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Assessment of fish diversity in Shatghari point of Surma River, Golapgonj, Sylhet, Bangladesh

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Abstract
A quest was conducted to assess the status of fish diversity in Shatghari point of Surma river, Golapganj, Sylhet from January 2015 to September 2015. Multivariate analyses were performed using the software PRIMER V_6 and Canonical Correspondence Analysis (CCA) was done using the PAST software. In the present study, 34 species of fishes belonging to 7 orders were identified from the study area where Cypriniformes (11 species) encompassing highest percentage (76.56%) of the whole biomass. The Shannon-Wiener diversity index, Margalef richness index, Pielou's evenness index and Simpson dominance index were found to be 2.31±0.69, 3.86±0.31, 0.46±0.03 and 0.88±0.007 respectively. Among the identified fish species, 44.63% were recorded as threatened according to IUCN and 5.49% were exotic species in respect of number. Top most 14 fish species were considered for CCA and it's indicate that, two most important environmental parameters CO_2 and TDS are shaping species assemblage structure in Surma River at Shatghari point. All the water quality parameters found within the permissible limits for fishes. In epilogue, bearing all the outcomes found in the study indicates that, the Shatghari Point of Surma River is enriched with fish diversity.

Keywords: Threatened species, Diversity index, Water quality parameters, Fish assemblage, Surma River

1. Introduction
Bangladesh is a small riverine country situated in the South East Asia of the world. It is blessed with vast water resources in the form of ponds, natural depressions (*haors* and *beels*), lakes, canals, rivers and estuaries. There are about 46,99,387 hectares inland waters which consists of 39,16,828 hectares open water and 7,82,559 hectares closed water bodies. Marine water contain 1,66,000 km^2 in the Bay of Bengal [4].

Inland water resource of Bangladesh is measured to be one of the richest in the world and potential for fisheries development. At present Bangladesh is ranked 4th in aquatic biodiversity in Asia and abundant with freshwater and marine water resources comprised of 260 indigenous species and 12 exotic species, prawn 24, shrimp 36 and 475 marine species [4]. The freshwater bodies of Bangladesh are considered a home to at least 265 species of fin fishes [18].

Fish production in inland water is decreasing day by day due to over exploitation of fish resources with increasing population pressure, the adverse effect of flood control structures on the fish habitat, filling of river bottoms by siltation, fishing by nets made of synthetic monofilament fiber (current nets), use of over dosages of fertilizers and insecticides in agricultural lands, indiscriminate fishing, industrial pollution etc. Among 260 freshwater fish species 56 species are critically endangered, endangered or vulnerable [8]. The average annual rate of growth of the fisheries sector is 6.15% over the last 10 years [15]. Major sources of fish production in the past were the inland open waters which contributes more than 90% of the country fish production and the remaining came from fresh water aquaculture and marine fisheries. But in recent years, however, the availability of several fish species has declined, and many are thought to be critically endangered. Now a day's siltation has threatened the existence of most of the river. Other reasons are uncontrolled use of chemicals, fertilizers and insecticides, destruction of natural breeding and feeding grounds, harvesting of wild brood fishes [2].

IUCN Red list (2003, Bangladesh) revealed 54 threatened freshwater species in Bangladesh of which 12 are critically endangered, 28 are endangered and 14 are vulnerable [9]. IUCN Red List (2000) revealed 54 threatened species of fishes in Bangladesh, some of them are: Grey feather back (*N. notopterus*), Freshwater eel (*A. bengalensis*), Snakeheads (*C. marulius*, *C. barca* and *C. orientalis*), Darkina (*R. rasbora*), Bhagna (*L. boga*), Olive barb (*P. sarana*), Baghair (*B. bagarius*), Bacha (*E. vacha*), Tara baim (*M. aculeatus*), Napit koi (*B. badis*). Those threatened species are commonly found in the study area.

Sylhet occupies the North East part of Bangladesh and is blessed with freshwater aquatic biodiversity, because a large freshwater basin geographically located in this region. Sylhet basin is a freshwater region; as a result, the commercially important freshwater fish species are more available in this region. For our research purpose, we have selected the Surma River at Shatghari point which is being used as a breeding ground (on the basis of availability of fish seeds) for a lot of fishes, which can be a valuable assets in case of providing the huge fish demands for the country. There was no documentation on biodiversity of Shatghari point of the Surma River. So the crux of the present research was to find out the diversity of fishes, seasonal variation and water quality which has a greater influence on fish.

2. Methodology

The research was accomplished in greater Sylhet region (Fig. 1). The sampling station was selected in SurmaRiver at Shatghari point, Sylhet.

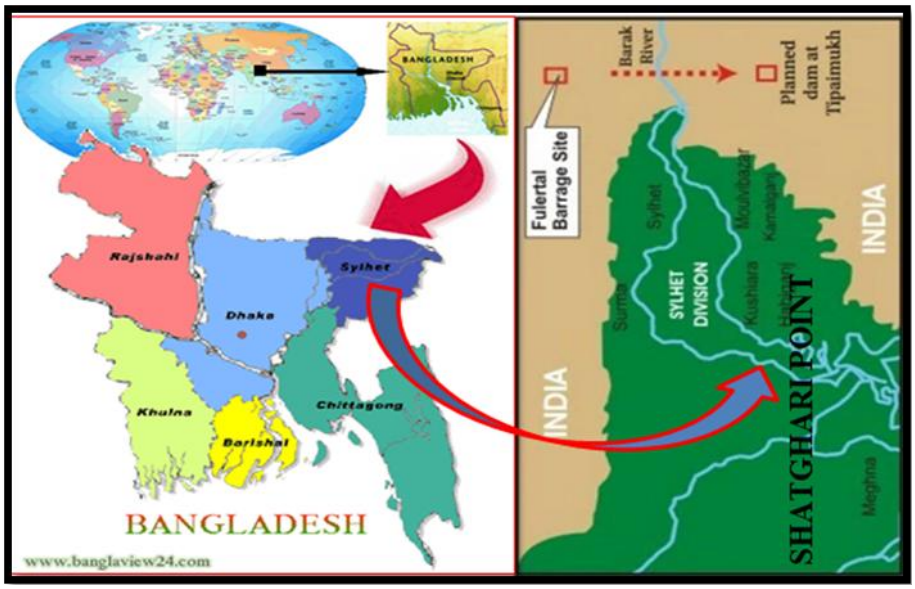

Fig 1: Map showing study area in Surma River at Shatghari Point, Sylhet.

The study was conducted for a period of nine months from January 2015 to September 2015. According to Indian Meteorological Department, the year was divided into four seasons- winter (December-March), summer (April-June), monsoon (July-September) and post-monsoon (October-November). Sampling was done on the basis of questionnaire interview with fishers on monthly basis for fish diversity assessment to delineate the veritable population configuration. Water quality parameters were assessed monthly *in situ*. Exactly 10 parameters were assessed of the study area namely- Water temperature (°C), transparency (cm), pH, DO (mg/l), CO_2 (mg/l), ammonia (mg/l), TDS (mg/l), nitrite (mg/L), hardness (mg/l) and chloride (mg/l). Data of other three parameters-air temperature, relative humidity and rainfall were collected from Bangladesh Meteorology Division, Sylhet Branch. The water quality parameters were assessed *in situ* monthly interval between 8.30 AM to 12.00 AM on each sampling day throughout the entire study period. Titration methods were done by using HACH Test Kit (Model: FF-2, Cat No. 2430-01). In the present study, diversity of fish species were evaluated by dint of Shannon-Wiener index (*H'*) (Shannon, 1949; Shannon and Weaver, 1963; Ramos *et al.*, 2006), species richness by Margalef index (*d*) (Margalef, 1968), evenness by Pielou's index (*J'*) (Pielou, 1966), and dominance by Simpson index through the following formula:

Shannon-Weaver diversity index (*H'*)

***H'* = - *Sum*[*pi* x log (*pi*)]** Where, H' = Shannon Wiener index**,** Pi = ni/N**,** ni = no. of individuals of a species**,** N = Total number of individuals

Margalef species richness (*d*)

d* = *(S-1)/log (N) Where, S = Total species**,** N = Total individuals.

Pielou's evenness index (*J'*)

$$(J') = \frac{H(s)}{H(max)}$$

Where, H (s) = the Shannon-Wiener information function, H (max.) = the theoretical maximum value for H(s) if all species in the sample were equally abundant.

Simpson dominance index (*c*)

$$C = \sum_{i=1}^{s} (ni/N)_2$$

Where, ni = number of individuals in the 'each' species, N = total number of individuals, S = total number of species

A one-way analysis of variance (ANOVA) was used to test for significant difference in environmental variables and

diversity indices among the seasons. For ANOVA test SPSS software V15.0 (Statistical Package for Social Sciences) was used. All the multivariate analyses were performed by the software PRIMER V_6 (Plymouth Routines Multivariate Ecological Research) (Clark and Warwick, 1994).
Canonical correspondence analysis (CCA) was used to investigate the relationship between species assemblage composition and environmental variables. PAST (Paleontological Statistics) version 2.16 was used to perform CCA.

3. Results and Discussions

3.1 Fish assemblage

In the present investigation 34 species of fishes belonging to seven orders were identified from the study area (Table 2). The governing order was Cypriniformes (11 species) encompassing 76.56% of the whole biomass followed by Siluriformes (6 species) 15.71%, Perciformes (7species) 3.54%, Synbranchiformes (3 species) 3%, Beloniformes, (1 species) 0.89%, Clupeiformes, (1 species) 0.21%, and Decapoda, (1 species) 0.03% (Fig. 3). Total individuals under each species were used to find out the dominancy of each species in the study area. From the (Table 2) it is seen that, Mola (*Amblypharyngodon mola*) covers the highest percentages 59.46% followed by Tengra (*Mystus vittatus*) comprising 8.88% of the total biomass.

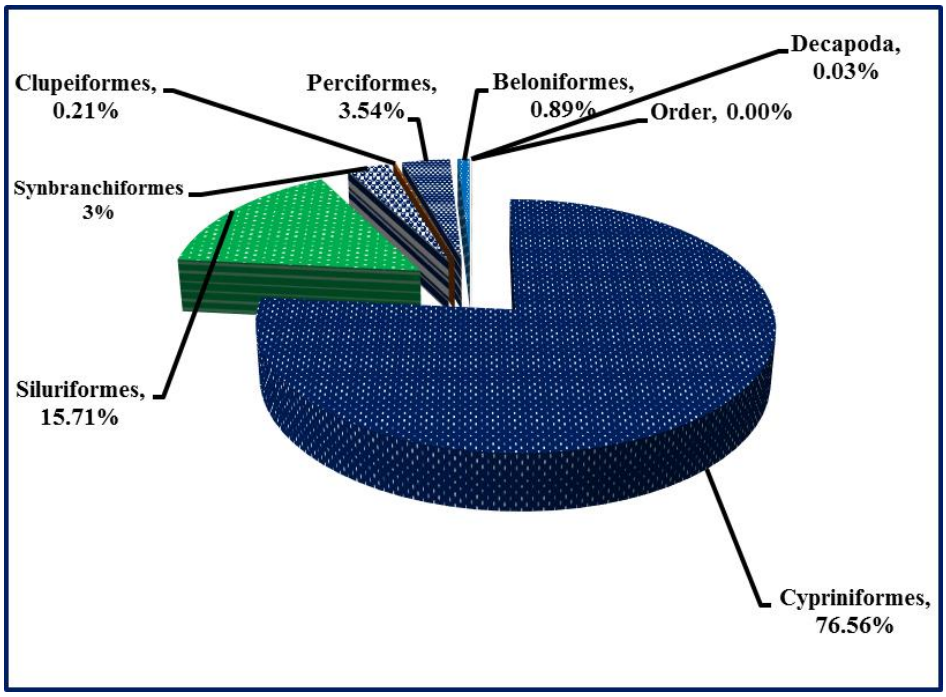

Fig 3: Fish assemblage in Surma River at Shatghari Point, Sylhet

3.2 Fish species diversity indices

3.2.1 Shannon-Weaver diversity index (H')

The mean Shannon-Weaver diversity index (H') oscillated from 1.795 (in summer) to 2.575 (in winter) with a yearly mean value of 2.31±0.69 (Fig. 4). No significant difference was observed among the seasons (F= 1.308; P = 0.338)

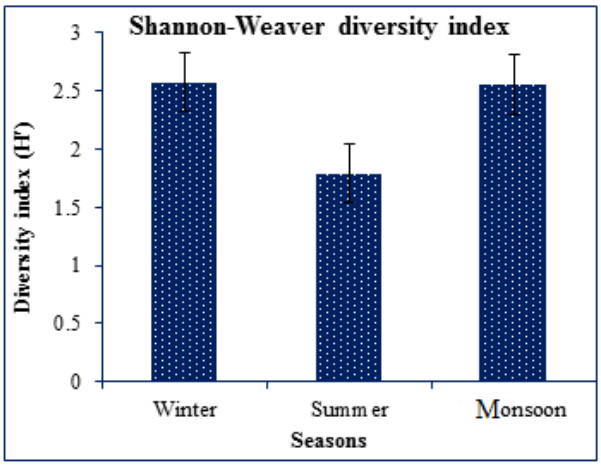

Fig 4: Shannon-Weaver diversity index (H′) in seasons

3.2.2 Margalef richness index (d)

The tiniest mean Margalef richness index was witnessed in summer 3.519 and utmost in monsoon 4.038 with yearly mean value of 3.86±0.31 (Fig. 5).Significant difference was observed among the seasons (F= 6.699; P = 0.030).

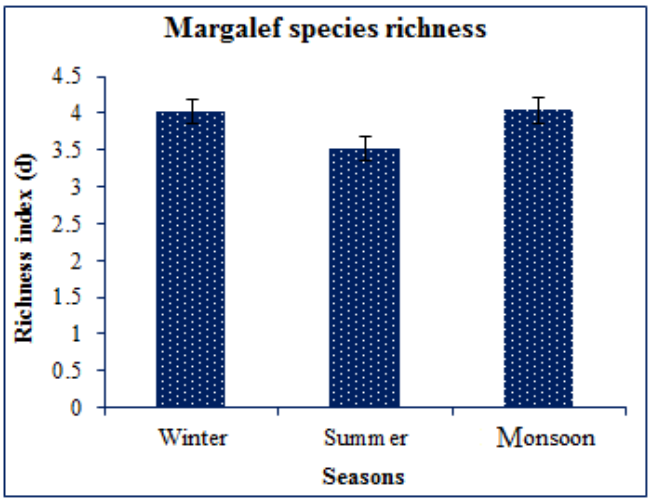

Fig 5: Margalef species richness (d) in seasons.

3.2.3 Pielou's evenness index (J')

The minimum mean evenness value 0.44 was documented in winter and maximum 0.47 in summer with a yearly mean

value of 0.46±0.03 (Fig. 6). No significant difference was observed among the seasons (F= 0.882; P = 0.461).

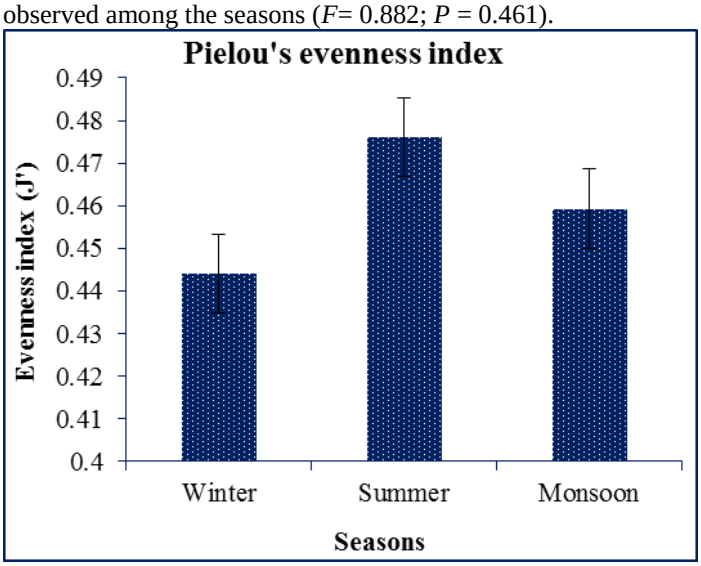

Fig 6: Pielou's evenness index (J') in seasons.

3.2.4 Simpson dominance index (c)

The maximum mean dominance value 0.889 was observed in winter and lowest 0.886 in monsoon with a yearly mean value of 0.88±0.007 (Fig. 7).No significant difference was observed among seasons (F= 1.568; P = 0.283).

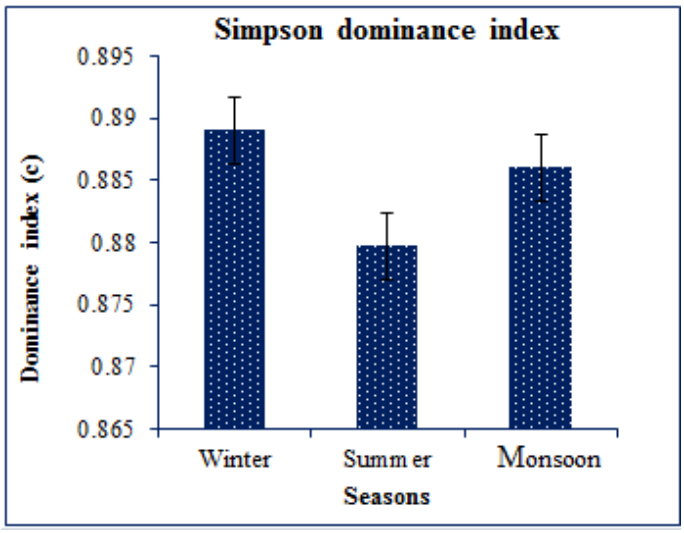

Fig 7: Simpson dominance index (c) in seasons.

The degree of pollution was assessed and revealed (Table 1) along with values based on the assortment of the Shannon-Weaver diversity index as recommended by Biligrami (1988). All the seasons showed values ranging from 1.795-2.575 representing moderate to light pollution. The results suggesting that, the overall condition of the water bodies of Sylhet region is found to be good. However, government and NGOs intervention for conserving theses endangered species *in situ* will be very helpful for the use of future generation.

Table 1: Shannon-Weaver diversity index (H') and pollution level given by Biligrami (1988).

Shannon-Weaver Diversity index(H')	Pollution level	Winter	Summer	Monsoon
3.0-4.5	Slight			
2.0-3.0	Light	2.575		2.552
1.0-2.0	Moderate		1.795	
0.0-1.0	Heavy			

Patra (2011) documented seven catfish species from Karala River and the species diversity index of different sampling sites ranged from 1.04 to 1.218. The evenness index at three sapling stations (SI = 0.947, SII = 0.707 and SIII = 0.879) indicates uneven distribution of catfishes in this tributary. The present finding showed higher species diversity along with maximum species richness compared to Karalla River. Bashar [3] observed 18 catfish species under 6 families**.** The evenness index value derived from the present study also indicated the even distribution of fish species in the study area which ranges from 0.44 to 0.47. The species richness was obtained highest in summer season 3.519 followed by monsoon 4.038. The uppermost mean dominance value was 0.889 observed in winter and lowest 0.879 in summer.

There were no big differences among the dominance values of the study area. The endangered fish species diversity, richness, evenness and dominance of the study area were not found satisfactory may be due to the presence of an unknown factor. On the other hand, it can also be the results of overfishing during the breeding seasons of these fish species. So it is felt the needs to conserve these species in situ by adopting some stringent rules and regulations for saving these valuable fish species by creating awareness among the illiterate fishermen.

Table 2: List of different fish species with their family name, scientific name, common name, local name, total number of individuals and percentages (%).

Order	Family	Scientific name	Common name	Local name	Monthly Average Individuals	Individual Based Percentage	Order %
Cypriniformes	Cyprinidae	*Catla catla*	Indian major carp	Catla	8.11	0.41	76.56
		Cirrhinus cirrhosis	Indian major carp	Mrigal	11.89	0.60	
		Cyprinus carpio	Common carp	Carpio	5	0.25	
		Labeo calbasu	Black rohu	Kalibaush	2.22	0.11	
		Labeo rohita	Indian major carp	Rui	8.78	0.44	
		Amblypharyngodon mola	Molacarplet	Mola	1168.89	59.46	
		Puntius ticto	Ticto barb	Tit punti	77	3.91	
		Puntius sarana	Olive barb	Sarpunti	4.44	0.22	
		Puntius sophore	Spot fin swamp barb	Jatpunti	37.78	1.92	
		Osteobrama cotio	Cotio	Dhela	22.88	1.16	
		Esomusdanricus	Gangeticrasbora	Darkina	121.66	6.18	
	Cobitidae	*Lepidocephalichthys guntea*	Guntea loach	Gutum	36.33	1.84	

Siluriformes	Bagridae	*Sperata aor*	Long-whiskered catfish	Ayre/Aor	1.22	0.06	15.70
		Mystus tengra	Stripped dwarf catfish	Bujuri Tengra	125.78	6.39	
		Mystus vittatus	Striped dwarf catfish	Tengra	174.67	8.88	
	Siluridae	*Wallago attu*	Freshwater shark	Boal	3.22	0.16	
		Ompok pabda	Pabdah catfish	pabda	2.56	0.13	
	Chacidae	*Chaca chaca*	Indian chaca	Cheka	1.33	0.06	
Synbranchiformes	Mastacembelidae	*Mastacembelus pancalus*	Striped spiny eel	Guchibaim	26.11	1.32	3.05
		Macrognathus aculeatus	One striped spiny eel	Tara baim	27.33	1.39	
		Mastacembelus armatus	Tire-track spiny eel	Shalbaim	6.67	0.33	
Clupeiformes	Clupeidae	*Gudusia chapra*	Indian river shad	Chapila	4.11	0.20	0.20
Perciformes	Channidae	*Channa punctatus*	Spotted snakehead	Taki	9.22	0.46	3.53
		Channa striatus	Snakehead murrel	Shol	1.89	0.09	
	Gobiidae	*Glossogobius giuris*	Bar eyed goby	Bele	19.67	1.00	
	Osphronemidae	*Colisa fasciatus*	Striped gourami	Kolisha	6.63	0.33	
	Anabantidae	*Anabas testudineus*	Climbing perch	Koi	1.33	0.06	
	Ambassidae	*Parambasis ranga*	Rangachanda	Lalchanda	16.44	0.83	
	Chandidae	*Chanda nama*	High fin glassy perchlet	Lambachanda	14.33	0.72	
Beloniformes	Belonidae	*Xenentodon cancila*	Fresh water gar fish	Kakila	17.56	0.89	0.89
Decapoda	Palaemonidae	*Macrobrachium rosenbergii*	Prawn	Golda	0.67	0.03	0.03

3.3 Canonical correspondence analysis (CCA)

Canonical correspondence analysis provided insight into the relationship between the fish assemblage and environmental variables (Marshall and Elliott, 1998) showed in Fig. 8. For CCA the top most 14 fish species were considered (Table 3). The length of vector of a given variable on the CCA plots reveals the significance of that variable. Species plotted closer to the vector have stronger relationship with them. The CCA ordination indicates CO_2 and TDS are two most important environmental parameters shaping species assemblage structure in Surma River at Shatghari point than the other variables.

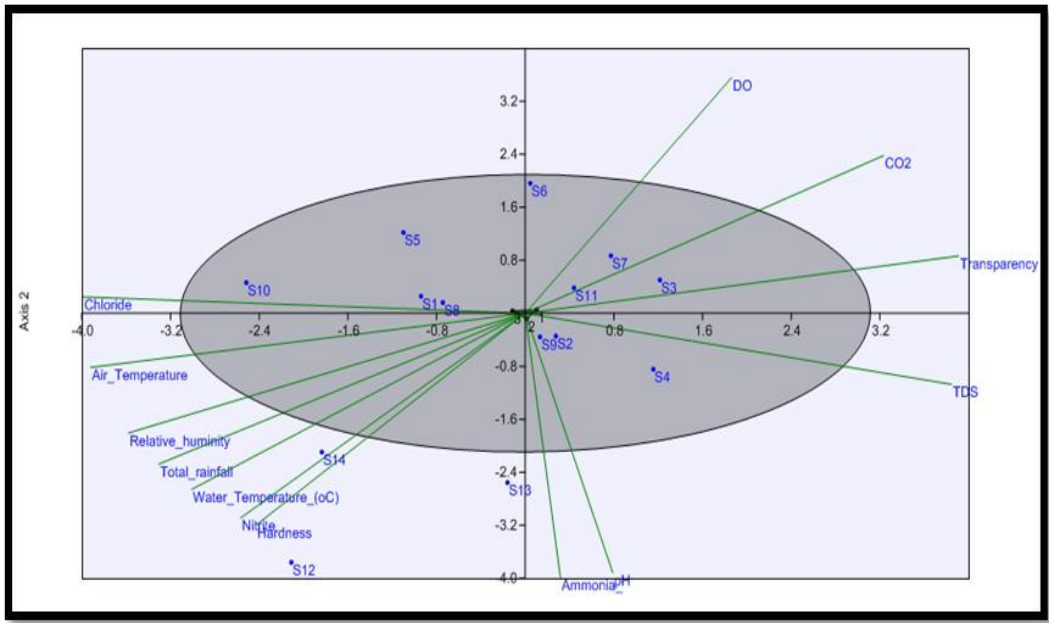

Fig 8: CCA showing relationship of environmental variables with fishes.

Salinity is strongly allied with distribution of estuarine fish communities as reported by many authors (Marshall and Elliott, 1998; Selleslagh and Amara, 2008). But from the present study in Surma River (freshwater) the CCA ordination plot revealed that *Mystus vittatus*, *Mystus tengra* and *Mastacembelus pancalus* has the highest level of TDS preference than the other parameters. On the other hand, *Esomus danricus*, *Puntius sophore* and *Osteobrama cotio* has the highest level of CO_2 preference than the other parameters, and *Lepidocephali chthysguntea* was only dominated by DO.Other parameters like chloride, air temperature, relative humidity, total rainfall, Water temperature, nitrate and hardness found to be no influence on the distribution of those available fishes.The species like *Puntius ticto*, *Macrognathus*

aculeatus and *Xenentodon cancila* found to be not influenced by any of these parameters.

Table 3: Top fourteen fishes in terms of individuals are used for CCA.

Scientific Name	Local Name	Indications	Winter (1)	Summer (2)	Monsoon (3)
Amblypharyngodon mola	Mola	S1	15.94	17.60	19.78
Mystus vittatus	Tengra	S2	17.92	19.20	17.24
Esomus danricus	Darkina	S3	13.94	12.37	10.79
Mystus tengra	BujuriTengra	S4	13.59	14.41	10.75
Puntius ticto	Tit punti	S5	7.50	7.31	9.40
Lepidocephalichthys guntea	Gutum	S6	4.03	3.1	3.94
Puntius sophore	Jatpunti	S7	4.25	3.71	3.61
Macrognathus aculeatus	Tara baim	S8	2.62	2.87	3.12
Mastacembelus pancalus	Guchibaim	S9	2.64	2.87	2.63
Xenentodon cancila	Kakila	S10	1.42	1.79	2.46
Osteobrama cotio	Dhela	S11	2.46	2.35	2.26
Parambasis ranga	Lalchanda	S12	1.04	2.39	2.01
Glossogobius giuris	Bele	S13	1.74	2.59	1.93
Chanda nama	Lambachanda	S14	1.07	1.84	1.76

3.4 Physico-chemical parameters

The limnological parameters such as water temperature, transparency, pH, DO, Chloride, Ammonia, Total hardness, CO_2, TDS, Nitrite were determined. The determined value of these parameters is shown in the table 4. The surface water temperature was varied from 21.87 °C (winter) to 30.68 °C (summer) with a total mean value 27.46±5.11 °C and DO ranged from 5.7 (in summer) to 8.48 mg/L (in winter), with a total mean value of 7.037±1.30 mg/L. Significant difference was observed among the seasons for the both parameters. On the other hand, transparency varied from 18.01cm (in monsoon) to 48.57cm (in winter) with a total mean value of 32.38±13.46 cm, pH ranged from 7.3 (in monsoon) to 7.47 (summer) with a total mean value of 7.36±0.23, chloride varied between 39.33 (in winter) to 45.13 mg/L (in summer) with a total mean value of 41.93±10.82, ammonia varied from 0.0067 (in monsoon) to 0.024 (in summer) with a total mean value of 0.012±0.018 and 0.51±0.09 respectively, hardness documented 78.77 mg/L during summer and lowest value was 55.07 mg/L during winter with a total value of 68.57±12.95 mg/L, CO_2 oscillated from 3.077 (in monsoon) to 4.1 mg/L (in winter) with a total mean value of 3.43±0.65 mg/L, TDS oscillated from 90.67 (in monsoon) to 96330 mg/L (in winter) with a total mean value of 94.17±8.12 mg/L, Nitrite ranged from 0.006 (in winter) to 0.008 mg/L (in summer) with a total mean value of 0.007±0.007 mg/L. No. significant difference was observed among the seasons.

Table 4: Limnological parameters measured in the study area.

Water quality Parameters	Winter	Summer	Monsoon	Level of significant
Water Temperature (^{0}C)	21.87±5.66	30.68±9.55	29.83±9.28	*
Transparency (cm)	48.57±3.61	30.57±16.44	18.01±15.32	NS
pH	7.32±0.24	7.47±2.71	7.3±2.45	NS
DO (mg/l)	8.48±0.67	5.7±2.84	6.93±2.48	*
CO_2 (mg/l)	4.1±0.36	3.13±0.66	3.077±1.06	NS
Ammonia (mg/l) (NH_3)	0.0062±0.004	0.024±0.02	0.0067±0.02	NS
TDS (mg/l)	96.33±13.50	95.5±32.30	90.67±30.02	NS
Nitrite (mg/l)	0.006±0.006	0.008±0.005	0.0076±0.006	NS
Hardness (mg/l)	55.07±8.44	78.77±26.20	71.87±24.07	NS
Chloride (mg/l)	39.33±13.32	41.33±13.21	45.13±15.10	NS

Note: NS= Not significant, *= P≤ 0.05 of significant

The present findings are congruent with the findings of Yadav [20] Ganga river, Ghazipur, Iqbal [7] River Soan, Pakistan, Jain and Sharma [11] Rampur reservoir, Kamal [12] Mouri river, Khulna, Ahmed [1] Padma River at MawaGhat of Munshiganj, Kumar [13] Yamuna River, India and Rashid [19] Khiru River, Mymensingh. According to Iwama [10] physico-chemical parameters are considered as the most important in the identification of the nature, quality and type of the water (fresh, brackish, saline water) for any aquatic ecosystem. Fish survive and grow best in waters with a pH between 6 and 9 (Iwama) [10]. In present study, the value of pH throughout the annual cycles was revented within the range of reference data.

Conclusion

The study identified 34 species of fishes belonging to 7 orders were Cypriniformes (11 species) was the dominant family. Mola (*Amblypharyngodon mola*) covers the highest percentages of species composition. Water quality parameters were studied and recorded as more or less suitable for fish distribution but CO_2 and TDS influence the shaping species assemblage structure in Surma River at Shatghari point. In present study, the value of pH and other hydrological parameters throughout the annual cycles were in conformity with the permissible limits for the maximum growth of fishes. Fish catching percentage also indicates the maximum relative abundance of species in the river. The Surma River river is a good source of indigenous fish species, so in depth research is needed to manage this water resource and ensure the sustainable utilization of the valuable resource.

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