Ecologia

ISSN 1996-4021

Academic
Journals Inc.

www.academicjournals.com

OPEN ACCESS **Ecologia**

ISSN 1996-4021
DOI: 10.3923/ecologia.2020.38.49

Research Article
Effects of Environmental Condition on Spatial-temporal Changes of Fish Diversity and Morphology of Shitalakshya River

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Abstract

Background and Objective: River Shitalakshya considered as one of the most prominent rivers in the flood plain region of Bangladesh having polluted with municipal and domestic sewage leads to unsuitable for aquatic species. Thus, present study has been undertaken to study water quality parameters, spatial-temporal abundance of fish species and morphological changes of river pattern of Shitalakshya River during July, 2015 to June, 2016. **Materials and Methods:** Water quality parameters were tested using specific test kits, fish specimens were collected from set beg net (SBN) and seine net to analyze and calculate the diversity indices. **Results:** The temperature of water ranged from 22.8-30°C and dissolved oxygen (DO) were found at lower value (ranged from 0.64-2.94) throughout the study period. A total of 4579 individual's specimens were found belonging to 23 finfish species of which the most dominant species was *Anabas testudineus*. Based on diversity indices, Shannon-Wiener Index (H) and Margalef's richness were adopted very lower value which indicated that the river had poor fish assemblages. Landsat thematic mappers of 3 years (1988, 1998 and 2008) and rest one (2018) from Landsat OLI and TIRS sensor study showed that the river areas were reducing due to the human intervention. **Conclusion:** Results in the present study denote that the water is much polluted and the river areas are also reducing day by day.

Key words: Shitalakshya River, hydrological parameters, fish species abundance, river pattern, set beg net, *Anabas testudineus*

Citation: Md. Bokthier Rahman, Md. Mozahidul Islam, Mst. Ruma and Md. Mizanur Rahman, 2020. Effects of environmental condition on spatial-temporal changes of fish diversity and morphology of Shitalakshya River. Ecologia, 10: 38-49.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Bangladesh is known as a low-lying riverine plot, traversed by many branches and tributaries of the Ganges and Brahmaputra rivers system. Being a country of rivers, Bangladesh is also rich in the diversity of various aquatic animals especially fish[1]. The fisheries sector of Bangladesh has been accounted as a potential source of food security, nutrition supply, employment generation, foreign currency earning and socio-economic status improvement of country people[1,2]. At present time, fish has been considered as a reference diet compare to other meat producing animals due to carry out the animal protein requirement in the diet of consumer. Along with the protein sources fish also contains saturated and unsaturated fatty acid which helps to reduce coronary heart diseases[3,4]. So, demand for fish has been increased overtime and this possesses a huge fishing pressure on the lotic environment. Thus, in recent years, the fisheries resources of Bangladesh have been observed at declining status. The declining status of fish could be described on the basis of environmental modifications and anthropogenic activities. Several key natural factors such as temperature fluctuation from lower to higher, introduction of salt water into freshwater, natural calamities (flood, river erosion etc.) could interact with each other and combine to give rise to constraints with far-reaching influences upon the physiological performance of living organisms, ultimately affecting their ability to grow, survive and reproduce[5]. In spite of environmental causes, several anthropogenic activities like over-exploitation, agricultural run-off, industrial activities, municipal wastes and ship breaking activities etc.

River Shitalakshya, a distributary of old Brahmaputra River, located at Narayangang city is considered as one of the most prominent rivers in the flood plain region of Bangladesh. In Narayangang, various types of industrial units like garments, paper mills, power plants, sugar mills, tanneries, textile mills, brick industry etc. have been established on the bank of the Shitalakshya River. Everyday huge quantities of wastes and effluents are discharged into the river directly or indirectly without any treatment and also municipal and domestic sewage sludge's from Narayangang urban areas and finally finds their way at untreated status into the river[6]. Besides, intensification of terrestrial land for human habitat, crop land and development of industries significantly changes the river pattern Shitalakshya River to a great extent. All of these factors are highly associated with abrupt changes of water quality parameters which significantly possess negative impact on reproduction, growth, survivability and migration patterns of fish[6]. Therefore, Shitalakshya River is become unsuitable for aquatic species especially for fish to survive. As a result, diversity of fish species is alarmingly reduced with accumulating contaminations from industrial sources and fishing pressure[7]. Hence, some basic information about the present status of fish diversity, causes of fish reduction, conservation challenges and finally, management strategies are prerequisite to conserve the valuable fisheries resources of Shitalakshya River. Therefore, the objectives of present study have been undertaken to view the changes of river pattern, environmental variables, spatial-temporal changes of fish diversity, declining causes of fish species and overall management approach of fisheries resources of Shitalakshya River, Bangladesh.

MATERIALS AND METHODS

Study area and duration of research: The present experiment has been carried out on Shitalakshya River, situated at the Narayanganj district of Bangladesh (Fig. 1). The river is about 110 km long and at its widest, near Narayanganj, it is 0.3 km across. The river's maximum depth is 21 m and average depth is 10 m. To execute the objectives of the present study, relevant data were collected on monthly basis for a period of 1year from July, 2015 to June, 2016.

Water sample analysis: Water quality parameters like salinity was measured using a refractometer (CBF 062, Japan), pH using pH meter (pH 211, Hanna Instruments, Italy), a temperature meter to measure temperature and a DO meter (AZ8402, China) to measure dissolved oxygen concentration. A Secchi disk (20 cm diameter) was used to measure the water transparency.

Fish specimen collection and identification: Fish specimens were collected from 5 fishing spots (S1, S2, S3, S4 and S5) of Shitalakshya River. Ten fishermen (two from each station) were hired temporarily for fish specimen's collection. Set beg net (SBN) and seine net are used to capture fish species by following lunar periodicity (full moon and new moon), during these periods higher abundance of fishes were reported by the fishermen and fish vendors[1]. Total numbers of individual species were counted in each sampling day from these stations. For laboratory study, 10% of the total catch was taken covering representative group of fish and preserved in 10% buffered formalin solution in a previously leveled plastic jars according to species and size. In the laboratory, the collected specimens were identified to species level with the help of standard taxonomic keys[8-10].

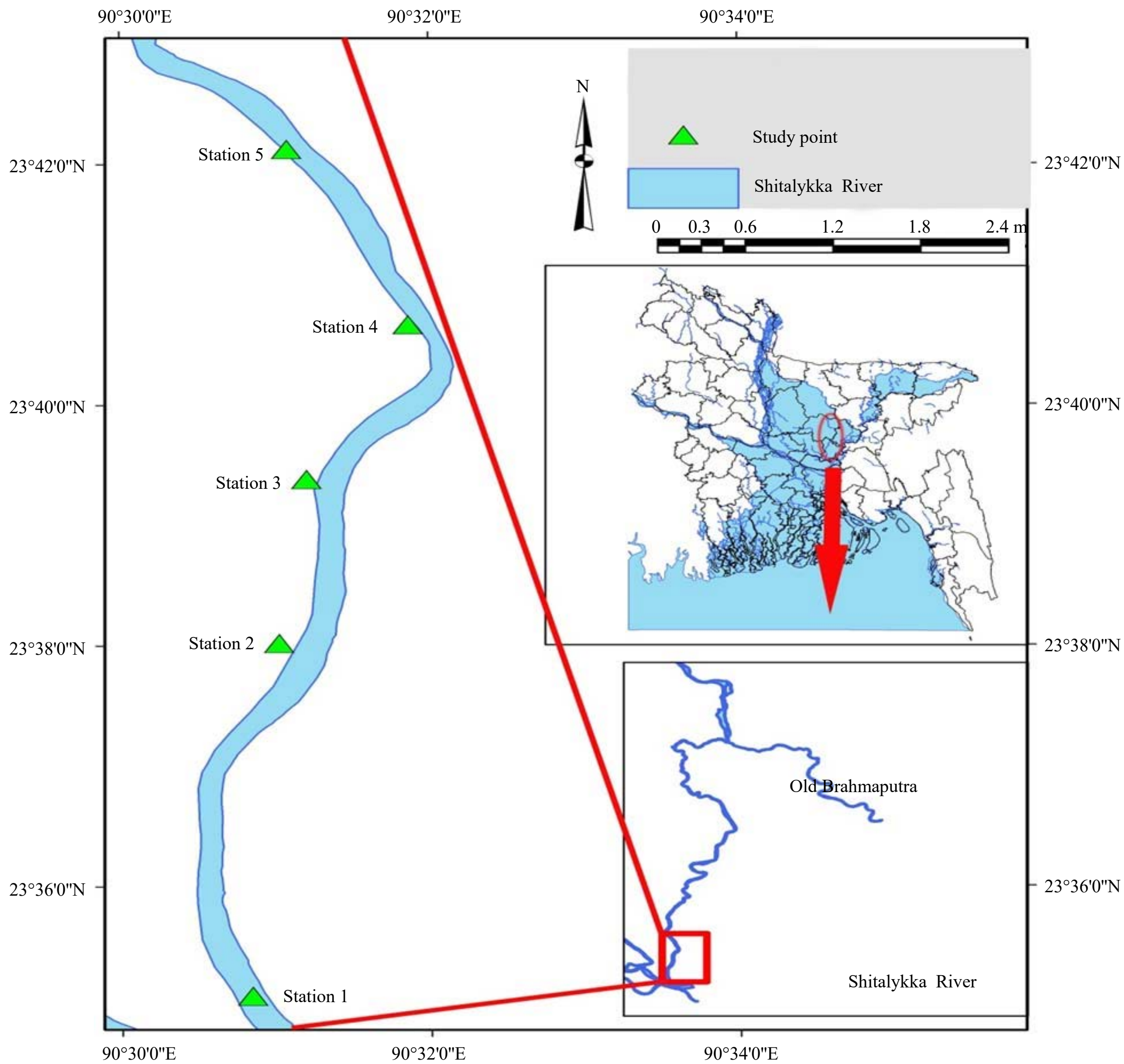

Fig. 1: Map of Shitalakshya River with 5 sampling stations created using ArcMap (Version: 10.5)

Statistical analysis

Fish samples and water quality parameters analysis: Species diversity was assessed using four different indices viz., species richness, Shannon-Wiener diversity, Evenness and Dominance Indices in spatial and temporal spectrum. Shannon-Weiner diversity index:

$$H = -\sum\left[\left(\frac{ni}{N}\right)\times\ln\left(\frac{ni}{N}\right)\right]$$

Buzas and Gibson's evenness (E = eH/S), Simpson's dominance index:

$$D = \sum\left[\left(\frac{ni(ni-1)}{N(N-1)}\right)\right]$$

and:

$$1-D = 1-\sum\left[\left(\frac{ni(ni-1)}{N(N-1)}\right)\right]$$

Margalef richness index (d) (d = S-1/lnN) was calculated[2].

Pearson's correlation coefficient is calculated using SPSS (16.0) to know the correlation matrix among the water quality parameters. The hierarchical clustering[11] was calculated to produce a dendrogram based on Bray-Curtis similarity matrix for investigating similarities among the species.

River morphology

Image acquisition: In order to study Shitalakshya River morphology, the cloud free satellite imagery of winter season image is collected from USGS earth explorer website in the four-years 1988, 1998, 2008 and 2018. In these imageries, first three are from Landsat thematic mapper and rest one from Landsat OLI_TIRS sensor. Study has covered the middle mature part of the river which geographically located into 90°29' 5.278" east longitude to 90°36' 21.889" and 23°33' 20.449" north latitude to 23°54' 57.659". To develop major classification and study area fixation scheme, major land use pattern identified through field visiting. After completing field visit of 1 km in-out flat buffering area of Shitalakshya River adjacent area considered for further study. In addition to this, it is found that study portion land use patter basically lies into four land use classes.

Image pre-processing: Image preprocessing like atmospheric and radiometric correction is required for several imageries as our study scheme[12]. In our study area relatively flat in nature and significant area occupied into agriculture and settlement. However, Image characteristic of a plain land and terrain rugged feature is different in their nature, atmosphere, climate and weather pattern. According to this study, the collected 4 year image quality, orthometric correction, haze and cloud cover relatively well for further analysis so far, no major correction is required for this study. Furthermore, orthorectified Landsat satellite imagery with significantly low screen and land cloud cover makes itself suitable for further analysis without making major corrections. In addition to this, the area of interest (AOI) fitted in path 137 and 044. So far, mosaic king and major atmospheric and radiometric correction is not required in this study.

To produce False Color Composite (FCCs) of the imageries, all individual bands have stacked where thermal band also included because it emphasizes into water body. However, this selected AOI includes total area of 10,532 ha including about 25% of waterbody and 65% of landmass where significant area occupied into agricultural land and it's about 52% is forest.

Image classification and LULC map preparation: Satellite image classification by user defined pixel or sample is the fundamental step of river morphology and other land use pattern analysis. Study result and preciseness depends on different factor likewise image classification method[13], sampling accuracy and software uses. Object based image classification is more accurate than pixel based image classification[14]. Intrigued, object-based image classification scheme soiled for this study which is fast, worthy method of classification by using eCognition Developer v9.0 platform.

Image segmentation: Segmentation is the first and foremost step in OBIC which also vary with the use of different algorithms. Multispectral Segmentation algorithm with scale parameter 10, shape 0.1 and compactness 0.5 is found suitable for this study.

Sample selection: Supervised classification method incorporate user defined known segments, for identifying unknown segments which also depends on proper visualization. Six-layer mixing with parametric value 0.5 found suitable for identification. This study assigned 4 major classes entitled Agriculture, River, Grass-Shrub, Settlement and waterbody where waterbody classes combines the inland ponds, cannels and wetlands. Each class sample defines purpose minimum 50 sample segments are defined based on the field collected points real scenario and the help of Google earth pro 7.0.

Image classification and digitizing: Nearing neighborhood classification is frequently used and also used this study with applying standard NN value to classes. During this classification, all four classes and unclassified classes is selected, algorithm parametric value, class description alive for extraction all parametric values and information. After successful classification image is exported as geotiff raster format. Comma Separated Value format (csv) also exported to store all information details. Classified raster images converted to vector format using ArcMap 10.5 (Esri, Calfornia, United States). On screen digitizing is used for correction of misclassified portions.

Accuracy assessment: Accuracy assessment is the method where describes the accuracy level of the map according to real field component[15]. This study combines the random sampling point generation and using Google earth pro for identifying the real feature based on the fine resolution imagery in the earth current feature and also the temporal analysis.

RESULTS AND DISCUSSION

Water quality parameters: Water quality parameters (temperature, transparency, pH, salinity and DO) of different stations of Shitalakshya River at different months were studied which presented in Fig. 2. Higher temperature (30°C) was recorded for October, 2015 and lower temperature (22.8°C) for February of the following year. Variation in temperature was observed from month to month in the study area.

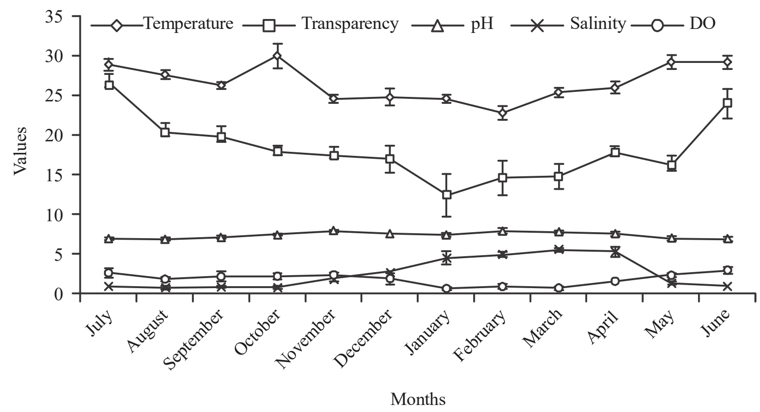

Fig. 2: Water quality parameters for different stations and months during 2015 and 2016

Table 1: Correlation matrix among the water quality parameters of Shitalakshya River significance level (2 tailed)

Parameters	Temperature	Transparency	pH	Salinity	DO
Temperature	1				
Transparency	0.625*	1			
pH	-0.759**	-0.666*	1		
Salinity	-0.714**	-0.667*	0.700*	1	
DO	0.688*	0.787**	-0.574	-0.844**	1

*Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed)

Temperature was found significantly positive correlations with transparency and dissolved oxygen as r = 0.625 and 0.688 ($p<0.05$) and significant negative correlations with pH and non-significant with salinity as r = -0.759 and -0.714 ($p<0.01$), respectively (Table 1). The recommended level of water temperature was 20-30°C[16] which support the present study. The temperature variation in the study area was found interrelated with the emission of solar radiation from season to season and warmer effluents from industries decomposed in the river water without any recycling.

During rainy season, transparency was shown at higher level (ranged from 18-26.6 cm) due to great discharge of water which reliefs to carry out waste water and lower transparency range (12.4-17.7 cm) (Fig. 2) in winter season with lower current velocity and rainfall. Transparency showed significantly negative correlations with pH where r = 0.666 ($p<0.05$). Transparency variation was common in the study period where lower value. During rainy season, transparency was shown at higher level due to great discharge of water which reliefs to carry out waste water and lower transparency rate in winter season with lower current velocity. So, transparency of water has a substantial link with exchange of water i.e., regular water current, rainfall etc.

In the study area, similar pH values were recorded throughout the study period of which most value are acidic condition (ranged from 6.9-7.95). The recorded pH value from lower to higher was found correlated with study of studied Herrera-Silveira *et al.*[17], Islam *et al.*[18] and Taner *et al.*[19].

On the other hand, based on salinity level the river has been classified as moderate saline water body. The salinity level fluctuated (from 0.75-5.53 ppt) (Fig. 1) depending on water discharge, season, dumping of solid particles, industrial effluents etc. Table 1 shows that pH of the river had significantly positive correlation with salinity with r value 0.700 ($p<0.05$). Dissolved oxygen concentration is act as the major factor triggering the species abundance, distribution and survivability in any water body[20]. In dry season, very lower concentration of DO was recorded due to the stagnant water. The study shown very lower DO concentration in compare with references value of DO (6.0->7.3)[21]. In general, the water quality conditions of present study suggested that the water health status was occasionally threatened.

Fish assemblages: A total of 4579 individual's species were computed under 23 finfish species from Shitalakshya River during January, 2015 to June, 2016. Higher number of individuals (1330) was coded for *Anabas testudineus* (Fig. 3) and lower number (15 individuals) was found for *Esomus danricus* which composition 29.05 and 0.33%, respectively (Table 2). Significant variations in both species and individual were shown from station to station and also from season to season. Among the selected stations, higher

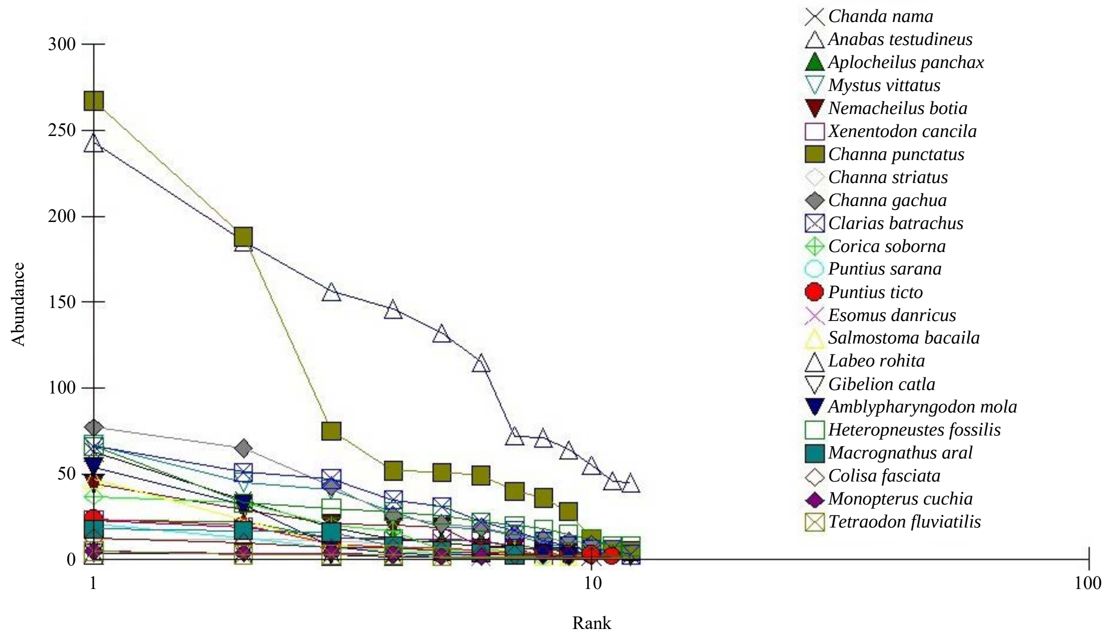

Fig. 3: Abundance plot of individual species

Table 2: Temporal and spatial species abundance in Shitalakshya River during July 2015 to June 2016

Families	Species	Species code	Composition (%)	Total	St1	St2	St3	St4	St5	Pre-monsoon	Monsoon	Post-monsoon
Ambassidae	*Chanda nama*	C1	3.73	171	52	48	21	0	50	37	124	10
Anabantidae	*Anabas testudineus*	C2	29.05	1330	282	164	328	209	347	175	659	496
Aplocheilidae	*Aplocheilus panchax*	C3	2.36	108	37	29	13	17	12	32	76	0
Bagridae	*Mystus vittatus*	C4	5.72	262	56	0	98	33	75	64	169	29
Balitoridae	*Nemacheilus botia*	C5	3.65	167	22	44	33	32	36	39	107	21
Belonidae	*Xenentodon cancila*	C6	2.16	99	12	17	23	13	34	22	77	0
Channidae	*Channa punctatus*	C7	17.67	809	189	121	143	158	198	268	385	156
	Channa striatus	C8	1.09	50	9	11	8	8	14	6	44	0
	Channa gachua	C9	6.57	301	47	54	77	65	58	31	77	193
Clariidae	*Clarias batrachus*	C10	6.62	303	55	67	57	59	65	53	78	172
Clupeidae	*Corica soborna*	C11	2.77	127	5	13	17	42	50	14	113	0
Cyprinidae	*Puntius sarana*	C12	1.31	60	11	14	9	9	17	10	46	4
	Puntius ticto	C13	1.92	88	27	0	5	43	13	17	62	9
	Esomus danricus	C14	0.33	15	5	3	0	0	7	4	11	0
	Salmostoma bacaila	C15	2.21	101	7	12	8	32	42	12	85	4
	Labeo rohita	C16	0.22	10	0	0	2	5	3	2	8	0
	Gibelion catla	C17	0.37	17	2	0	6	4	5	2	13	2
	Amblypharyngodon mola	C18	2.45	112	12	9	47	32	12	6	101	5
Heteropneustidae	*Heteropneustes fossilis*	C19	6.25	286	54	63	62	72	35	74	103	109
Mastacembelidae	*Macrognathus aral*	C20	1.55	71	21	34	7	9	0	7	61	3
Osphronemidae	*Colisa fasciata*	C21	1.22	56	6	8	34	2	6	14	37	5
Synbranchidae	*Monopterus cuchia*	C22	0.44	20	3	5	5	7	0	7	9	4
Tetraodontidae	*Tetraodon fluviatilis*	C23	0.34	16	6	0	0	4	6	3	11	2
Total		23	100.00	4579	920	716	1003	855	1085	899	2456	1224

number of individuals were estimated from St5 (1085) which followed by St3 (1003), St1 (920) and lower individuals from St2 (716). Season wise estimation of individual revealed that monsoon (June-October) was observed with maximum number of individuals (2456), followed by post-monsoon (November-February) (1224 individuals) and minimum number (899 individuals) was coded during pre-monsoon (March-May) period (Table 2). Monthly sampling showed that higher and lower individual was 874 and 71 for October, 2015 and May, 2016, respectively.

Based on present result of fish diversity, it was clear that the River Shitalakshya contains very low fish species both in

Table 3: Fish diversity indices according to months, season and stations in Shitalakshya River from July 2015 to June 2016

Sampling times	Taxa_Sums	Individuals	H	Evenness	D	1-D	Margalef
Stations wise biodiversity indices							
St1	22	920	2.32	0.46	0.16	0.84	3.08
St2	18	716	2.43	0.63	0.12	0.88	2.59
St3	21	1003	2.32	0.48	0.16	0.84	2.89
St4	21	855	2.45	0.55	0.12	0.88	2.96
St5	21	1085	2.33	0.49	0.16	0.84	2.86
Month wise biodiversity indices, July, 15 to Jun, 2016							
July	22	456	2.42	0.51	0.14	0.86	3.43
August	23	360	2.74	0.67	0.08	0.92	3.74
September	22	420	2.61	0.62	0.10	0.90	3.48
October	19	874	2.12	0.44	0.19	0.81	2.66
November	9	277	1.53	0.51	0.30	0.70	1.42
December	9	193	1.56	0.53	0.26	0.74	1.52
January	13	446	1.71	0.42	0.25	0.75	1.97
February	13	291	1.82	0.48	0.23	0.77	2.12
March	15	266	2.06	0.52	0.18	0.82	2.51
April	21	404	2.07	0.38	0.25	0.75	3.33
May	20	224	2.54	0.64	0.11	0.89	3.51
June	19	368	2.24	0.49	0.21	0.79	3.05
Season wise biodiversity indices							
Pre-monsoon	23	899	2.36	0.46	0.15	0.85	3.24
Monsoon	23	2456	2.58	0.58	0.12	0.88	2.82
Post- monsoon	17	1224	1.78	0.35	0.23	0.77	2.25

number and individuals compare to other study areas[22-25] of the country. The most important key factors of lowering the fish species are the introduction of heavy effluents with solid particles from industries developed on the bank of the river. Narayangang, the second most vital industrial zone of Bangladesh, is the harbor of various types of industrial units (chemical, fertilizer, cement, oil, textile, tannery industries, power stations etc.). At present, the river is the residence of different type of heavy metals (Cr, Cd, Ni, Cu and Zn)[7] instead of fish/ other important aquatic species. During pre and post-monsoon, the water quality turned into black and produced acidic flavor due to the absence of rainy season and lower discharge of river water with heavy effluents of industrial and municipal wastes.

From the present study, among all the species, some dominant species were noticed named *Anabas testudineus*, *Channa punctatus*, *Channa gachua*, *Clarias batrachus*, *Heteropneustes fossilis* etc. The dominancy nature could be described on the basis of DO concentration. The dominant fish species in the study area could be survived at lower DO concentrations and waste water containing water body.

Biodiversity indices: Species diversity denotes to the number of species and their relative abundance in a well-defined region. Diversity indices value varied depending upon the number of species as well as number of individuals in each fish species[26]. Table 3 represents the calculated value of Shannon-Wiener Index (H), Gibson's evenness, Simpson's dominance index (D), Simpson's index of diversity (1-D) and Margalef's index of present study. According to month, the highest H value (2.74) was recorded in the month of August, 2015 and lowest value (1.53) for November of the same year. On the other hand, monsoon had maximum H value (2.58) compare to other seasons. Shannon-Wiener index of diversity value lower than 2 indicating that the environment poor in quality[27]. For 4579 individuals under 23 fish species, the evenness value was ranged from 0.35-0.67. The value of Evenness (E) varied[28] between 1 and 0 where the closer to 1 the more even the populations of fish that form the community. Lower value of evenness index in the present study indicates that the community was dominated by some species. Similar result also observed from other study[26]. Among the stations, the Simpson's dominance index for fish species was 0.16, 0.12, 0.16, 0.12 and 0.16 for St1, St2, St3, St4 and St5, respectively. November, 2015 had higher D value (0.30) as compare to other months of study period. Higher D value as 0.23 was found in post-monsoon followed by pre-monsoon (0.15) and lower D value (0.12) was found during monsoon period. On the other hand, the calculated Simpson's index of diversity (1-D) was ranged from 0.70-0.92 for all stations, months and seasons used in this experiment. Simpson's dominance index (D) value ranged from 0-1 (0, represents no dominance and 1, represents complete dominance i.e., the environment have single species)[1]. As the present result of D is close to zero (0), therefore, it is remarked that the river was dominated by some species. Margalef

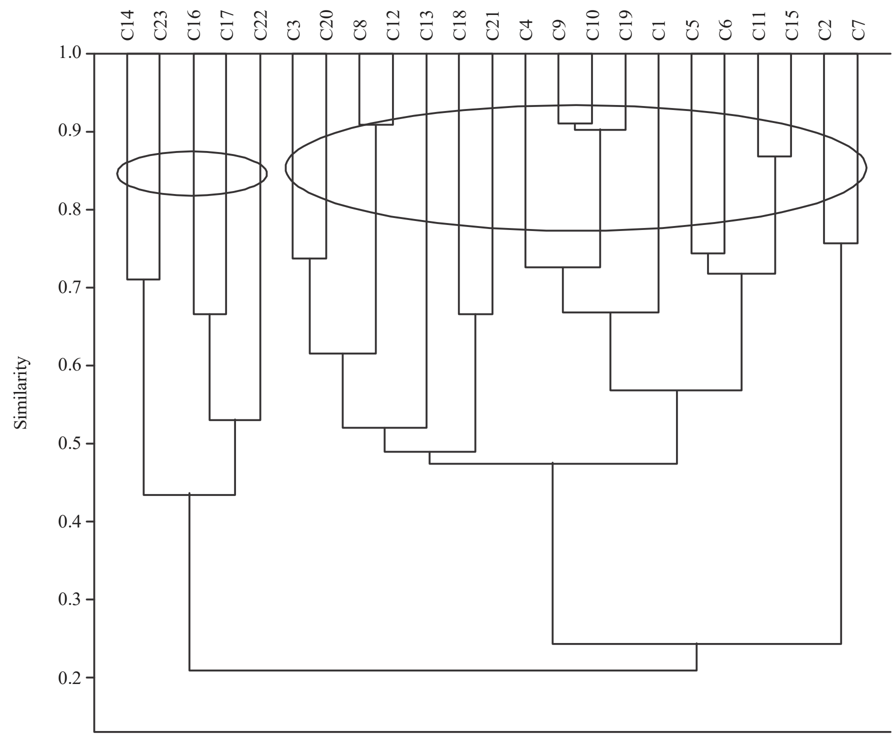

Fig. 4: Spatial and temporal cluster of recorded fish assemblages based on Bray-Curtis similarity matrix

Table 4: Area statistics of the year 1988, 1998, 2008 and 2018 in hector (ha)

Area statistics	Area 1988	Area (%)	Area 1998	Area (%)	Area 2008	Area (%)	Area 2018	Area (%)
Agriculture	5,489	52	5,869	56	5,943	56	3,201	30
Settlement	2,532	24	2,372	23	2,581	25	4,661	44
River	2,105	20	1,870	18	1,700	16	2,042	19
Waterbody	405	4	420	4	308	3	627	6
Total	10,532	100	10,532	100	10,532	100	10,532	100

richness is an important diversity index to measure food chains in an ecosystem i.e., higher richness value indicating longer food chain. Higher Margalef richness (3.08) was shown in St1 where lower value (2.59) was documented from St2. On the basis of months, the Margalef richness was ranged from 1.42-3.74. The Margalef richness of pre-monsoon, monsoon and post-monsoon period was 3.24, 2.82 and 2.25, respectively. The present study indicated that Margalef richness in the study area was found with very low value focusing that the river had poor food chains.

Spatial and temporal relation of fish diversity: The similarity level of available fish species was also identified by cluster analysis based on Bray Curtis similarity matrix (Fig. 4). Through cluster analysis, 2 major groups were identified, of which the 1st group consists of 18 fish species and 2nd group had 5 fish species.

River morphology: Table 4 presents the statistical information of Shitalakshya River is being used over 30 years interval from 1988-2018. Total study area is 10,532 ha and Shitalakshya River above 2000 ha and it is about 20% of the total area. Results showed that among the total area (10,532 ha) agriculture used as 52% (5,489 ha) in 1988 which slight increased both in 1998 and 2008 (56%) (Fig. 5). Finally, agricultural area substantially reduced in 2018, now it is only 30% of the total area and about 22% agricultural area was reduced in last 30 years. Agriculture area was occupied into settlement area from 24-44% significantly in this interval (Table 4) and the figure (Fig. 5 and 6) is only about 2831 ha. In 1988, the river area was 2,105 ha (20%) which reduced to 18% and 16% in 1998 and 2008, respectively. But, in 2018, the river area was increased a total of 19%. Same result also found in case of waterbody which increased from 4-6%.

In Shitalakshya River, most active shifting area is lower part of the estuary, middle curve part and the upper curve part

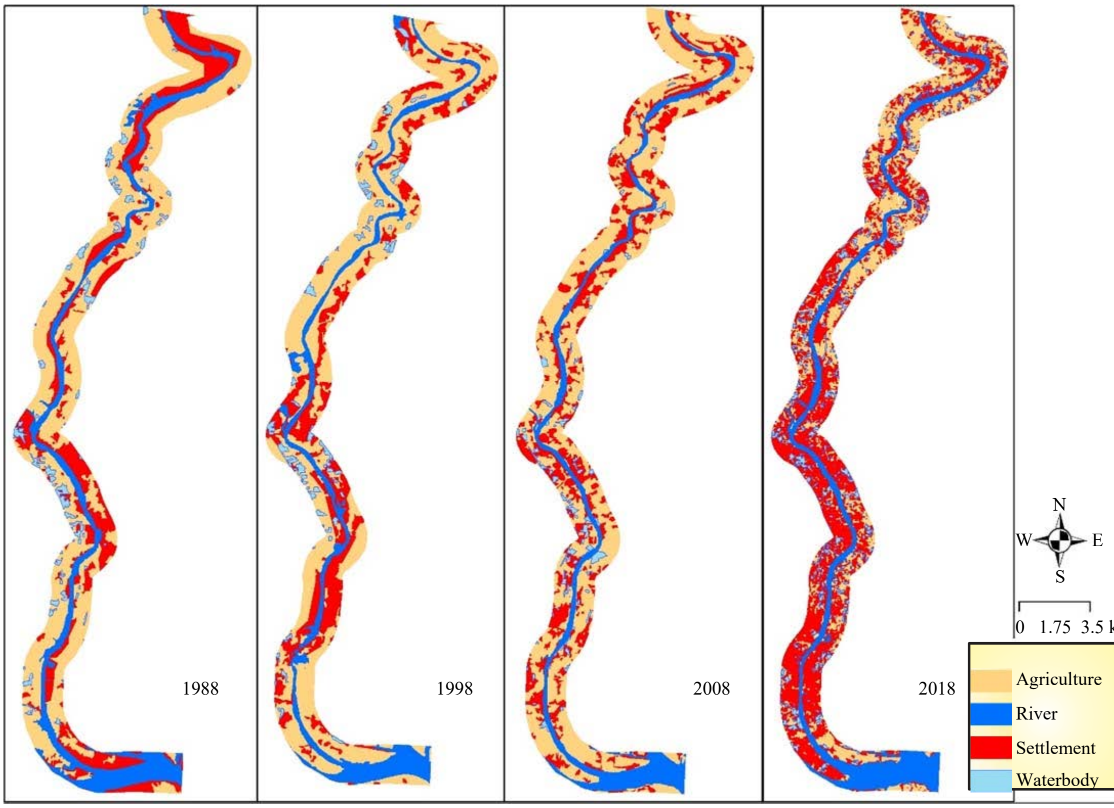

Fig. 5: Temporal resolution of the Shitalakshya River in 10 years interval

Table 5: Conversion analysis of Shitalakshya River area in 1988-1998

Parameters	Agriculture	River	Settlement	Waterbody	Total
1988-1998					
Agriculture	3,582	327	1,800	160	5,869
River	133	1,619	102	16	1,870
Settlement	1,592	137	556	87	2,372
Waterbody	182	22	74	142	420
Total in 1988	5,489	2,105	2,532	405	10,532
1998-2008					
Agriculture	3,850	203	1,623	266	5,943
River	114	1,539	44	3	1,700
Settlement	1,796	97	589	99	2,581
Waterbody	109	31	116	52	308
Total in 1998	5,869	1,870	2,372	420	10,532
2008-2018					
Agriculture	2,390	11	733	67	3,201
River	246	1,640	133	23	2,042
Settlement	2,881	45	1,588	148	4,661
Waterbody	426	4	127	71	627
Total in 2008	5,943	1,700	2,581	308	10,532

(Fig. 6). This figure also indicates that a major branch of Shitalakshya River has diminished in 1998 which had in 1988, (Fig. 5-upper part), second magnified portion indicate that the river boundary was significantly higher in 1998, though it is absent now in the year 2018.

Table 5 (1988-1998, 1998-2008, 2008-2018) and 6 (1988-2018) are representing the conversion analysis of Shitalakshya. Conversion analysis of Shitalakshya River represents that the main river area was remained intact above 1600 ha in every year, except in 1998-2008 interval. In

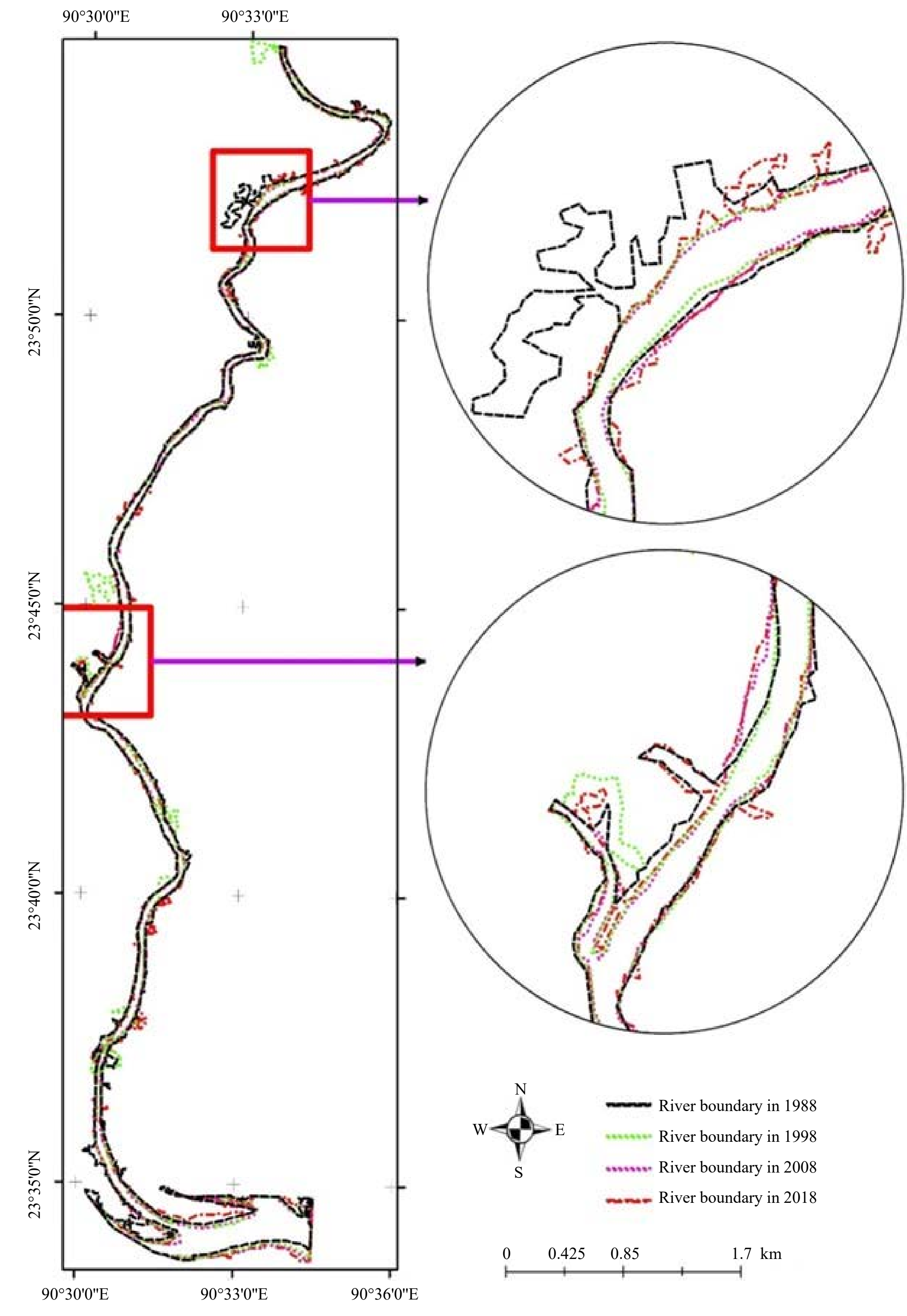

Fig. 6: Changes of the Shitalakshya River courses over 30 years interval developed using ArcMap (version: 10.5)

this interval, most of the diversion has occurred which present in Fig. 5, the second magnified feature present that the river line change significantly. In the interval of 1988-1998 (Table 6) present that about 1619 ha river intact from its earlier year 1988, however, 327 ha river used as agriculture practiced area in these 10 years interval. Though, 133 ha agricultural area eroded to Shitalakshya River in these 10 years interval. The results specified that increase of industrial activities, ship

Table 6: Conversion analysis of the area between 1988 and 2018

1988-2018	Agriculture	River	Settlement	Waterbody	Total
Agriculture	2,196	108	807	90	3,201
River	88	1,725	229		2,042
Settlement	2,831	243	1,357	230	4,661
Waterbody	375	28	138	86	627
Total in 1988	5,489	2,105	2,532	405	10,532

breaking activities along the coast of the river and finally expansion of settlement areas would cause the direct reduction of water area Shitalakshya River.

CONCLUSION

The present study has been undertaken to provide a baseline data on environmental variables and fish species abundance based on some important statistical analysis. Overall, poor water quality parameters (temperature, transparency, salinity, pH and DO) were recorded which suggested that the health status of river water occasionally threatened for aquatic organisms especially for fish species. To protect the valuable water resources and eco-friendly environment, the river should dredge restriction on direct dumping of municipal waste and effluents and using illegal fishing equipment's. Overall, government should make massive precautionary measures about the upcoming disasters beforehand caused due the environmental variables.

SIGNIFICANCE STATEMENT

River Shitalakshya considered as one of the most prominent rivers in the flood plain region of Bangladesh. Everyday huge quantities of wastes and effluents are discharged into the river directly or indirectly without any treatment and also municipal and domestic sewage sludge's from Narayangang urban areas and finally finds their way at untreated status into the river. As a result, the water quality parameters are changed to unsuitable for surviving the fish species. In addition, due to expansion of shelter for overcrowding and industrial areas, Shitalakshya River is dramatically reduced to its wide overtime. This study will help the researcher to uncover these critical areas of Shitalakshya River and also help the researcher as well as government bodies to take proper initiative to manage the river resources and its areas.

ACKNOWLEDGMENT

My Research Project was partially sponsored by National Science and Technology under Ministry of Bangladesh with grant number 39.012.002.01.03.019.2016-546.

REFERENCES

1. Rahman, M.B., M.S. Hoque and M.M. Hasan, 2015. Selectivity of fishing gears and their effects on fisheries diversity of Rabnabad channel of Patuakhali district in Bangladesh. Acad. Res. Int., 6: 184-196.
2. Rahman, B.M., Z.M.S. Hoque, M.M. Rahman and A. Nahar, 2017. Exploration of fishing gear and fisheries diversity of Agunmukha river at Galachipa Upazila in Patuakhali district of Bangladesh. Iran. J. Fish. Sci., 16: 108-126.
3. Mozaffarian, D. and E.B. Rimm, 2006. Fish intake, contaminants and human health: Evaluating the risks and the benefits. J. Am. Med. Assoc., 296: 1885-1899.
4. Tavazzi, L., A.P. Maggioni, R. Marchioli , S. Barlera and M.G. Franzosi *et al*., 2008. Effect of n-3 polyunsaturated fatty acids in patients with chronic heart failure (the GISSI-HF trial): A randomised, double-blind, placebo-controlled trial. Lancet, 372: 1223-1230.
5. Claireaux, G. and C. Lefrançois, 2007. Linking environmental variability and fish performance: Integration through the concept of scope for activity. Philos. Trans. R. Soc. B: Biol. Sci., 362: 2031-2041.
6. Alam, M.N., F. Elahi and M.D. Didar-UL-Alam, 2006. Risk and water quality assessment over view of river Sitalakhya in Bangladesh. Acad. Open Int. J., Vol. 19.
7. Miah, M.I., R. Ferdausi, K.R. Hasan, M.A. Siddiq and S.M. Farid, 2010. Species composition and gear used in fishing during premonsoon period in the Shitalakshya river at Siddirgonj area, Narayangonj. J. Agrofor. Environ., 4: 71-73.
8. Talwar, P.K. and A.G. Jhingran, 1991. Inland Fishes of India and Adjacent Countries. Vol. 2, IBH Publishing Co. Pvt. Ltd., New Delhi, India, Pages: 1158.
9. Rahman, A.K.A., 2005. Freshwater Fishes of Bangladesh. 2nd Edn., Zoological Society of Bangladesh, Dhaka, Bangladesh, Pages: 263.
10. Hossain, M.S., N.G. Das and M.S.N. Chowdhury, 2007. Fisheries Management of the Naaf River. Coastal and Ocean Research Group of Bangladesh, Bangladesh, Pages: 157.
11. Clarke, K.R. and R.M. Warwick, 1994. Change in Marine Communities: An Approach to Statistical Analysis and Interpretation. Plymouth Marine Laboratory, UK., Pages: 144.
12. Anonymous, 2016. User manual ATCOR2 and ATCOR3. ATCOR for Imagine 2016. Haze reduction, atmospheric and topographic correction. Geosystems, France. https://www.geosystems. de/fileadmin/ redaktion/Downloads/Produkte/ATCOR/ATCOR-for-IMAGINE-2016_Manual.pdf

13. Blaschke, T., 2010. Object based image analysis for remote sensing. ISPRS. J. Photogramm. Remote Sens., 65: 2-16.
14. Robertson, L.D. and D.J. King, 2011. Comparison of pixel-and object-based classification in land cover change mapping. Int. J. Remote Sens., 32: 1505-1529.
15. Brown, K.R., 2014. Accuracy assessment of land-cover maps with high resolution imagery. Winrock Int., 1: 1-13.
16. Rahman, M.A. and D.A. Bakri, 2010. A study on selected water quality parameters along the river Buriganga, Bangladesh. Iran. J. Energy Environ., 1: 81-92.
17. Herrera-Silveira, J.A., F.A. Comin, N. Aranda-Cirerol, L. Troccoli and L. Capurro, 2004. Coastal water quality assessment in the Yucatan Peninsula: Management implications. Ocean Coastal Manage., 47: 625-639.
18. Islam, M.A., M.M. Hossain, M.E. Ahsan and A. Nahar, 2015. Status and current worries of fish diversity in the Payra river, Patuakhali, Bangladesh. Int. J. Fish. Aquat. Stud., 2: 160-165.
19. Taner, M.Ü., B. Üstün and A. Erdinçler, 20111. A simple tool for the assessment of water quality in polluted lagoon systems: A case study for Küçükçekmece Lagoon, Turkey. Ecol. Indicat., 11: 749-756.
20. Hossain, M.S., N.G. Das, S. Sarker and M.Z. Rahaman, 2012. Fish diversity and habitat relationship with environmental variables at Meghna river estuary, Bangladesh. Egypt. J. Aquat. Res., 38: 213-226.
21. Herrera-Silveira, J.A. and S.M. Morales-Ojeda, 2009. Evaluation of the health status of a coastal ecosystem in Southeast Mexico: Assessment of water quality, phytoplankton and submerged aquatic vegetation. Mar. Pollut. Bull., 59: 72-86.
22. Rahman, M.B., M.S. Hoque, S.S. Mukit, M. Azam and M. Mondal, 2016. Gears specific catch per unit effort (CPUE) with special reference to declining causes of ichthyofauna in the Kajal river of southern Bangladesh. Int. J. Fish. Aquat. Stud., 4: 382-387.
23. Rahman, M.M., M.B. Rahman, E. Okazaki and M.N.A. Rithu, 2016. Assessment of species specificity of fishing gears and fish diversity status in the Andharmanik river of coastal Bangladesh. J. Fish. Aquat. Sci., 11: 361-369.
24. Rahman, M.M., M.B. Rahman, M.N.A. Rithu and M.S. Hoque, 2016. Observation on selectivity of fishing gears and ichthyofaunal diversity in the Paira river of Southern Bangladesh. Int. J. Fish. Aquat. Stud., 4: 95-100.
25. Ruma, M., M.M. Hossain, F. Ahamed and M.B. Rahman, 2018. Fishing practices in Sandha river: An impact assessment on fisheries resources. Am. J. Biol. Life Sci., 6: 55-61.
26. Acharjee, M.L. and S. Barat, 2014. Seasonal dynamics of ichthyodiversity in a hill stream of the Darjeeling Himalaya, West Bengal, India. J. Threatened Taxa, 6: 6635-6648.
27. Mishra, A., S.K. Chakraborty, A.K. Jaiswar, A.P. Sharma, G. Deshmukhe and M. Mohan, 2010. Plankton diversity in Dhaura and Baigul reservoirs of Uttarakhand. Indian J. Fish., 57: 19-27.
28. Krebs, C.J., 1999. Ecological Methodology. 2nd Edn., Benjamin/Cummings, San Francisco, CA., ISBN: 978032 1021 731, Pages: 620.