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STUDY ON THE PRESENT STATUS OF ENDANGERED FISHES AND PRODUCTIVITY OF TEESTA RIVER CLOSEST TO BARRAGE REGION

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A B S T R A C T

This study was conducted to monitor the present condition of endangered fishes and productivity of Teesta river closest to Teesta barrage situated in the Lalmonirhat district of Bangladesh. Water and sediment samples were collected twice in a month during the study period from six different (3 upstream and 3 downstream) sites with three replications for each. Required information about threatened fishes was collected from the sampling region associated fishermen and fish markets. The study disclosed over 50 threatened fish species in Teesta river including several threatened fishes namely *Bagarius bagarius, Sisor rabdophorus* etc. The commonly available endangered fishes were *Macrognathus aculiatus, Mastacembelus armatus, Barilius tileo, Raiamas bola, Botia dario, B. lohachata* etc. which are rarely available in nationwide. Planktonic flora and fauna determination revealed that comparatively higher density of plankton (n >11500 per liter) as well as more number of planktonic flora (>21 nos.) and fauna (>9 nos.) were monitored in the early monsoon and monsoon season (April-September) and comparatively lower planktonic density (n<10000 per liter) and less number were found in pre-monsoon season (January-February). The investigation of benthic fauna showed that the riverine ecosystem near to barrage contained 16 species of macro-benthos from different groups. Lastly, it can be noticed that it is very essential to take all effective necessary actions to provide good productivity and conserve the ichthyodiversity of Teesta river that will help to conserve the commonly available endangered and critically endangered fishes of Teesta river.

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INTRODUCTION

Teesta is one of the longest rivers of the northern part of Bangladesh and makes a total run of about 170 km from its entrance into Bangladesh to the Kamargani Mouza of Gaibandha where it merges with Brahmaputra River just south of Chilmari Thana of Kurigram district. The Teesta dependent area covers almost the entire greater Rangpur district which includes Lalmonirhat, Nilphamari, Gaibandha, Kurigram and Rangpur, located in the north-eastern part of the country (Islam et al., 2014). Teesta river has great importance for bearing country's largest irrigations project. Teesta Barrage is located on Teesta river at Duani in Hatibandha upazila of Lalmonirhat district. The barrage is a 615 m long concrete structure fitted with 44 radial gates having a discharge capacity of 12,750 cusec of water. At the right bank of the barrage a canal is taking off 280 cusec of water for irrigation. A flood embankment of about 80 km has also been constructed for the provide protection from flood to the adjoining areas. This was designed to provide irrigation water, flood protection and drainage facilities for 749000 ha of cultivated land. The gross benefited area of the Teesta barrage project is 750,000 ha, of which 540,000 ha is irrigable. The Teesta Barrage is the largest irrigation project in the country which spreads over seven districts in greater Rangpur, Dinajpur and Bogura. Transboundary Rivers have long been a source of enormous tension between riparian states (Asaduzzaman and Rahman, 2015). The report of World Commission on Dams, (2000) noted that large dams and diversion projects can led to the loss of forests and wildlife habitat, aquatic biodiversity and can affect downstream floodplains, wetlands, reveries', estuarine and adjacent marine ecosystem.

Bangladesh has vast productive fresh water resources with diversified macro and micro aquatic flora and fauna. Out of 260 freshwater fishes in Bangladesh, over 140 species have been classified as 'small indigenous species (SIS)'. Currently, diversity and abundance of several SIS has tremendously reduced due to some stressors dominantly by over fishing, dryness and anthropogenic activities (Wahab, 2003). IUCN-Bangladesh, (2015) reported that about 64 freshwater fish species are under threats of extinction and this scenario is worsening as the threatened fish species are greatly influenced by climate change-oriented warming, massive bed siltation, pollution etc. Although several small fish species have now apparently disappeared and become endemic in the major parts of Bangladesh, still different threatened fishes are locally available in different rivers of North Bengal especially in Teesta river (Khan et al., 2013; Amin et al., 2019). On the other hand, plankton is one of the most essential characteristics of the aquatic ecosystem for maintaining its stability and a means of coping with any environmental change therefore plankton community structure observation may be used as a reliable tool for biological monitoring studies to assess the pollution status of aquatic bodies (Hambright and Zohary, 2000). The diversity of species, amount of biomass and abundance of plankton communities as well as benthos can be used to determine the health of an ecosystem and evaluation tool for the health status of a river ecosystem (Yazdian et al., 2014). Therefore, this research work has been conducted to know about the current status of endangered fishes, productivity and health status of the studied river ecosystem including seasonal variations near to Teesta barrage region.

MATERIALS AND METHODS

Site selection

The study was carried out for a period of four months from July, 2018 to April, 2020. The proposed research work was designed to collect fish and plankton sample from the upstream and downstream regions of Teesta barrage in Teesta river. For plankton sampling six different sampling sites three upstream and three downstream were selected to collect water and sediment sample from the river (Table 1 & Figure 1). Samples were collected from all selected site fortnightly.

Fish sample collection

To collect fish sample from upstream and downstream site fishermen using seine net (Berjal) were called for collection of fish as well catch information. Net hauling was performed by fishermen around three hours and collected fish samples were then identified through their various morphometric and meristic characteristics. The taxonomic studies of fish were done according to (Rahman, 2005; Talwar and Jhingran, 1991). Then fish species were systematically classified according to fishbase database, Bangladesh Species Database (bdspdb) and Integrated Taxonomic Information System (ITIS). Recorded data were then sorted and tabulated. Conservation status of fishes was confirmed was determined by following the database of IUCN Bangladesh (2015) and Bangladesh Species Database (bdspdb).

Figure 1. Sampling points from where samples and data were collected and recorded in Teesta river

Table 1. Sampling sites of Teesta barrage with geographical location

	Site no.	Site description	Latitude	Longitude
Upstream	Site 1	Near to the main barrage,	26°10'49.8360"	89°03' 14.8320"
region	Site 2	20 m away of the barrage	26°10' 42.1680"	89°3' 24.5880"
	Site 3	30 m away of the barrage	26°10' 41.6640"	89°2' 49.6320"
Downstream	Site 1	Near to the main barrage	26°10' 39.4176"	89°3' 0.0360"
region	Site 2	20 m away of the barrage	26°10' 32.3040"	89°3' 0.9360"
	Site 3	30 m away of the barrage	26°10' 31.4760"	89°3' 14.4000"

Collection and preservation of plankton and Benthos

Plankton samples were collected from sub-surface water of each sites of Teesta river by using plankton net (mesh size, 0.04 mm) for the qualitative and quantitative study of plankton. Ten liters of water samples were passed through the plankton net. Then the collected sample was preserved by marking with site number, sample number and date of the data collection immediately in plastic bottles with 10% formalin solution for the further study. Sediment-samples were collected with the help of Ekmen Drager. Both the plankton and sediment samples were taken to the laboratory of Fisheries Biology and Genetics Department of Hajee Mohammad Danesh Science and Technology University (HSTU) using ice-box for further study. Electron microscope was used to identify the plankton samples whereas benthos samples were identified by eye observation.

Table 2. List of threatened species found in Teesta barrage region of Teesta river

Sl No.	Order	Family	English name	Local name	Scientific name	Threatened status		Availability
						IUCN (GB)	IUCN (BD)	
1.	Symbrachiformes	Synbranchidae	Gangetic Mudeel	kuchia	*Monopterus cuchia*	LC	VU	CA
2.	Tetraodontiformes	Tetraodontidae	Ocellated Pufferfish	Tepa/ Potka	*Tetraodon cutcutia*	LC	LC	AV
3.	Clupeiformes	Clupeidae	Indian river shad	Chapila	*Gudusias chapra*	LC	VU	AV
4.		Clupeidae	Ganges River Spart	Kachki	*Corica soborna*	LC	LC	AV
5.	Beloniformes	Belonidae	Freshwater Garfish	Kakila	*Xenentodon cancila*	LC	LC	CA
6.	Siluriformes	Sisoridae	Sissor catfish	Chenua	*Sisor rabdophorus*	LC	CR	RA
7.		Sisoridae	-	Baghair	*Bagarius bagarius*	NT	CR	RA
8.		Bagridae	Gangetic mystus/ Day's Mystus	Gulsha tengra	*Mystus cavasius*	LC	NT	RA
9.		Bagridae	Stripped river catfish	Tengra/Rani tengra	*Mystus vittatus*	LC	LC	RA
10.		Siluridae	Two Stripe Gulper Catfish/ Indian Butter catfish	Pabda/ Madhu pabda	*Ompok pabda*	NT	EN	AV
11.		Siluridae	Freshwater shark	Boal	*Wallago attu*	NT	VU	AV
12.		Bagridae	Long-Whiskered Catfish	Aor/Airh	*Mystus aor*	LC	VU	AV
13.		Claridae	Walking catfish	Magur	*Clarias batrachus*	LC	LC	CA
14.		Heteropneustedae	Stinging catfish	Shingi	*Heteropneustes fossilis*	LC	LC	CA
15.		Pangasidae	Yellowtail Catfish	Pangas	*Pangasius pangasius*	LC	EN	RA
16.		Ailiidae	Garua Bachcha /Gagora catfish	Ghaura	*Clupisoma garua*	LC	EN	AV
17.	Channiformes	Channidae	Spotted snakehead	Taki	*Channa punctatus*	LC	LC	CA
18.		Channidae	Stripped snakehead	Shol	*Channa striatus*	LC	LC	CA
19.		Channidae	Great Snakehead/Giant snakehead	Gazarh	*Channa marulius*	LC	EN	RA
20.	Osteoglossiformes	Notopteridae	Bronze Featherback/ Grey featherback	Foli	*Notopterus notopterus*	LC	VU	AV
21.		Notopteridae	Clown Knifefish/Humped featherback	Chital	*Notopterus chitala*	NT	EN	AV
22.	Mastacembeliformes	Mastacembelidae	Barred spiny eel/ Stripped spinyeel	Gochi/ Guchi baim	*Macrognathus pancalus*	LC	LC	AV
23.		Mastacembelidae	One stripped spiny eel	Tara baim	*Macrognathus aculeatus*	NE	NT	CA
24.		Mastacembelidae	Tire-track spinyeel	Sal baim	*Mastacembelus armatus*	LC	EN	AV
25.	Perciformes	Ambassidae	Elongate Glass-perchlet	Nama chanda	*Chanda nama*	LC	LC	CA
26.		Ambassidae	Indian Glassy Fish	Gol chanda / Tek chanda	*Parambassis ranga*	LC	LC	AV
27.		Ambassidae	Highfin Glassy Perchlet	Lal chanda/ Ranga chanda	*Parambassis lala*	NT	LC	AV
28.		Gobiidae	Tank goby	Baila/Bele	*Glossogobius giuris*	LC	LC	CA
29.		Anabantidae	Climbing perch	Koi	*Anabas testudineus*	DD	LC	AV
30.		Osphronemidae	Banded gourami/ Stripped gourami	Kholisha	*Colisa fasciatus/ Trichogaster fasciata*	LC	LC	CA

Table 2. List of threatened species found in Teesta barrage region of Teesta river **(contd.)**

31.	Cypriniformes	Cyprinidae	Spotted Barb/ Pigmy barb	Phutani punti	*Puntius phutunio*	LC	LC	RA
32.		Cyprinidae	Pool Barb	Jatpunti	*Puntius sophore*	LC	LC	CA
33.		Cyprinidae	Ticto barb/Two-spot barb	Tit punti	*Puntius ticto*	LC	VU	AV
34.		Cyprinidae	Olive barb	Sarpunti	*Barbodes sarana*	LC	NT	CA
35.		Cyprinidae	Bata labeo	Bhangan bata	*Labeo bata*	LC	LC	CA
36.		Cyprinidae	Glass-barb	Mola punti	*Puntius guganio*	LC	LC	RA
37.		Cyprinidae	Reba Carp	Bhagna/ Tatkini	*Cinhinus reba*	NE	NT	CA
38.		Cyprinidae	Nipati	Nipati/Gofi chela	*Danio dangila*	LC	VU	RA
39.		Cyprinidae	Silver hatchet chela	Chep Chela	*Chela cachius*	LC	VU	AV
40.		Cyprinidae	Indian glass-barb/Indian hatchetfish	Kash Khaira/Laubuca	*Chela laubuca/ Laubuka laubuca*	NE	LC	CA
41.		Cyprinidae	Tileo baril	Khorki	*Barilius tileo/ Opsarius tileo*	LC	EN	CA
42.		Cyprinidae	Hamilton's Barila/ Burmese baril	Juary/Joya	*Barilius bendelisis*	LC	EN	CA
43.		Cyprinidae	Indian trout	Bhol	*Raiamas bola*	LC	EN	CA
44.		Cyprinidae	Flying barb	Darkina	*Esomus danricus*	LC	EN	
45.		Cobitidae	Bengal/ Necktic Loach	Rani mach / Bou-mach	*Botia dario*	LC	EN	AV
46.		Cobitidae	Hora Loach	Rani mach /Bou-mach/ Beti	*Botia dayi*	NE	EN	RA
47.		Cobitidae	Reticulate loach	Putul/ rani/ Beti	*Botia lohachata*	NE	EN	CA
48.		Cobitidae	Gongota loach	Poia/Ghar-poia/ Pahari gutum	*Somileptes gongota/ Canthophrys gongota*	LC	NT	CA
49.		Cobitidae	Guntea Loach	*Puiya/ Gutum/* Pui-mach	*Lepidocephalus guntea/ Lepidocephalichthys guntea*	LC	LC	CA
50.		Balitoridae/ Nemachelidae	Molted loach/ Sand loach	Bilturi/Balichata gutum	*Acanthocobitis botia*	LC	LC	AV

IUCN categories: NE- Not Evaluated; DD- Data Deficient; LC- Least Concern; NT- Near Threatened; VU- Vulnerable; EN- Endangered; CR- Critically Endangered. Available status: CA- Commonly Available; AV- Available; RA-Rarely Available
Source: Bangladesh Species Database (*Beta version 2020*), FishBase ver. (12/2019), BD- Bangladesh; GB-Global

Analysis of plankton and benthos

Qualitative analysis

Taxa of plankton were identified to genus level with the help of taxonomic keys from the text book of (Babar and Haworth, 1981; Bellinger, 1992; Pontin, 1978; Lind and Brook; 1980) with magnification of 10 × 0.25 under binocular microscope.

Quantitative analysis

For quantitative study of plankton Sedgewick- rafter chamber was used. The used rafter-chamber (Figure 2) was 50 mm long, 20 mm wide and 1 mm deep. The total area of the bottom was approximately 1000 square mm and total volume was 1000 cubic mm.

Plankton number was calculated by following equation:

Number of planktons, N = $\frac{A*c}{F*V*L} * 1000$ (plankton cell/liter)

Here,

F= Number of the SR cell field
C=Volume of final concentration of sample
A= Total number of planktons counted
L= Volume of original water
V= Volume of SR cell (1 cubic meter)
N= Number of plankton cell per litter

Data analysis

Collected data were analyzed by computer software Microsoft Excel 2010.

RESULTS

Present status of endangered fishes in Teesta barrage region of Teesta river

The natural water bodies of the Northwest part of Bangladesh were blessed with small indigenous fish species. Although, the availability of indigenous fishes is declining due to various man-made and natural stressors nationally, most of the threatened fishes of Bangladesh are available in different natural waters of Rangpur and Dinajpur districts. There were 50 species recorded as available endangered fish of barrage region of Teesta river (Table 2). Those species belongs to order Cypriniformes (20), Perciformes (6), Mastacembeliformes (3), Osteoglossiformes (2), Channiformes (3). Siluriformes (11), Clupeiformes (2) and one species each from the order Symbrachiformes, Tetraodontiformes and Beloniformes. It is obvious that Cypriniformes the most dominant order both in number and species followed by Siluriformes, Perciformes, Channiformes, mastacembeliformes, osteoglossiformes, Clupeiformes, Symbrachiformes, Tetraodontiformes and Beloniformes.

Available plankton and benthos in the studied river

Planktonic flora and fauna (Figure 2) determination revealed that comparative higher density of plankton (n >11500 per liter) as well as more number of planktonic flora (>21 nos.) and fauna (>9 nos.) were found in the early monsoon and monsoon season (April-September).

On the other hand, comparative lower density (n<10000 per liter) and less number of both phytoplankton (<11 nos.) and zooplankton (<7 nos.) were reported in the pre-monsoon season (January-February). Akter et al., (2018) recorded phytoplankton density was found the maximum and the minimum in the dry and wet season, respectively in the Jamuna River that supports the present findings. Again Malik and Bharti, (2012) found that the plankton density was highest during summer-winter and lowest during monsoon in the Sahastradhara stream as the current research said. A total of 30 species of plankton had been recorded from the barrage region of Teesta river of which 21 species (70%) were phytoplankton and 9 species (30%) were zooplankton. Among the phytoplankton, there were 9 species of bacillaryophyta (43%) representing the dominant phytoplankton group followed by charophyta (19%), chlorophyta (19%), cyanophyta (9%) and dinophyta (10%) (Table 3 and Figure 3).

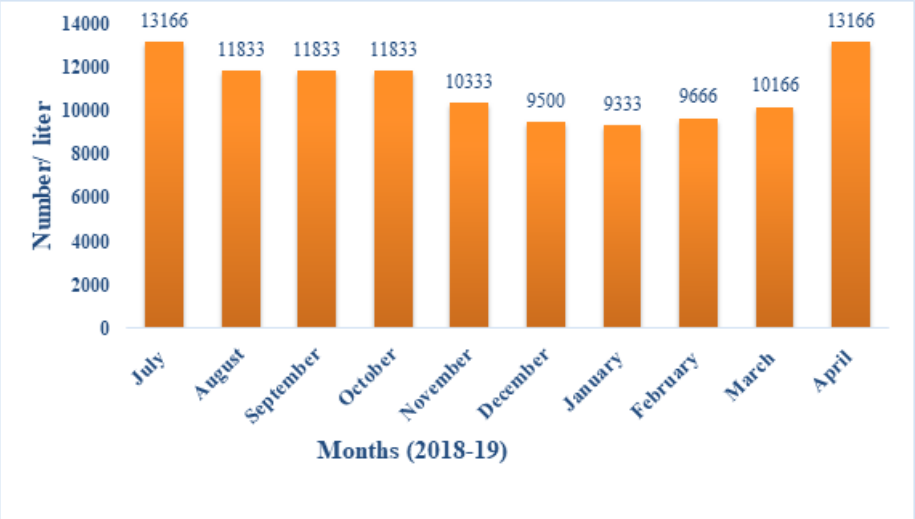

Figure 2. Planktonic concentration of Teesta river detected in the study period

The common phytoplankton in the Teesta riverine ecosystem (barrage region) in monsoon season were *Asterionella, Biddulphia, Ceratium, Clostridium, Cosmodismus, Chlorella, Cyclotella, Dinophysis, Fragillaria, Melosira, Micrasteria. Navicula, Oscillatoria, Pediastrum, Scenedesmus, Spirogyra, Spirunila, Surirella, Synedra etc* (Table 4). According to Hossain *et. al.,* (2017) most of the above mentioned planktonic flora were available in the riverine ecosystem. Relative lower and higher numbers of plankton availability found in the pre-monsoon (December-January) and pick monsoon season (July-September) respectively indicated that both diversity and abundances of planktonic flora and fauna were importantly influenced by seasonal variation particularly for thermal change. These findings suggested that Teesta riverine ecosystem was more productive during pre-monsoon and monsoon season. Sixteen species of benthos belongs to class Gastropoda, Bivalvia, Branchiura and Insecta (Table 5). Khan et al., (2007) stated that 20 different species of macrobenthos along with major number of Gastropodes and bivalve were found in the Mouri river. Sarker et al., (2016) identified 5 major groups of macrobenthos (Polychaeta, Oligochaeta, Arthropods, Gastropods and Bivalvia) in Bakhlali river estuary.

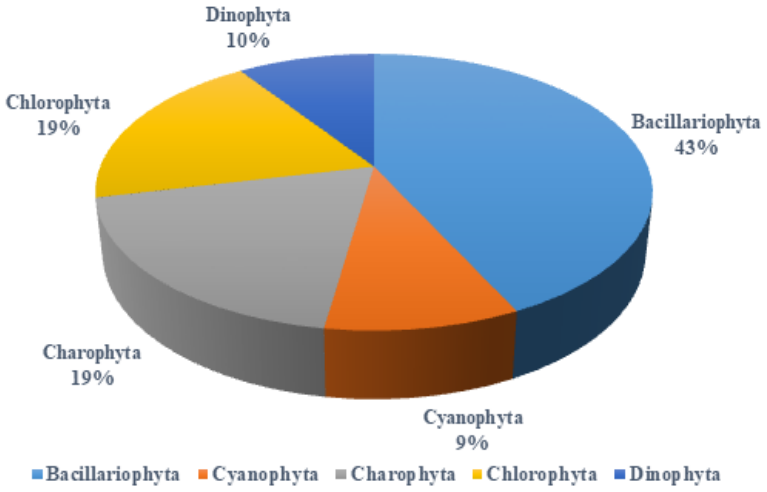

Figure 3. Phytoplankton abundance in Teesta river in barrage region

Table 3. Available groups of Plankton from the upstream and downstream region of Teesta barrage

Year	Months	Phytoplankton										Zooplankton							
		Bacillariophyta		Cyanophyta		Charophyta		Chlorophyta		Dinophyta		Copepoda		Cladocera		Rotifera		Crustacean larvae	
		Up	Do	Up	Do	Up	Do	Up	Do	Up	Do	Up	Do	Up	Do	Up	Do	Up	Do
2018	Jul	9	5	2	1	4	4	4	3	2	2	2	2	2	3	0	2	1	2
	Aug	9	5	2	1	4	4	4	3	2	2	2	2	2	3	0	1	1	2
	Sep	9	4	2	1	3	3	4	5	2	2	2	2	2	3	0	1	1	2
	Oct	9	6	2	1	4	3	4	4	2	1	2	2	2	3	0	1	1	2
	Nov	7	5	2	2	3	2	3	2	2	1	2	2	2	2	2	1	2	2
	Dec	3	3	1	1	0	0	3	3	0	0	2	2	2	2	1	0	1	1
2019	Jan	3	3	1	1	0	0	3	3	0	0	1	1	1	1	0	0	1	1
	Febr	4	3	1	1	1	1	3	2	2	2	1	1	1	1	0	0	1	1
	Mar	3	5	0	2	1	3	2	4	2	2	1	1	3	2	1	1	2	2
	Apr	6	9	2	2	4	4	4	3	2	2	2	1	3	2	2	1	2	2

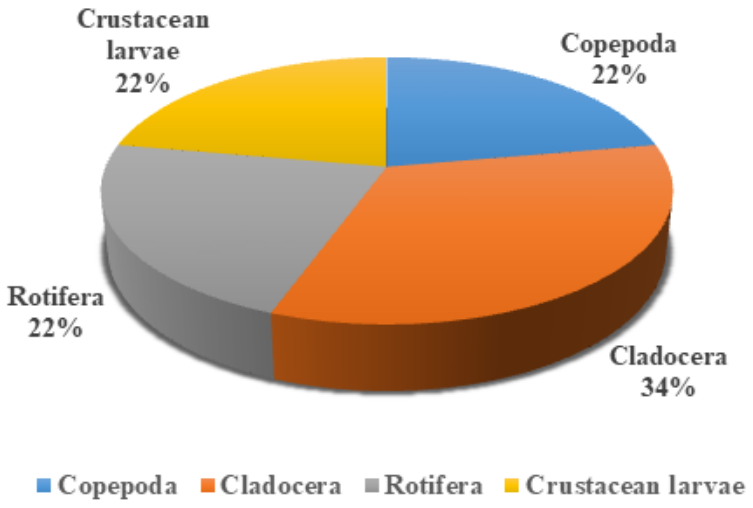

Figure 4. Zooplankton abundance in Teesta river in barrage region

Table 4. Monthly available species of Plankton from of Teesta barrage region of Teesta river ('+' indicates present and '–' indicates absent)

Plankton species		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Phytoplankton											
Bacillariophyta											
1.	*Cyclotella*	+	+	+	+	+	+	+	+	+	+
2.	*Asterionella*	+	+	+	+	+	-	-	-	-	+
3.	*Navicula*	+	+	+	+	+	+	+	+	+	+
4.	*Synedra*	+	+	+	+	-	-	-	-	-	+
5.	*Tabellaria*	+	+	+	+	+	-	-	-	-	+
6.	*Fragilaria*	+	+	+	+	+	+	+	+	+	+
7.	*Surirella*	+	+	+	+	+	-	-	-	-	+
8.	*Biddulphia*	+	+	+	+	+	-	-	+	+	+
9.	*Melosira*	+	+	+	+	-	-	-	-	+	+
Cyanophyta											
10.	*Oscillatoria*	+	+	+	+	+	+	+	+	+	+
11.	*Spirunila*	+	+	+	+	+	-	-	-	+	+
Charophyta											
12.	*Closterium*	+	+	+	+	+	-	-	-	-	+
13.	*Spirogyra*	+	+	+	+	+	-	-	+	+	+
14.	*Cosmarium*	+	+	-	+	-	-	-	-	+	+
15.	*Micrasterias*	+	+	+	+	+	-	-	-	+	+
Chlorophyta											
16.	*Pediastrum*	+	+	+	+	+	+	+	+	+	+
17.	*Chlorella*	+	+	+	+	+	+	+	+	+	+
18.	*Scenedesmus*	+	+	+	+	-	-	-	-	+	+
19.	*Ulothrix*	+	+	+	+	+	+	+	+	+	+
Dinophyta											
20.	*Dinophysis*	+	+	+	+	+	-	-	+	+	+
21.	*Ceratium*	+	+	+	+	+	-	-	+	+	+
Zooplankton											
Copepoda											
1.	*Cyclops*	+	+	+	+	+	+	+	+	+	+
2.	*Diaptomus*	+	+	+	+	+	+	-	-	-	+
Cladocera											
3.	*Daphnia*	+	+	+	+	+	+	+	+	+	+
4.	*Dyaphanosoma*	+	+	+	+	+	+	-	-	+	+
5.	*Bosmina*	+	+	+	+	-	-	-	-	+	+
Rotifera											
6.	*Brachionus*	+	+	+	+	+	+	-	-	+	+
7.	*Notholka*	+	-	-	-	+	-	-	-	-	+
Crustacean larvae											
8.	*Nauplius*	+	+	+	+	+	-	+	+	+	+
9.	*Pseudosida*	+	+	+	+	+	+	-	-	+	+

Table 5. Available benthic invertebrate from the Teesta river near to barrage

	Class	Family	Local Name	Scientific Name
1.	**Branchiura**	Argulidae	Fish lice	*Branchiura sp.*
2.	**Insecta**	Chironomidae	Chironomus	*Chironomus sp.*
3.		Viviparidae	Badami choto shamuk	*Bellamya bengalensis*
4.		Paludomidae	Choto gulshamuk	*Paludomus conica*
5.		Planorbidae	Golshamuk	*Planorbis sp.*
6.		Viviparidae	Choto shamuk	*Viviparous bengalensis*
7.	**Gastropoda**	Limnaedae	Patla shamuk	*Limnaea sp.*
8.		Ariophantidae	Pasanugul shamuk	*Macrochlamys sequax*
9.		Bulinidae	Pasanu shamuk	*Indoplanorbis sp.*
10.		Viviparidae	Pasanudurakata shamuk	*Bellamya dissimilis*
11.		Pachychilidae	Pasanulamba shamuk	*Brotia costula*
12.		Cyrenidae	Gol jinuk	*Corbicula sp.*
13.		Unionidae	Jinuk	*Lamellidens marginalis*
14.	**Bivalvia**	Sphaeriidae	Musculium	*Musculium sp.*
15.		Thraciidea	Pelopia	*Pelopia sp.*
16.		Unionidae	Unio	*Unio sp.*

Source: molluscabase.org, GBIF—the Global Biodiversity Information Facility, World Register of Marine Species (WoRMS)

DISCUSSION

Among the recorded species of this findings, 5 species were found nearly threatened (NT) globally reported by IUCN (2015). According to IUCN Bangladesh, 2 species critically endangered (CR), 13 species endangered (EN), 8 species vulnerable (VU) and 5 species were categorized as threatened. There is a very scarce information on the status of fish biodiversity of Teesta river has not been studied till date. Khan et al., (2013) stated, 42 fish species belonging to 7 common groups were identified from the Teesta river which was lower than the present findings. Sarker, (2018) noted that 77 SIS species alone from Teesta river which was much higher than our report. Ali et al., (2014) described 53 species of fish from Chitra river. Parvez et al., (2017) mentioned 55 freshwater fish species were from Dhepa river. According to the information provided by the fishermen, over 40 threatened fishes were currently available in barrage region of Teesta river (Table 3) from where some showed abundant in the studied river although these fishes are rarely available nationwide. Several important studies performed by Amin et al., (2010, 2019) also reported that some vulnerable and endangered indigenous fishes were locally abundant in the natural waters of the Northwest part of Bangladesh including the natural waters of Dinajpur district. According to this research findings, the abundant threatened fishes in the barrage area of Teesta river were Joya (*Barilus bengalensis*), Bhol (*Raiamas bola*), Tara baim (*Macrognathus aculiatus*), Chela (*Chela laubuca*), Boal (*Wallago attu*), shol (*Channa striatus*), bhagna (*Chirhinus reba*), balichata gutum (*Acanthocobitis botia*), Pahari gutum (*Somileptes gongota*), rani (*Botia dario*), putul rani (*Botia lohachata*), Khorki/Tila koksha (*Barilius tileo*), *etc*. During winter season (December-January) the studied river contained less water when local people prepared Katha (fish shelter with tree branches) and at the pre-monsoon season (February-March) they caught fish indiscriminately from the katha. Fishermen also informed that almost similar fish species were found in the upstream and downstream poles of Teesta barrage. It is important to note that several critically endangered fishes such as: bagair (*Bagarius bagarius*), chenua (*Sisor rabdophorus*), ghaura (*Clupisoma garua*) *etc.* are reported to be available in the barrage area of Teesta river.

The presence of more plankton during early monsoon and monsoon and less in the pre-monsoon or winter indicated that Teesta riverine ecosystem was more productive in early monsoon and monsoon might be due to increased temperature and rainfall. The finding also agreed with Shafi et al., (1978), Patra and Azadi (1985), Chakrabarty et al., (1995), Khan et al., (1998). Bacillariophyceae (Diatoms) was found to be dominant group of phytoplankton by Jha et al., (2014) in Manakudy estuary, Ishaq and Khan (2013) in the Jamuna River. A study on Halda river recorded the phytoplankton population belong to classes Chlorophyceae, Cyanophyceae, Bacillariophyceae and Myxophyceae (Patra and Azadi, 1985). Shafi et al., (1978) reported the availability of higher percentage composition of phytoplankton (76.0 - 93.6%) from the Meghna river. In the present investigation phytoplankton formed 65.6% of the total plankton abundance. Akter et al., (2018) noted 9 species of phytoplankton dominated by Bacillariophyceae in the Jamuna River which is more or less similar to the present findings. Ahsan et al., (2012) described 19 taxa of phytoplankton in Ganges-Meghna river system route. The group of phytoplankton belonged to Chlorophyceae (7 taxa), Bacillariophyceae (6 taxa) and Cyanophyceae (6 taxa). The present findings of teesta river showed 9 Bacillariophyceae spp., 4 Chlorophyceae spp. and 2 Cyanophyceae spp. reflects the similarity. Other relevant study conducted by Amin et al., (2019) in the Kanchan river of Dinajpur district noticed almost similar findings. On the other hand, 11 zooplankton contained the dominant group cladpcera (37%) representing 4 species followed by rotifer (27%), copepod (18%) and crustacean larvae (18%) (Figure 4). These zooplankton species were *Bosmina, Brachiomysis, Cyclops, Daphnia, Diaphanosoma, Diaptomus, Nauplius, Pseudosida etc.* (Table 4). Saunders and Lewis Jr (1988) noted the Copepods, cladocerans, rotifer and nuplilus crustacean larvae dominated by the zooplanktonic genera in the Caura River. Mozumder et al., (2011) also identified protozoan, copepods, cladocera and ostracoda from coastal aquatic environment of Mathbaria, Bangladesh. Zooplankton belonging Copepodes, Cladocerans, Rotifers and Crustaceans were found to be dominant by Ahsan et al., (2012), Chowdhury and Raknuzzaman (2005) and Ahmed et al., (2003). According to the study findings, Teesta barrage region associated riverine ecosystem consisted with 5 groups of phytoplankton and 4 groups of zooplankton (Table 3 and Table 4). This study also distinguished the available planktonic flora and fauna in the upstream and downstream regions of Teesta barrage in Teesta river. According to the result (Table 3) little more phytoplankton genera were found in the upstream region than the downstream region whereas opposite scenario was visualized in case of zooplankton availability. This may be the impacts of water flow and upwelling.

Benthic invertebrates provided about 60% of the total natural food items for aquatic animals and also play an important role in sediment-water interaction through their burrowing and feeding activities. The investigation of benthic fauna in the Teesta river showed that the riverine ecosystem near to barrage contained 16 species of macro-benthos (Table 5) from different groups. A couple of published reports (Lliopoulou- Georgudaki et al., 2003, Azrina et al., 2006) mentioned that macrobenthos were the basic components of the aquatic chains of rivers and ubiquitous in all aquatic ecosystems and showed sensitivity towards aquatic pollution. The findings of this study demonstrated that the availability of the threatened fishes are reducing gradually in the Teesta river although some endangered and critically endangered fishes are still commonly available. The monitored productivity indicators particularly the availability of planktonic flora and fauna showed comparative better condition in early monsoon and monsoon season than pre-monsoon and late monsoon.

CONCLUSION

The Teesta is a productive river having a great potentiality to conserve the fish biodiversity. But the situation is getting degraded gradually due to various natural and manmade causes. The findings of this study demonstrated that the availability of the threatened fishes are reducing gradually in the Teesta river although some endangered and critically endangered fishes are still commonly available. The monitored productivity indicators particularly the availability of planktonic flora and fauna showed comparative better condition in early monsoon and monsoon season than pre-monsoon and late monsoon season. Finally, it can be concluded that it is very essential to take all effective necessary actions to provide good productivity and to conserve the ichthyodiversity of Teesta river that would also be helpful to conserve the commonly available endangered and critically endangered fishes of Teesta river.

CONFLICT OF INTEREST

Authors declared that there is no conflict of interest.

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