crustacea were recorded as major group among the macrobenthos groups (Figure 2). Previous study also showed Polychaeta and Crustacea were dominant groups of macro benthos in Mouri river, Khulna (Khan et al., 2007) and Bakkhali channel system, Cox's Bazar (Abu Henaet al., 2012) in Bangladesh. Hossain et al. (2013) reported Polychaeta as the major macro-fauna from two important islands, Hatiya and Nijum Dweep.

In present study, Polychaeta was dominant among the macrobenthos groups in dry season (Figure 2b). Sivadas et al., (2010) studied seven stations within the Mormugao harbor area for benthos and environmental variables and found a total of 71 taxa where polychaeta abundance, biomass and species number was highest during the post-monsoon, mainly due to new recruitment as the pre-monsoon is the most stable period for community development when the fauna was dominated by opportunistic deposit feeding polychaeta species.

In the present study, the value of Shannon-Weiner diversity index (H') ranged from 1.92 to 2.25 during dry season and 1.58 to 2.03 during wet season. The highest value was 2.25 recorded at station S1 in dry season and the lowest value 1.58 was recorded at station S7 in wet season (Figure 3).

Khan et al. (2007) observed the value ranging from minimum of 1.20 to a maximum of 1.49, Montajami et al., (2012) observed values ranging from minimum of 1.22 to a maximum of 2.70 and Hossain et al., (2013) observed values ranging from minimum of 1.24 to a maximum of 1.97. The present study is supported by all of the above findings. Ransom and Dorris (1972) made a similar observation in their work on Keystone reservoir in the U.S.A. The somewhat lower values of the index of diversity during the investigation can be attributed to the residual effect of the pollutants settled at the bottom which come from different domestic sources, municipal wastes disposal, agricultural wastes and industrial wastes discharge to the river. According to Wilhm and Dorris (1966), species diversity (S-W) index (H) value ranged from >3 indicates clean water, 1.00 to 3.00 indicates moderately and <1.00 indicates heavily polluted condition of water. Therefore, the maximum impact of pollution in the Feni River Estuary is felt at station S7 in the wet season due to the domestic discharge and runoff. Although several studies have reported the dominance of the resident species in the estuaries (Thompson, 1966; Hotos and Vlahos, 1998).

Seasonal variation of macrobenthos of the present study was significant (Figure 4). This is may be attributed for the marked differences of salinity between the season because of rainfall. During the monsoon season, huge amounts of freshwater flow into the river and create a freshwater-influenced estuarine environment. Most of the researchers reported less abundance of benthos during monsoon was due to monsoon rain and huge water flow from northern state of India. Which are supports the findings of the presence of a freshwater species in the investigated area.

5. CONCLUSION

In this study, seasonality of the environmental conditions explained the major variations of the macrobenthos. Seasonal variations occurred not only in total abundance and diversity but also in the structure of the species assemblage of the Feni River, Bangladesh. A total of 17 families under 5 major groups/taxa were identified that yielded a total of 34, 726 ind./m^2 from all stations of the study areas. Besides, the abundance and diversity of soft-bottom macrobenthos of the intertidal zone of the Feni River estuary is seem to be influenced by estuarine hydrological conditions.

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