

Mangrove associated macrobenthos community structure from an estuarine island

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Abstract. Rahman MDH, Hossain MB, Habib A, Noman MDA, Mondal S. 2021. Mangrove associated macrobenthos community structure from an estuarine island. *Biodiversitas* 22: 247-252. Macroinvertebrate living on or around the mangroves has not been or less investigated in Bangladesh. This study was carried out to describe the density, distribution, and community structure of mangrove associated macrobenthos in Nijhum Dwip, central coast of Bangladesh. A total of 17 taxa were identified belonging to mainly Polychaetes (67.37%), Mysids (23.53%), Isopods (3.83%), Amphipods (0.58%), and Gastropods (0.29%). Polychaetes were dominant by contributing 67.37% of total macrobenthos. The number of benthic fauna ranged from 359 to 1617 inds./m² with a mean value of 1003.93± 400.3 inds./m². There was no significant difference observed ($p > 0.05$) in the abundance of macrofauna among the stations. The maximum Shannon-Wiener Index (H') of species diversity was found at St2 (1.323) and the lowest at St4 (0.8) in the monsoon period possibly due to high rainfall and disturbance of benthic habitat. The Shannon-Wiener diversity values suggest the area was less polluted. The information from the present study can be used to measure the impacts of pollution to conserve biodiversity in sustainable manner.

Keywords: Estuarine island, macrobenthos, mangrove ecosystem, Nijhum Dwip, Bangladesh

INTRODUCTION

The coastal vegetated wetlands such as mangroves, seagrass beds, and salt marshes account for <0.2% of the total ocean area and have been considered as most productive ecosystems in the world (Su et al. 2020). Mangrove ecosystems normally occur in sheltered locations along the coastline. In optimum condition mangrove ecosystem develops into a large productive forest (Loughland et al. 2020). In addition, mangroves play an important role worldwide serving as unique and vital ecosystems connecting the land and sea in tropical and subtropical coastal regions (Li et al. 2017). They provide shelter, food, breeding sites for marine organisms, and ecosystem services on which coastal people depend on their livelihood, and for their socioeconomic development (Lee et al. 2014; Chen et al. 2015). These ecosystems provide diverse ecological benefits including supporting high biodiversity and ecosystem service functions (Luo et al. 2010; Su et al. 2020). Due to their effects on biodiversity and productivity of macrofauna, estuarine and marine ecosystems also serve as nursery grounds for ecologically and economically important marine species (Bertelli and Unsworth 2014). However, the increased anthropogenic activities in the coastal regions also produced adverse effects on marine life and disturb the coastal environment particularly mangrove ecosystem (Faroq and Siddiqui 2020). Bangladesh coastline is also

prone to various natural disasters such as cyclones, river erosion, salinity intrusion, floods, high population density, and poor socio-economic conditions. The Sundarbans is the biggest mangrove forest in Bangladesh, which is used as strengthen of coastal forest (Iftekhar and Takama 2008). Different mangrove communities support different macrobenthic faunal communities (Samidurai et al. 2011; Chen et al. 2015). The sediment differs among mangrove communities, which has great effects on diversity indices (richness, evenness) of macrobenthic fauna (Alfaro 2010; Chen et al. 2015; Leung 2015). In addition, variation in species diversity and population of benthic organisms reflects the environmental composition and condition in specific wetland (Leung and Cheung 2017). Research on community structure of macrobenthic fauna in mangrove areas might provide valuable information on management, restoration, and sustainable use (Chen et al. 2015). Thus, it follows the community structure of macrobenthos in an estuarine island and/or changes in a mangrove forest succession.

Like other estuarine islands, the Nijhum Dwip island occupies large area of mangroves including mudflats, tidal creeks with high level of biodiversity (Asadujjaman et al. 2012). This island is under Hatiya Upazila and Noakhali District, Bangladesh. The island began to form in the 1950s, at present the total area of the island is 4,057 ha and the soil is mainly undeveloped with little development of Meghna alluvial deposits. The surface soil is primarily

medium-textured silt loam and poor in organic matter. However, the ecosystem appears to be declining phase due to ecological and climate change (Iftekhar and Takama 2008). Mangrove ecosystems are at high risk around the world despite their unique properties and ecological functions (Li et al. 2017). Like any other ecosystem in the world, these resources also have been declining due to human activities particularly deforestation, over-exploitation, illegal fishing, improper waste management, pollution, and other anthropogenic activities (Adeel and Pomeroy 2002). All of these caused serious threats to marine biodiversity. If this current trend of environmental degradation continues then marine ecosystem will be irreversible, damaged, and finally leading to resource depletion (Olumukoro and Azubuikwe 2009). In Bangladesh mangrove ecosystems also under high risk due to population boom, rapid economic development in aquaculture, agriculture, industry, and urban construction. Bangladesh coastline is very vulnerable and quite sensitive to coastal erosion due to climate change (Habib 2010). Therefore, it is very important to understand the pattern of species biodiversity distribution, and in recent years ecologists have given more attention to it as well (Yunandar et al. 2020).

Macrobenthic organisms are the most important permanent residents in the coastal wetlands. They used to monitor the effects of organic enrichment, various types of aquatic pollution, and anthropogenic influences, because of their sedentary life-patterns, distribution, and abundance (Farooq and Siddiqui 2020). In addition, they also act as bio-indicator for environmental monitoring (Farooq and Siddiqui 2020), which can be reliably used for the classification of coastal areas, rivers, and the state of the ecosystems (Hatami et al. 2017; Tania et al. 2020). Long-life cycles of macrobenthic organisms allow ecologists to determine any decline in environmental quality, which could be assessed by studying the population responses of the coastal zoo benthos and the effects on the coastal biodiversity (i.e., organisms community composition, structure, and subsequent functioning. Thus, the study of benthic organisms and their community structure is important (Noman et al. 2019). Some previous researches were conducted on macrobenthic community from Bangladesh coastal waters such as estuarine macrophytes diversity in mangrove in Cox's Bazar (Abu Hena et al. 2013), occurrence and abundance of macrobenthos in Hatiya and Nijhum Dwip (Asadujjaman et al. 2012), diversity of fish fauna and their status, conservation (Ali et al. 2014), seasonal and spatial distribution of macrozoobenthos from Meghna river estuary (Hossain et al. 2009), intertidal macrobenthic fauna and their relations with environmental variables in Karnafuli estuary (Islam et al. 2013), diversity, distribution, and abundance of benthos in Mouri river, Khulna, Bangladesh (Khan et al. 2007), recent study on cage culture effects on macrobenthic community in Dakatia river (Tania et al. 2020), and spatial and seasonal distribution of intertidal macrobenthos with their biomass and functional feeding guilds in Naf river estuary Bangladesh (Noman et al. 2019). However, none of the previous studies have focused on mangrove-associated

macrofauna. Therefore, the specific aim of the present study was to describe the abundance, distribution, and community structures of macro invertebrates that were living on mangroves or in the sediment adjacent to mangroves.

MATERIALS AND METHODS

Study area

The present study was conducted from the Nijhum Dwip Island, which is situated in the southern part of Bangladesh. It is a mangrove intertidal zones where continuous high tides and low tides have fluctuated. The study was conducted in the monsoon season (July to September) in 2017. Five stations were selected from around the Nijhum Dwip Island, Bangladesh (Figure 1). These stations are, station 1 (St1) Char Usman (22°02'24.239N, 90°58'41.274E), station 2 (St2) Batayeenguscho gram (22°02'34.012"N, 90°58'53.406E), station 3 (St3) Murkhali (22°02' 41.581"N, 90°58'57.293E), station 4 (St4) Jatrakhali (22°02'24.274"N, 90°58'44.192E), station 5 (St5) Chorakhali (22°02'19.015"N, 90°58'21.138"E). Stations were selected based on the presence of mangroves and low anthropogenic activities. Samplings were performed three times from each station and total of fifteen times from the sampling sites.

Sample collection, sieving, sorting, and identification

Benthos was collected using Eijkman Dredge having a mouth opening of 0.01 m² (dimension: 10cm ×10cm ×10cm). Samples were collected from the intertidal zones during the low tides from around the Island. Five replicates samples were collected from each station. The sediment samples were transferred from polyethylene bag to bucket and washed with clean water, then hand-sieved through 0.5 mm mesh to get the macrobenthos. The sieved organisms and residues were immediately preserved with 10% formalin solution in plastic container with labeling until further analysis. To increase the visibility of benthic infauna small amount of Rose Bengal was added to the formalin solution of the plastic container. Macrobenthos were separated manually in a tray under enough light availability. Samples were counted and calculated for total amount of inds./m². Then the sorted samples were preserved into 70% alcohol solution in small vials for identification.

Data analysis

The diversity of benthic fauna and one-way ANOVA were performed using PAST version 3.10 (Hammer et al. 2001). Shapiro-Wilk test and Levene's test of homogeneity in terms of ANOVA were performed to analyze the normality and homogeneity of the variance. Data were transformed square root before further analysis when the data showed skewness One-way ANOVA was performed to test the hypothesis whether there was significant difference among the stations at the 95% confidence level.

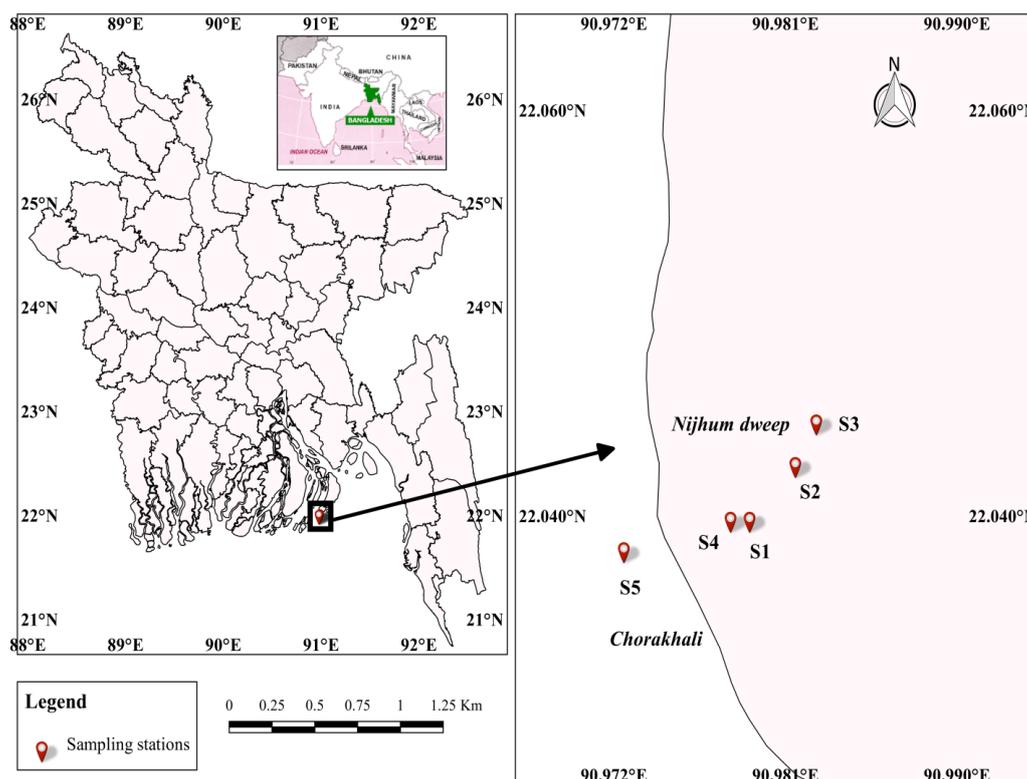


Figure 1. Map of the study region with the sampling sites in Nijhum Dwip Island, Bangladesh indicated by St1 to St5

RESULTS AND DISCUSSION

Abundance of macrobenthos taxa

In the present study, a total number of 17 taxa of macroinvertebrate infauna and a total number of 5292 inds./m² was found from all stations during the study period (Table 1). The number of benthic infauna in the present study ranges from 359 to 1617 inds./m² (Table 1). The highest numbers of individuals were found at St2 (1617 inds./m²) and the lowest number of benthos were (359 inds./m²) found at St5. The average density of the present study was 1003.93±400.3 inds./m² (Table 1). Asadujjaman et al. (2012) studied the abundance of macrobenthos and found the density of macrobenthos ranged between 4511 inds./m² to 433 ind./m² in Hatiya and Nijhum Dwip island. Khan et al. (2007) recorded the average density of benthos 630-1040 inds./m² in Mouri river, Khulna which supports the result of the present study. Tania et al. (2020) also reported huge number of macrobenthos in monsoon season. However, St3 showed less abundance of macrobenthic community in the present study, this might be the result of fishing, and tourism activities. Human intervention might be the reason for discrimination of abundance of macrobenthos (Noman et al. 2019).

Abundance of taxonomic groups

The group of Polychaeta (3644 inds./m²) infauna were identified from the study area during monsoon period as the most abundant group while Gastropoda (15 inds./m²)

and Hirunida (15 inds./m²) were found least abundant group (Table 2). In the present study, 10 genera of macrobenthos were recorded whereas 5 macrobenthic groups were mostly dominated namely Polychaeta, Gastropoda, Mysida, Isopoda, and Amphipoda (Table 2). The result has more or less similar to the findings of Hossain et al. (2009), Asadujjaman et al. (2012), Hossain et al. (2013), and Noman et al. (2019). In addition, Raja et al. (2014) and Xu et al. (2016) reported that Polychaetes formed the largest group among all groups of taxa, which supported the results of the present study. The difference between the present study and those studies is that no Oligochaetes were found in the present study. However, we hypothesize, this may indicate that studied areas are still unpolluted. Lin and Yo (2008) investigated that aquatic Oligochaetes are abundant in polluted areas, which commonly used as bioindicator to study pollution in rivers and streams (Lin and Yo 2008).

Diversity indices

The station-wise diversity indices, number of taxa (S), number of individuals, Dominance (D), Shannon-Wiener diversity index (H'), and Margalef richness index (J') value are presented in Table 3. Shannon-Wiener diversity (H') index value of benthic infauna ranged from 0.8 to 1.323 (Table 3). The Shannon-Wiener (H') index value from Khan et al. (2007) and Sarker et al. (2016) was almost close to the present study. However, Pawar (2015) reported a very low diversity value (0.203 to 0.332) from the heavily polluted area which reveals that macrobenthic community

was under stress conditions. Besides, another study revealed that higher cadmium concentration in the sediment leads to lower diversity (H') of infaunal community (Leung and Tam 2013). Unlike aforementioned studies, the diversity value of our study was not very low to predict the influence of pollution. The Margalef richness (J') richness diversity of the present study ranged from 0.245 to 0.630. This result showed a difference from the

findings of Sarker et al. (2016). This difference is mainly due to the variation of salinity, sediment condition, and contamination factor. Noman et al. (2019) also reported that inconsistent results might occur due to variation in ecological characteristics (water parameters, sediment characteristics, grain size, organic content, habitat condition, and anthropogenic factors).

Table 1. Total benthic family (inds./m²) found in the study period

Name of the taxa	St1	St2	St3	St4	St5	Mean±SD	Total	Average percentage (%)
Nereididae 1*	163	356	30	637	355	308.13±93.47	1541	30.6
Nereididae 2*	89	326	30	518	163	225.13±60.19	1126	22.36
Nephtyidae*	163	15	30	0	59	53.27±19.97	267	5.29
Eunicidae	25	30	0	0	0	20.73±15.55	55	2.06
Glyceridare	0	30	30	0	15	14.73±7.06	75	1.46
Goniadidae	0	445	0	0	0	29.67±24.05	445	2.95
Nemanerididae	30	0	0	0	60	17.8±12.88	90	1.77
Lumbrinidae	0	0	45	0	0	8.87±6.43	45	0.88
Isopoda	0	0	119	0	74	38.53±27.06	193	3.83
Mysid	356	385	15	15	415	236.93±100.32	1186	23.53
Crab larvae	45	0	0	0	0	8.87±8.87	45	0.88
Shrimp larvae	74	0	15	0	15	20.67±12.17	104	2.05
Hisonidae	0	0	15	0	0	2.93±2.93	15	0.29
Amphipoda	0	15	15	0	0	5.87±3.99	30	0.58
Hirunidae	0	0	15	0	0	0±00	15	0.29
Insect larva	0	15	0	0	30	8.87±6.43	45	0.88
Gastropoda	0	0	0	15	0	2.93±2.93	15	0.29
Total	945	1617	359	1185	1186	1003.93±400.3	5292	100

Note: St: Station

Table 2. Abundance of taxonomic groups (inds./m²) found at the study period

Group	Mean±SD	Total	Average percentage (%)	Rank
Polychaeta	678.33±239.6	3644	67.37	1
Gastropoda	2.93±2.93	15	0.29	7
Amphipoda	5.87±3.99	30	0.58	6
Isopoda	38.53±27.06	193	3.83	3
Mysida	236.93±100.32	1186	23.53	2
Crab larvae	8.87±8.87	45	0.88	5
Shrimp larvae	20.67±12.17	104	2.05	4
Hirunidae	0±00	15	0.29	7
Insects larvae	8.87±6.43	45	0.88	5
Hisonidae	2.93±2.93	15	0.29	7

Table 3. Diversity indices observed in the present study

Parameters	St1	St2	St3	St4	St5
Taxa (S)	4	6	5	3	5
Individuals (Total)	993	1319	355	1185	1184
Dominance (D)	0.385	0.326	0.607	0.478	0.521
Shannon-Wiener (H')	1.14	1.323	1.274	0.8	0.985
Evenness (E')	0.8	0.714	0.867	0.826	0.747
Margalef richness (J')	0.436	0.603	0.63	0.245	0.389

Note: St: Station

Pollution indicator groups

The Polychaeta community is generally being used for the status of the benthic environment (Dean 2008; Hossain et al. 2020). Among them, the presence of positive indicator group denotes the poor environmental condition and the absence of negative indicator groups prevail the detrimental environmental (Belan et al. 2013; Hossain et al. 2020). The caprellids (especially *Capitella capitata*) are well known positive indicator groups which were not found in our study region. Besides, along this coastline, a recent study of Hossain et al. (2020) found the negative indicator taxa Nerididae and Nephtyidae had higher abundance in the unpolluted site than the reference site. Similarly, in our study Nerididae and Nephtyidae were the most dominant taxa that may denote the non-polluted environment.

In conclusion, the species diversity and the pollution indicator taxa of the present study areas revealed that all stations of the study were less polluted during the study period. The obtained information can be used for further analysis to compare the pollution status using macrobenthos in this area, and conservation of macrobenthos biodiversity. However, a long-term study focusing on macrobenthos and sediment parameters is recommended to further in-depth quantification of the pollution in this area.

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