FISH DIVERSITY AND WATER CHARACTERISTICS IN THE REJU KHAL RIVER ESTUARY, BANGLADESH

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ARTICLE DETAILS

ABSTRACT

Hydrobiological characteristics determine the health of an aquatic ecosystem. Reju Khal estuary on the subtropical coasts is among the major estuarine system in Bangladesh. Monitoring the water characteristics and fish diversity of this estuary is very important due to its ecological and economical services provided to the coastal areas. Consequently, the present study investigated the occurrence and abundance of the ichthyofaunal assemblages and hydrobiological characteristics (temperature, pH, salinity, dissolve oxygen, total dissolve solids, sechi depth, phytoplankton and zooplankton abundance) from December 2012 to August 2013. The ranges of the hydrobiological factors were 16-26°C for surface water temperature, 7- 8 for pH, 8-29 PSU for salinity, 3-4 mg/L for dissolved oxygen (DO), 33- 35 mg/L for total dissolved solids (TDS), 21-45 cm for sechi depth, 27-45 individuals/m³ for zooplankton abundance and 9400-17100 cells/L for phytoplankton abundance. Overall, 6706 individuals of the faunal population comprised of 36 species from 23 families were captured. The species recorded during the study are the representative of the subtropical coasts. The similarity percentage analysis (SIMPER) suggested that *Stolephorus indicus* was found to be the most contributory species followed by *Mugil cephalus* and *Mystus gulio*. The results of this study will be helpful for management and planning for water quality monitoring in this estuary. It is suggested that frequent monitoring of the hydrobiological recourses of the estuarine systems is very necessary in near future to detect the shifting of baselines, assisting ecosystems-based monitoring and enhancing restoration efforts.

KEYWORDS

1. INTRODUCTION

Based on a study, shallow coastal habitats such as estuaries are considered as physical and biological transition among land, freshwaters and the sea that support abundant life forms [1,2]. According to research, estuaries are highly complex, dynamic and productive habitat mainly because of continual tidal mixing of fresh- and saline-waters [3]. However, ecological integrity of the estuarine systems has been a major concern in recent times due to human intervention and global environmental changes [4,5].

Research showed a wide range of human interventions especially alteration of the habitat, inputs of freshwater, sediment and nutrient, introduction of the invasive species and over exploitation of the floras and faunas have fundamentally been affecting the estuarine systems [6]. These disturbances especially have resulted in the changing pattern of the physiology and ecology of the aquatic biota. Therefore, regular monitoring of the estuarine water characteristics is important to discern the shifting baselines, assist ecosystem-based monitoring and enhance restoration efforts [7].
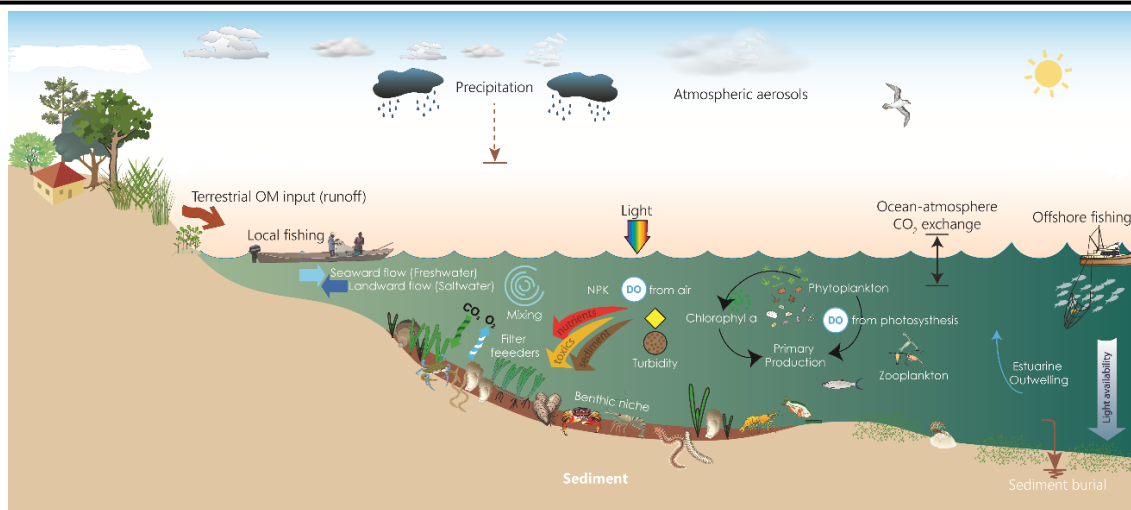
Figure 1: Interlinkage among hydrobiological parameters in a typical estuarine system (adapted from Saifullah et al. 2016); (symbols for diagrams courtesy of the Integration and Application Network, University of Maryland Center for Environmental Science)

The extreme and varying environmental gradients of estuaries favour a variety of fish species through various physico-chemical features and trophic structures (Figure 1). According to previous researchers, these ecosystems offer protection not only for resident species but also for a wide range of marine and fresh water species which migrate to the estuaries at certain stages of their life cycle [8-10]. For example, there are some teleost species that enter into the estuaries in the first year of their life, use the habitat as nurseries before migrating towards the deeper waters as they grow while some others complete their life cycle in the estuaries and are known as the true estuarine species [11,12]. Freshwater fish species usually concentrate in the upper reaches of estuaries while the marine ones' drift on the mouth. The distinct characteristic of estuary is the low fish diversity associated with high abundance of individual species, the majority of which show broad tolerance limits for hydrobiological factors. In the estuarine systems, the major biotic and abiotic factors that regulate the occurrence and abundance of fish assemblages include water temperature, salinity, turbidity and dissolve oxygen concentrations all of which tend to have seasonal fluctuations in the subtropical estuaries [13-16].

Based on a study, Bangladesh is blessed with an extended coastline and estuarine ecosystems that are one of the main sources of fish production, and employment for millions of rural people [17,18]. The study area Reju Khal estuary on the south eastern coast of Bangladesh represents typical subtropical estuaries and is among the major estuarine systems in Bangladesh. It is regarded as an important estuarine system both ecologically and economically [19]. This estuarine system is characterized with semi-diurnal type tides (two high tides and two low tides during 24 hrs and 52 minutes) and is mostly influenced by the monsoon wind. The coastal waters in Bangladesh has been vulnerable to pollution due to contaminant from the waste water effluents, ship breaking yards, runoff from agriculture, and operation of the river and ports. In contrast to the importance of estuarine ecosystems in fish production, and increasing pollution threats these ecosystems, only a few studies have reported the ecological characterization of the subtropical estuaries while comparatively less is known about the estuarine fish species composition and factors controlling their distribution and abundance [20,22].

Studies on fish diversity and hydrobiological characteristics are essential for proper planning and management in order to exploit maximum benefit from the extended estuarine waters of Bangladesh to support the livelihood of millions of rural people. Furthermore, as the species living in the estuarine ecosystem are limited and sensitive to hydrobiological changes, these species can act as bio-indicator for environmental changes [23]. Subsequently, detail information about fish species composition and their relationship with hydrobiological parameters followed by regular monitoring program could help identifying the changes in estuarine environment. Therefore, this study attempts to (a) characterize the hydrobiological parameters; (b) investigate the fish species composition, and their abundance; and (c) determine the relationship between fish abundance and hydrobiological characteristics in a subtropical estuary, the Reju Khal estuary, Bangladesh. This study should provide important data set to help enhancing coastal monitoring and restoration program and managing fisheries resources.

2. MATERIAL AND METHODS

2.1 Study area

Rezu Khal estuary is located (21°17'35.42''N to 21°18'28.34''N and longitude 92°2'27.15''E to 92°4'30.90''E) in Cox's Bazar, southeastern coast of Bangladesh. Sources of Rezu Khal lie on the north Arkan Mountain and flows over the Bandarban district before flowing into the Bay of Bengal. The intertidal estuarine mudflat is occupied with mangrove and salt marshes. The Reju Khal River has two streams that join together near Jaliapalong and finally reach to the Bay of Bengal. The entire sampling was carried out near Jaliapalong Bridge of the Reju Khal estuary (21°17′21.06″N and 92°3′36.40″E; Figure 2 and 3).
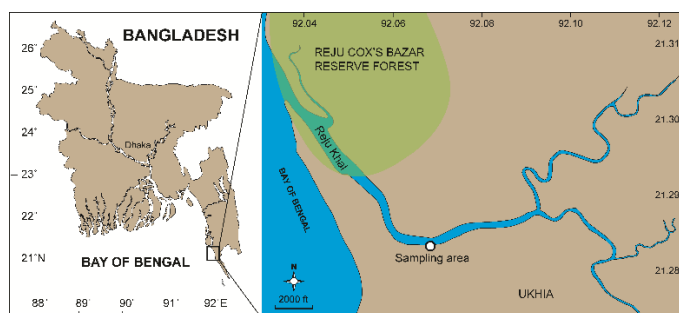
Figure 2: Study area map showing Reju Khal estuary on the southeastern coast of Bangladesh.

Figure 3: A view of Reju khal estuary near the Jaliapalong Bridge, Cox's bazar, Bangladesh.

2.2 Sample collection, preservation and laboratory treatment

According to a researcher there are three dominant seasons in Bangladesh such as pre monsoon (from March to May), rainy monsoon (from June to October) and winter (from November to February) [24]. In the present

study seasonal samples were collected during December 2012 (to represent the winter season, April 2013 (to represent pre-monsoon season), and August 2013 (to represent monsoon season) using estuarine set bag net (ESBN) over three consecutive days during full moon following previous study [25]. Full moon period has been chosen for the sample collection because of highest occurrence of faunal population reported by the fishermen during that time. Three replicates of ESBN were considered during sampling. The mesh size of the ESBN varied between 0.5 cm and 10 cm among different segments of the net. The operational structures of this net are illustrated in the previous study. Faunal population found in the ESBN were immediately kept in ice and preserved in 10% formalin upon arrival at the laboratory. In the laboratory, samples were identified based on their morphometric and meristic characteristics following the existing literature [26-28].

In situ hydrological factors such as water temperature, salinity, pH and water transparency were measured using thermometer, a refractro meter (NewS-100, TANAKA, Japan), digital pan pH meter (s327535, HANNA Instruments, USA) and secchi disk, respectively. In order to collect the phytoplankton and zooplankton samples, horizontal towed plankton nets of bolting silk (50 µm) were used. Study showed the biological samples were formalin preserved until laboratory treatments. Phytoplankton (cells/m³) and zooplankton (individuals/m³) were estimated following study [29]. Total dissolved solids (TDS; mg/L) were measured using APHA's method [30]. Three replicates were considered (n=3) for each measurement of parameters during sample survey. Hydrobiological characteristics of the estuary were recorded simultaneously with the ichthyofaunal assemblages.

2.3 Data analysis

Diversity of species assemblage was demonstrated by the Shannon–Wiener diversity Index($H' = -Pi \times \ln Pi$; Pi is the relative cover of ith species), Evenness index ($E = H'/(\ln S)$; where S is the total number of species; and ($D = (S - 1)/\log(N)$; N is the total number of population [31-

35]. One-way analysis of variance (ANOVA) was carried out in order to determine statistical differences of hydrobiological factors, faunal population and diversity indices among seasons by using the statistical application software, SAS (version.9.1).

Based on the species assemblages recorded during different seasons nonmetric multidimensional scaling (nMDS) plot was generated. Based on a study, hierarchical cluster analysis (HCA) was carried out for the fish assemblages recorded during different season and was expressed by dendrogram following the previous study [36,37]. Further, analysis of similarity was used to estimate the degree and significance of the nMDS [38]. Similarity percentage analysis (SIMPER) was carried out to investigate the most contributory and discriminating faunal species recorded in each season. Canonical correspondence analysis (CCA) was carried out to establish the relationship between hydrological factors and species assemblages [39]. In the CCA model only the species that contributed more than 5% were considered.

3. RESULTS

3.1 Physico-chemical characteristics and seasonal variation

Considering all seasonal samples, the maximum concentrations of measured physico-chemical parameters were observed in the premonsoon season (except salinity). The surface water temperature ranged between 16°C in winter and 28°C in pre-monsoon. The water pH varied from 7 in monsoon and 8 (recorded during both pre-monsoon and winter).

The range of the salinity varied between 8 PSU in monsoon and 29 PSU in winter. Dissolved oxygen ranged between 3mg/L (both in winter and monsoon) in monsoon and 4 mg/L in pre-monsoon. Total dissolved solids (TDS) ranged between 33 mg/L in monsoon and 35 mg/L in pre-monsoon. The secchi depth varied between 21 cm during monsoon and 45 cm during pre-monsoon. The ANOVA results showed that there were marked seasonal variations in all of the measured physicochemical factors (Table 1; P≤0.05).

Table 1: Seasonal hydrobiological factors in Reju Khal estuary, southeastern Bangladesh measured during present study (values are mean ± se; n=3; different letters within a column indicates significant statistical differences using Tukey's test at P≤0.05).

Season	Temp (°C)	pH	Salinity (PSU)	DO (mg/L)	TDS (mg/L)	Sec. depth (cm)	Zooplankton (individuals/m³)	Phytoplankton (cells/L)
Winter	16±0.2c	8±0.0a	29±0.6a	3±0.0b	34±0.0b	39±0.6b	27±4c	2200±86a
Pre-monsoon	28±0.0a	8±0.1a	27±0.6b	4±0.1a	35±0.1a	45±1.3a	45±9a	17100±108b
Monsoon	26±0.0b	7±0.0b	8±3.0c	3±0.0c	33±0.0c	21±0.9c	36±8b	9400±214c

### 3.2 Biological characteristics and seasonal variation

Phytoplankton abundance was highest in pre-monsoon (17100 cells/L) followed by monsoon (9400 cells/L) and winter (2200 cells/L). Further, zooplankton abundance was highest in pre-monsoon (45 ind./m³) followed by monsoon (36 ind./m³) and winter (27 ind./m³). Similar to the physico-chemical characteristics marked seasonal variation were also revealed for both phytoplankton and zooplankton abundance (P≤0.05; Table 1).

3.3 Fish assemblages: compositions and abundances

During the whole study period, 36 species under 23 families were identified from the RejuKhal estuary (Table 2). The maximum number of faunal population was recorded during winter (2879 individuals, 36spp.),

followed by monsoon (2193 individuals, 31 spp.) and post monsoon (1634 individuals, 31 spp.). The number of fish captured in different seasons varied significantly (F=7.11; P=0.06), however, it did not vary significantly among nets (F=0.84; P=0.47). The range of the Shannon–Wiener diversity index (H'), Margalef species richness (D), species Evenness (E) was found to be 3.1-3.5; 2.9-4.9 and 0.7-0.9 (Figure 4).

Table 2: Fish species composition and their relative contribution to the total faunal population recorded in each season from Reju Khal estuary, southeastern Bangladesh (Win., winter; pre-mon., pre-monsoon; mon., monsoon).
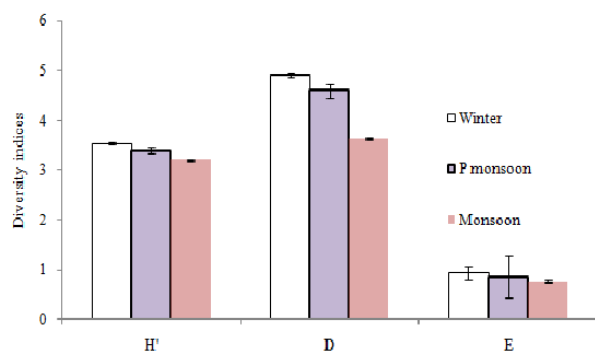
Figure 4: Diversity indices, Shannon–Wiener diversity index (H′), Margalef richness (D) and species Evenness (E) recorded during present study. Values are mean ± standard error; n=3.

Marked differences were found in Margalef species richness (F=6.19; P=0.03), species evenness index (F=22.55; P<0.001), however Shannon–Wiener diversity index did not show marked differences among seasons (F=4.94; P=0.53). SIMPER revealed that *S. indicus* (6%) was the most contributory species followed by *M. cephalus* (5.8%) and *M. gulio* (5.7%). The highest contributory species during the pre-monsoon season was *S. indicus* (6.0%) followed by *B. viridis* (5.4%) and *M. cephalus* (5.3%). During winter, the highest contributory species was *Escualosa* sp. (4.3%) followed by *E. thoracata* (4.3%) and *S. indicus* (4.0%). For monsoon season, highest contributory species was *Escualosa* sp. (8.0%) followed by *M. cephalus* (7.7%) and *R. asper* (7.7 %) (Table 3).

Table 3: Results of SIMPER showing the most contributory species considering total course of study and each seasonal sample.

Species	Average Abundance	Average Similarity	Contribution (%)	Cumulative Contribution (%)
Total course of study				
S. indicus	1.78	4.52	6.05	6.05
M. cephalus	1.67	4.34	5.8	11.85
M. gulio	1.66	4.28	5.72	17.57
L. tade	1.66	4.28	5.72	23.3
B. viridis	1.63	4.24	5.67	28.97
R. asper	1.59	3.92	5.24	34.21
T. nilotica	1.44	3.48	4.66	38.87
G. filamentosus	1.16	2.96	3.96	42.83
Escualosa sp.	1.43	2.73	3.65	46.47
E. thoracata	1.40	2.62	3.51	49.98
E. fusca	1.03	2.40	3.21	53.19
Each sample times				
Winter (average similarity 91.19%)				
Escualosa sp.	1.91	3.96	4.34	4.34
E. thoracata	1.9	3.94	4.32	8.66
S. indicus	1.84	3.64	3.99	12.65
Gobius sp.	1.72	3.56	3.9	16.55
L. tade	1.69	3.53	3.87	20.42
M. cephalus	1.68	3.52	3.86	24.29
M. gulio	1.67	3.49	3.83	28.12
B. viridis	1.58	3.16	3.47	31.58
R. asper	1.54	3.15	3.45	35.03
S. kuhli	1.51	2.94	3.23	38.26
P. lanceolatus	1.39	2.85	3.12	41.38
A. lanceolatus	1.32	2.74	3.10	44.38
Sillago sp.	1.28	2.64	2.90	47.28
A. melanoptera	1.32	2.64	2.89	50.17

Species	Ave. Abund	Ave. Simil	Cont. (%)	Cumul. Cont. (%)
Pre-monsoon (average similarity; 81.74%)				
S. indicus	1.76	4.97	6.09	6.09
B. viridis	1.58	4.4	5.38	11.47
M. cephalus	1.53	4.32	5.28	16.75
L. tade	1.49	4.27	5.23	21.97
M. gulio	1.54	4.19	5.12	27.1
T. nilotica	1.41	3.78	4.62	31.72
R. asper	1.39	3.51	4.29	36.01
J. vogleri	1.19	3.28	4.01	40.02
C. malabaricus	1.13	3.22	3.94	43.97
Gobius sp.	1.19	3.22	3.94	47.91
M. cordyla	1.17	3.19	3.90	51.81
Monsoon (average similarity; 75.09 %)				
*Escualosa*sp.	1.89	6.02	8.01	8.01
M. cephalus	1.79	5.81	7.74	15.75
R. asper	1.84	5.8	7.72	23.47
L. tade	1.79	5.72	7.61	31.09
T. nilotica	1.77	5.71	7.61	38.69
B. viridis	1.73	5.47	7.29	45.98
M. gulio	1.75	5.43	7.24	53.22

3.4 Fish assemblages: seasonal variations

Marked differences were found in fish assemblages among different seasons confirmed by ANOSIM (Global R=0.54; P=0.001; Table 4). Results of the SIMPER disclosed *Escualosa* sp. as the major discriminating species between monsoon and pre-monsoon season. *S. kuhli* was the major discriminating species between monsoon and winter. Further, between winter and pre-monsoon *Escualosa* sp. was the main discriminating species (Table 4).

Table 4: Outcomes of ANOSIM and SIMPER for the fish assemblages recorded from the Reju Khal estuary, Southeastern Bangladesh.

| ANOSIM (Global R=0.54; P=0.001)			SIMPER		
Season	R	P	Average Dissimilarity	Species	Contribution (%)
Monsoon vs. Pre-mon	0.70	0.05	33.17	*Escualosa* sp.	6.40
				E. thoracata	5.57
				H. georgii	4.67
				S. argus	4.32
Monsoon vs. Winter	0.70	0.05	28.9	*S. kuhli*	6.69
				Sillago sp.	5.72
				S. ruconius	5.69
				A. melanoptera	5.21
Winter vs. Pre-mon	0.41	0.05	21.48	*Escualosa* sp.	8.05
				S. argus	7.70
				E. thoracata	7.54
				H. georgii	5.58

Marked seasonal differences of the faunal populations were also confirmed from the outcome of the nMDS and HCA. The HCA generated from the species assemblage data revealed three distinct groups, first one comprised of the assemblage captured in the winter, the second one comprised of pre-monsoon and the third one comprised of pre-monsoon and monsoon (Figure 5a). The outcome of outcome of nMDS also suggests three distinct group such as faunal population recorded during the winter (marked as circle), pre-monsoon (marked as cross) and monsoon (marked as star) (Figure 5b). The result of ANOSIM was also consistent with the outcomes of both nMDS and HCA (Figure 5a and 5b).
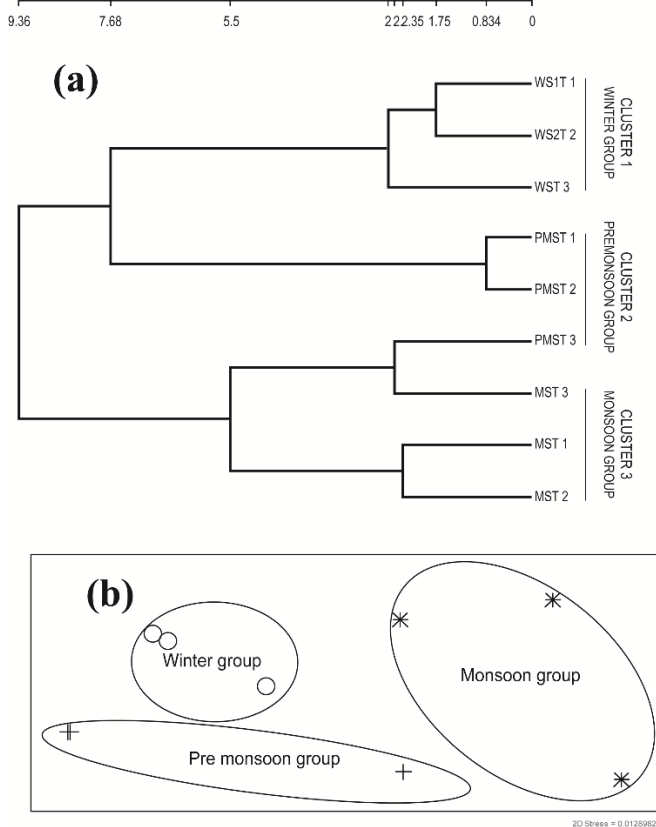
Figure 5: (a) Hierarchical cluster analysis and (b) non-metric multidimensional scaling (nMdS) plot of the faunal assemblages [log10(x + 1)] using Bray-curtis similarity matrix at the study area [legend for cluster analysis; W=winter; PM= pre-monsoon; M=monsoon; n1, n2 and n3 =Net 1, 2 and 3 and for nMDS, Winter., circle; Pre-monsoon., cross; Monsoon., stars; 2D stress=0.013]

3.5 Fish assemblages: relation with hydrobiological factors

The results of the canonical correspondence analysis (CCA) revealed that, CCA eigen values of the first two axes were 0.003 (CCA1; P=0.08) and 0.0009 (CCA2; P=0.09). The first canonical axes were accounted for 70.12% and together with the second axes accounted for 91.66% of the variance in the species abundance was explained by the environmental variables. The length of the environmental variables represented the relative importance of environmental gradient in the abundance of the major contributory fish species (Figure 6).
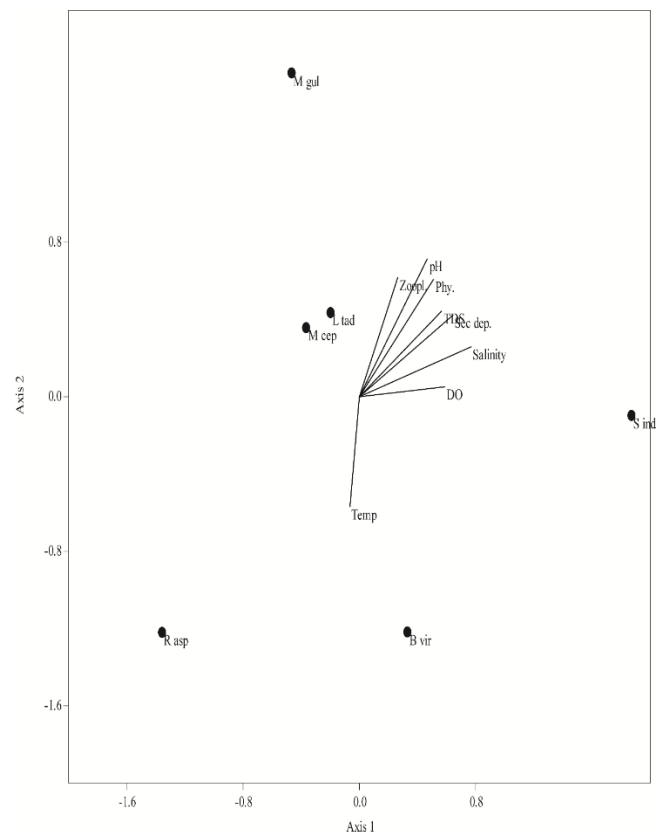
Figure 6: Canonical correspondence analysis (CCA) of the faunal population contributed >5% in relation to hydrobiological factors recorded during the present study (S ind., *S. indicus*; M cep*., M. cephalus;* M gul., *M. gulio;* L tad*., L. tade;* B vir*., B. viridis*., phy., phytoplankton; zoopl., zooplankton).

In the CCA model salinity (eigen value; 0.89) and secchi depth (eigen value; 0.90) and phytoplankton abundance (eigen value; 0.87) were highly correlated with the first ordination axis and represent the most important physico-chemical factor related to abundance of fisheries resources in the Reju Khal estuary.

4. DISCUSSION

Although Reju Khal estuary is among the major estuarine systems in the south eastern coastal region of Bangladesh, studies on the water characteristics together with the fish diversity are relatively less. The present study will provide a baseline for future research while exploring the fish fauna and relationship of water characteristics with the abundance of fish populations.

Based on a study, water temperature is an important factor influencing marine life [40]. In the Reju Khal estuary the range of the water temperature varied from 16°C (winter) to 28°C (pre-monsoon); the recorded temperature is not optimum (range 22- 31°C) for the growth of the fish [41]. Generally, surface water temperature of a water body is clearly correlative to the air temperature of that site. Besides, in the estuary surface water temperature is regulated by the tidal cycles and/or fresh water input from the upstream [42]. The observed pH value (7-8) of the Reju Khal estuary is within the limit recommended (6.5- 9.20) by the WHO [43] . Generally, DO concentrations of the estuary reflect the physical and biological process of the water. Dissolve oxygen concentration ranged between 3 to 4 mg/L which is consistent with previous studies in the same estuary and in Meghna river estuary in Bangladesh [44]. The obtained DO level was lower than the minimum recommended standard (5 mg/L) set by EPA Redbook [45]. Relatively low level of DO can be explained by the fact that the estuarine area receives high load of organic material coming from the nearby agriculture field of upstream areas, which needs high amount of oxygen for consequent decomposition.

According to a study, the sechi depth is a common parameter in aquatic productivity studies [46]. It measures transparency of the water and believed that the parameter is inversely proportional to the photosynthatically active radiation (PAR). Studies suggest that sechi depth has negative exponential relationship with the abundance of the

phytoplankton. This is because phytoplankton abundance and their decomposed materials decrease the water transparency. The reported sechi depth for this study (21-39 cm) was similar with that recorded from the same estuary 45-21 cm and Meghna estuary, Bangladesh 40-26 cm [47]. Lowest value (21 cm) of transparency depth was found during monsoon may be associated with the high amount of suspended particulate matter (SPM) from upstream areas. Based on the study carried out in the UK marine waters, have been suggested that sechi depth is more practical in clearer coastal waters with low concentrations of SPM, and therefore may not be feasible for the turbid estuarine water [48].

Based on recent studies, marked seasonal differences in hydrobiological factors is the striking features of the tropical and subtropical estuaries [49]. Consistent with the previous literatures our data set also suggest significant seasonal variation among season (Table 1). Studies reported that estuarine water characteristics are regulated by many factors including quality and quantity of fresh water inflow, biogeochemical process, evaporation process and exchange of seawater and fresh water [50].

The present study recorded 36 species of fin fish that have already been reported from the coastal waters of Bangladesh. A researcher recorded 21 species of finfish from Bakkhali estuary, while found 46 species in Karnaphulli estuary, and another researcher found 53 species in Meghna estuary [51]. However, number of species found in these estuaries is much lower than that reported from Naaf estuary (98 spp.). In the coastal waters of Bangladesh, a total of 152 species of finfish were recorded in the ESBN catch [52]. Therefore, all these estuaries comprised only a part of the total estuarine species and the species diversity and composition differed among estuaries. Some reports suggested that the number of faunal species recorded in the estuary is related to the size of estuary with larger systems generally having higher species diversity [53]. Besides, differences in the estuarine characteristics such as abiotic factors, geomorphology, amount of fresh water input, water depth are reported to be the influencing factors for the distribution of the species assemblages in the estuarine systems. However, sampling procedure, net type, human activities and sampling time must also be considered while this type of comparison is ascertained.

The present study revealed that Engraulididae was the most contributory family (Table 2), which is a common phenomenon in case of the tropical and subtropical estuaries and coasts [54]. Besides, results of the SIMPER suggested that species in Mugilidae such as *M. cephalus* and *L. tade* are among the dominating species (over 5% in the overall population; Table 3). Mugilids are opportunistic or cycle migrants, habituated with a wide variety of physico-chemical factors and they enter into the estuarine systems as nursery habitats and after onset of their sexual maturity they return back to the sea. The higher abundance of the Mugilids is also reported in the different estuarine systems of both north and southern hemisphere [55]. Another dominating fish species of the estuary is *Mystus* sp. This cat fish species is a euryhaline species occurring mostly in freshwater but also have been reported from the low salinity environments. Many reports suggested their geographical distribution in the Southeast Asian countries [56].

According to a research, seasonality in fish assemblages is a general characteristic of estuarine and coastal waters [57]. As expected, fish assemblage of the Reju Khal estuary also followed seasonal pattern (Table 4 and Figure 4). Seasonality is responsible for fluctuation of hydrological and meteorological parameters which in turn influence the fish assemblage in estuaries [58,59]. Seasonality also affects the spawning activity of fish and which ultimately influence in catch composition. Fish species diversity and population abundance was found to be highest in winter which is consistent with earlier studies of fish assemblages in similar habitats in Bangladesh. Similar results also reported from European and Asian estuaries [60-62].

The present study illustrated the relationship between species abundance and hydrobiological factors by CCA model. A group of researchers reported that in the CCA model species that are plotted close to the vector consider to be in strong correlation with them [63]. However, species plotted close to the origin may not have strong relationship with any of the studied environmental factors. Many previous studies related to estuarine fisheries assemblages illustrated the relationship between environmental factors and community assemblages. Consistent with the mentioned studies, results of the CCA model in the present study explained that

temperature, salinity, transparency and phytoplankton seem to have strong correlation with the variability of the species assemblages. One previous study has been reported that salinity is one of the most limiting factors in the distribution of fisheries assemblages from the Uruguayan estuaries [64]. They confirmed the interrupted recruitment pattern of the faunal assemblages in the studied habitat. In addition to that, they speculated that increase in the salinity level during the winter season may increase the number of marine migrant species in the estuaries.

Results of the present study indicated that significant positive correlations between water transparency (secchi depth) and abundance of estuarine assemblages confirmed by CCA. Marked positive relationship between turbidity and faunal assemblages have been well documented by many previous studies carried out in the laboratory and field investigations of estuarine coastal systems elsewhere [65-67]. Fish egg survival, hatching success, larval growth and population characteristics have been reported to be influenced by high turbid water. In addition to that, a group of researchers reported that larval fish/juvenile prefer turbid water to avoid predator bird and telosts [68]. Similar observation has been reported in the literature of Whitfield (1999). In addition to that, positive correlation between phytoplankton population and fish abundance that observed during present study is well supported by previous investigations carried out for the fish communities in southwest Finland [69]. Based on previous studies, usually fish larvae depend largely on the small prey such as phytoplankton and therefore, fish production is highly depends on the phytoplankton production [70-71].

5. CONCLUSION

Based on the present observation, water characteristics of the estuary indicate low concentration of DO, suggesting the presence of organic materials in the estuarine areas from the upstream areas. Proper management is recommended to overcome this problem. Besides, Reju Khal estuary support diversified ichthyofaunal assemblages. Fish assemblages of the estuary were distributed with the high abundance of three species, *S. indicus, L. tade* and *M. gulio.* These species seem to use this shallow habitat as nursery, feeding and breeding ground. The study represents a baseline for fish assemblages and water characteristics for local stake holders and government agencies associated with the coastal and conservation management on Bangladesh.

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