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RESEARCH PAPER

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Fish and Plankton Biodiversity in the Kishoreganj Haor, Kishoreganj, Bangladesh

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Abstract

Haor is a wetland environment considered as a rich diversified fisheries resource with important role on ecology, economy and social structure. The present study was conducted to evaluate the diversity of fish and plankton communities in the Kishoregonj haor, Kishoreganj, Bangladesh. Fish samples were collected from the fishers and fish landing station for taxonomic study from July 2017 to December 2018. Fish were identified through direct observation and using morphometric and meristic characteristics. A total of 23 genera of phytoplankton belonging to 4 classes were identified. A total 8 genera of Bacillariaophyceae, 9 genera of Chlorophyceae, 3 genera of Cyanophyceae and 3 genera of Euglenophyceae class were listed from the study area. In total 3 groups of zooplankton were identified, i.e. Phylum- Rotifera, Order-Cladocera and Sub-class-Copepoda in Kishoreganj haor. In the present study, a total of 79 species of fishes belonging to 27 families under 9 orders were recorded. Cypriniformes was found as the most dominant order comprising 31 species followed by Siluriformes (21) and Perciformes (15). The result of this study showed that the fish and plankton diversity indices in the Kishoreganj haor are good even some fish species are gradually decreasing.

Introduction

Haor is a productive wetland ecosystem with a high environmental, economic and social value that is characterized by being a bowl-shaped depression covered by water almost six months in a year starting from the monsoon (Sarma *et al.* 2010). Haor ecosystem covers about 25% of the Northeastern part of Bangladesh. In addition, it is a mosaic of wetland habitats including rivers, streams and irrigation canals, large areas of seasonally flood plains and hundreds of haors and beels (Hussain *et al.,* 2007). In seven districts of Bangladesh; Sylhet, Moulavibazar, Habiganj and Sunamganj in northeast, Netrokona and Kishoreganj in north central and Brahmanbaria in central eastern region of Bangladesh, a number of 423 haors comprising a surface area of about 8000 km^2 are present (Miah, 2013). The three sides of haor region are surrounded by mountain ranges of India, with Meghalaya in north, Tripura and Mizoram in south, and Manipur and Assam in east.

The haor region is crisscrossed by numerous rivers coming down from the hills of India with huge amount of runoff water during monsoon, which ultimately falls into Meghna basin (Ahmed, 2012; Rabby *et al*., 2011). Usually water body in the haor region remains at zero level from January to March and then starts to increase and go down again during August (Sarma, 2010; Nowreen *et al*., 2015). Mostly, in June and July, the water level reaches the highest point (Salauddin and

Islam, 2011). In addition, the rainfall in the haor region is comparatively higher than the other region of country. The average annual rainfall in the haor areas is 4130 mm, which is almost twice higher than the country's average annual rainfall (Nowreen *et al.,* 2015). The physical settings and hydrology of the haor region created countless opportunities as well as constraints for the inhabitants (Hanif *et al.,* 2015).

Haor contains diverse types of floral and faunal diversity especially reptiles, birds, fish species, amphibians etc., which play an important role in the existence of haor ecosystem (Choudhury, 2016). According to Pandit *et al.* (2015) over 84 species of fish were reported to be commonly caught by local fishermen in the haor region. Islam *et al*. (2008) recorded 108 species under 29 families of 10 orders from the haor region. Hence, the haor region plays important role for fish production, maintaining biodiversity, meeting local and regional demand (Salauddin and Islam, 2011). However, the Kishoreganj haor region is also known for its richest SIS (Small Indigenous Fish Species) biodiversity, consisting of 30 species belonging to 7 orders and 15 families (Rownok *et al.,* 2014).

Primary productivity is essential for fish species growth and distribution in natural water bodies. Primary production is mainly depending on nutrient concentration in aquatic environment. The variation in nutrient concentrations caused by changes in water flow and upwelling regimes of rivers is the cause of fluctuations of primary productivity (Lotze and Worm, 2002). The primary productivity describes the biological wealth of the water body, constituting a vital link in the food chain. Haor is considered to have an exceptionally higher primary productivity than other wetland habitat types (Muzaffar and Ahmed, 2007). In any aquatic ecosystem the phytoplankton works as the backbone of food chain that keeps the animals alive in aquatic environments. The phytoplankton communities of haor is very much linked with production of zooplankton and fish (Muzaffar and Ahmed, 2007). Muzaffar and Ahmed (2007) found 107 genera of phytoplankton in haor region and representing six classes. Azher *et al.* (2006) listed 75 plankton species (60 phytoplankton and 15 zooplankton) where Chlorophyceae and Copepoda was the most dominant groups in the Kishoreganj haor region. Fish diversity is an important index to conserve the fisheries resources in a particular region of a country. Very limited research works are available on protection of this fishery resource in Bangladesh. Therefore, the present study was conducted to assess the plankton and fish diversity in the Kishoreganj haor.

Materials and Methods

Study Area

This experiment was performed in the Kishoreganj haor (Figure 1). The area was selected considering its unique geographic location, richness of fishery resources and primary productivity and for species diversity. Total surface area of Karimganj upazila (Kishoreganj) is 200.52 km^2, located in between 24º22' and 24º32' north latitudes and 90º48' and 91º01' east longitudes. It is bounded by Tarail and Itna upazilas in north, Nikli, Katiadi and Kishoregonj Sadar upazilas in south, Nikli and Mithamoin upazilas in east, Kishoreganj Sadar upazila in west. In Karimganj, there is a renowned fish landing station called "Chamra Bondor". Most of fish caught in the Kishorgong haor region has been landed to this station.

Collection of Data

Samples of fish were collected from the fishermen' catches landed at different stations in the study area

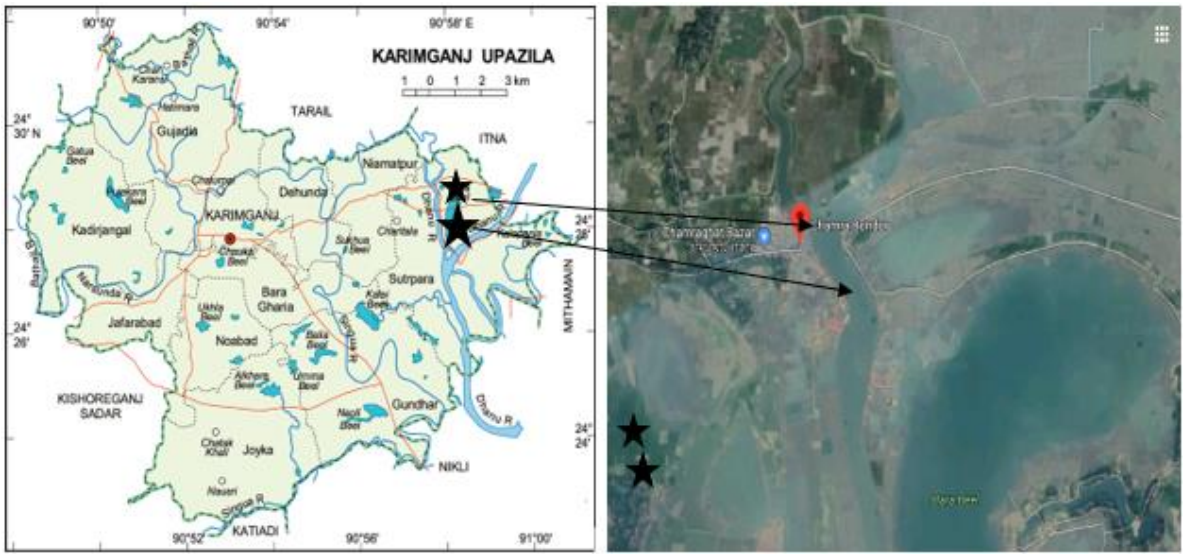

Figure 1. Map of the study area.

and from fish markets as well. Monthly sampling was carried out from July 2017 to December 2018. Plankton samples were collected personally by monthly field visits to the study area. Historical fishing data were collected by means of interviews conducted with boat owners of commercial fishing vessels, retailers, fish traders, local people, sport fishers, riverside settlers and from the sampling area. Additional historical data was also acquired from various relevant scientific articles, reports, maps website, library, Bangladesh Fisheries Research Institute, Department of Fisheries of Bangladesh and some local NGO offices.

Fish Identification

Most of the collected fish species were identified on the spot with the help of prepared freshwater fisheries resources list, related books and IUCN red list 2015. Fish samples were also brought to the laboratory for double confirmation to identify the fish species. The fish specimens were identified based on the morphometric and meristic appearances according to Rahman (2005), Talwar and Jhingran (1991).

Plankton Sampling

Monthly plankton samples from July 2017 to December 2018 were collected from 8 different locations in the Kishoreganj haor. Sampling was performed by using a plankton net with a mesh size of 25µm and a cod end to retain the organisms. The net was towed horizontally, and the plankton samples were collected from the sub-surface layer (0.2-0.5 m) of the water column. Immediately after collection, all samples were preserved in 5% buffered formalin and stored in 250 ml labeled plastic bottles. Then, the sample bottles were brought to the laboratory of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh, Bangladesh for qualitative analysis under microscope.

Identification of Plankton

Collected planktons were sorted out with the help of fine brushes, needle, forceps and an inverted microscope (OPTIA B- 350 Italy). Plankton sample was picked up with plastic dropper from plastic bottle. Then sample kept on glass slide for identification. Identification of plankton was done according to Bellinger (1992). Zooplanktons were identified following the keys given by Bhouyain and Asmat (1992).

Fish and Plankton Diversity Analysis

In this study, the Shannon-Weaver diversity index (1949) was calculated for evaluating the status of fish diversity using the following formulae:

$$H' = -\sum_{i=1}^{R} p_i \ln p_i$$

Where, H´ is the diversity index, p is the proportion (n/N) of individuals in one particular species (n) to the total number of individuals found (N), and R is the total number of species.

Results

Fisheries Resources

During the study period, a total of 79 fish species belonging to 27 families under 9 orders were collected from Chamra Bondor fish landing station, Karimganj, Kishoreganj, Bangladesh. Cypriniformes was the most dominant family with 31 species followed by Siluriformes (21 species), Perciformes (16 species), Clupeiformes (4 species), Anguilliformes (2 species), Beloniformes (2 species), Synbrachiformes (1 species), Tetraodontiformes (1 species) and Cyprinodontiformes (1 species) (Table 1 and Figure 2).

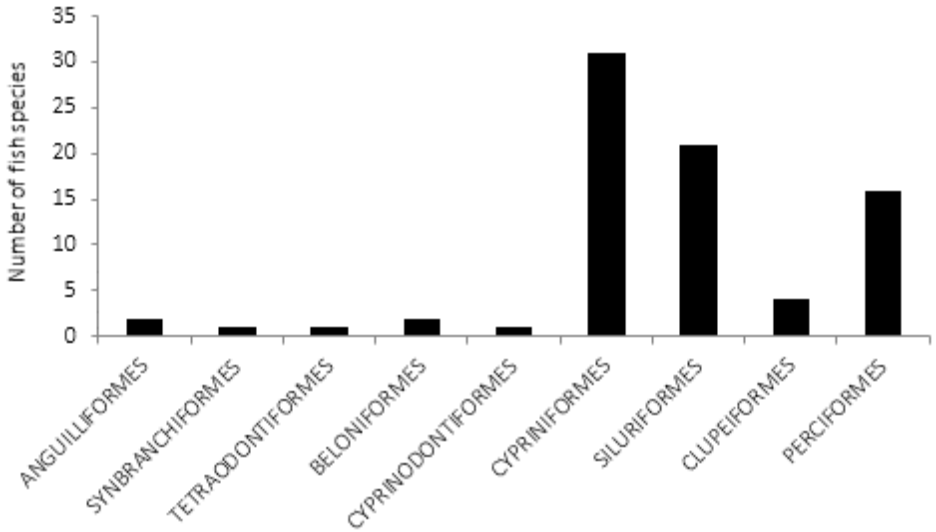

Figure 2. Species richness of different fish orders in the Kishoreganj haor during 2017-2018.

Table 1. Monthly variations in habitation rate of sea cucumbers

Order	Family	Scientific name	Local name	English name	Present status	IUCN status	No. of Species	Diversity index (H´)
ANGUILLIFORMES	ANGUILLIDAE	*Anguilla bengalensis*	Bamos, Bau baim	Giant Mottled Eel	RA	VU	2	1.1
	OPHICHTHIDAE	*Pisodonophis boro*	Nol baim	Rice-paddy Eel	CA	NO		4.0
SYNBRANCHIFORMES	SYBRANCHIDAE	*Monopterus cuchia*	Kuiccha	Cuchia/ Gangetic Mudeel	RA	VU	1	1.5
TETRAODONTIFORMES	TETRAODONTIDAE	*Tetraodon cutcutia*	Potka	Pufferfish	MA	NO	1	2.9
BELONIFORMES	BELONIIDAE	*Xenentodon cancila*	Kaikka	Freshwater Garfish	MA	NO	2	2.8
	HEMIRAMPHIDAE	*Hyporamphus limbatus*	Subol kaikka	Congaturi Halfbeak	RA	NO		1.2
CYPRINODONTIFORMES	CYPRINODONTIDAE	*Aplocheilus panchax*	Kanipona	Panchax Minnow	MA	NO	1	3.2
CYPRINIFORMES	CYPRINIDAE	*Securicula gora*	Naukka chela	Gora Chela	RA	NO	31	1.2
		Salmostoma phulo	Chela	Finescaled Razorbelly Minnow	MA	NO		2.7
		Salmostoma bacalia	Chela	Large Razorbelly Minnow	MA	NO		2.8
		Esomus danricus	Darkina	Flying Barb	RA	DD		1.3
		Parluciosoma daniconius	Darkina	Blackline Rasbora	RA	DD		1.4
		Barilius bendelisis	Nunchora	Hamilton's Barila	RA	EN		1.1
		Danio devario	Kash khauri	Devario Danio	CA	NO		4.1
		Amblypharyngodon mola	Mola	Pale Carplet	CA	NO		4.2
		Osteobrama cotio	Gilachaki	Cotio	RA	EN		1.2
		Labeo gonius	Ghonia	Kuria Labeo	RA	EN		1.3
		Labeo calbasu	Kalbaush	Kalibasu	RA	EN		1.9
		Labeo rohita	Rou/rui	Rohu	MA	NO		3.0
		Labeo angra	Karish, Dirua	Angra Labeo	RA	NO		1.4
		Labeo boggut	Nunia	Boggut Labeo	RA	DD		1.5
		Cirrhinus cirrhosus	Mrigal	Mrigal Carp	MA	NO		3.2
		Puntius sarana	Deshi sarpunti,	Olive Barb	RA	CR		1.7

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		Barbonymus gonionotus	Thai sarpunti	Silver Barb	RA	Not listed		1.8
		Puntius guganio	Titpunti	Glass Barb	MA	NO		3.0
		Puntius phutunio	Titpunti	Pigmy Barb	CA	NO		4.1
		Puntius conchonius	Punti	Rosy Barb	CA	NO		3.5
		Puntius ticto	Tita punti	Two-spot Barb	MA	VU		3.0
		Puntius sophore	Jat punti	Pool Barb	CA	NO		4.2
		Puntius terio	Teri punti	Onespot Barb	CA	NO		4.0
		Catla catla	Katal	Catla	MA	NO		3.6
		Hypophthalmichthys molitrix	Silver carp	Silver Cap	RA	Not listed		1.5
		Cyprinus carpio	Carpu	Common Carp	RA	Not listed		1.7
	BALITORIDAE	*Nemachilus botia*	Gutum	Mottled Loach	MA	DD		3.1
		Nemachilus zonalternans	Gutum	River Loach	MA	DD		3.2
	COBITIDAE	*Botia dario*	Bou mach	Bengal Loach	RA	EN		1.9
		Lepidocephalus guntea	Gutum	Guntea Loach	MA	NO		3.3
		Lepidocephalichthys annandalei	Gutum	Annandalei Loach	RA	NO		2.0
SILURIFORMES	CLARIIDAE	*Clarias batrachus*	Magur	Walking Catfish	CA	NO	21	4.1
	SILURIDAE	*Wallago attu*	Boal	Wallago	CA	NO		4.2
		Ompok bimaculatus	Pabda	Butter Catfish	CA	EN		3.5
		Ompok pabda	Lali paibba	Gulper Catfish	RA	EN		2.5
	HETEROPNEUSTIDAE	*Heteropneustes fossilis*	Shingi	Stinging Catfish	CA	NO		4.3
	SCHILBEIDAE	*Silonia silondia*	Shilon	Silond Catfish	CA	EN		3.2
		Ailia coila	Kajuli	Gangetic Ailia	CA	NO		3.5
		Pseudeutropius atherinoides	Batai	Indian Potasi	RA	NO		1.3
		Eutropiichthys vacha	Bacha	Batchwa Bacha	CA	CR		4.0
		Eutropiichthys murius	Bacha, Muri bacha	Indus Garua	CA	NO		3.4
		Clupisoma garua	Ghaura	Gagra	MA	CR		3.1
	BAGRIDAE	*Rita rita*	Rita, Rida	Rita	RA	CR		1.9
		Aorichthys aor	Ayer	LongWhiskered Catfish	CA	VU		3.7
		Aorichthys seenghala	Kata	Giant River-Catfish	MA	EN		2.8
		Hemibagrus menoda	Gang magur	Menoda Catfish	MA	NO		2.6
		Mystus cavasius	Gulsha	Gangetic Mystus	CA	VU		4.0
		Mystus bleekeri	Gulsha	Day's Mystus	CA	NO		4.1
		Mystus tengara	Bajari tengra	Tengara Mystus	CA	NO		4.2

		Mystus vittatus	Tengra	Striped Catfish	CA	NO		4.1
	SISORIDAE	*Gagata chenia*	Gun mach	Clown Catfish	RA	NO		1.5
		Bagarius bagarius	Bagha ayer	Gangetic oonch	MA	CR		2.6
CLUPEIFORMES	NOTOPTERIDAE	*Chitala chitala*	Chital	Clown Knifefish	MA	EN	04	2.9
		Notopterus notopterus	Foli	Bronze Featherback	MA	VU		3.2
	ENGRAULIDAE	*Setipinna phasa*	Bansh pata	Gangetic Hairfin Anchovy	RA	NO		1.8
	CLUPEIDAE	*Corica soborna*	Kachki	Ganga River Spart	RA	NO		1.3
PERCIFORMES	CHANNIDAE	*Channa striatus*	Shol	Striped Snaked	MA	NO	16	3.6
		Channa punctatus	Taki	Spotted Snakehead	CA	NO		3.7
		Channa orientalis	Taki, Telo taki	Walking Snakehead	MA	VU		3.1
	MASTACEMBELIDAE	*Macrognathus aral*	Tara baim	One-Stripe Spinyeel	MA	VU		3.2
		Mastacembelus armatus	Shal baim	Zig-Zag Eel	RA	EN		2.6
		Macrognathus pancalus	Guchi baim, Chikra	Striped Spinyeel	MA	NO		3.6
	BELONTIIDAE	*Colisa chuna*	Koiya chata	Honey Gourami	RA	NO		2.2
		Colisa fasciata	Khailsha	Giant Gourami	MA	NO		3.5
		Colisa lalia	Chata	Dwarf Gourami	MA	NO		3.4
	ANABANTIDAE	*Anabas testudineus*	koi	Climbing Perch	CA	NO		4.1
	GOBIIDAE	*Glossogobius giuris*	Baila	Tank Goby	CA	NO		4.0
		Brachygobius nunus	Bali kora	Bumblebee Goby	MA	NO		3.2
	NANDIDAE	*Nandus nandus*	Bheda, meni	Mud Perch	MA	VU		3.1
	CICHLIDAE	*Oreochromis niloticus*	Nilotica	Nile Tilapia	RA	Not listed		1.6
	AMBASSIDAE	*Chanda nama*	Chanda	Elongate Glass-perchlet	MA	VU		3.2
		Parambassis ranga	Tek chanda	Indian Glassy Fish	MA	VU		3.3
Average								2.8±1.0

[CA= Commonly available species, MA= Moderately available species, RA= Rarely available species, DD= Data Deficient, NO= Not Threatened, VU= Vulnerable, EN= Endangered, CR= Critically Endangered.]

Fish Availability in the Kishoreganj Haor

Comparing the present status of fish diversity with past status, it is clearly indicated that the number of fish species declined due to anthropologic factors (Figure 3).

Qualitative Analysis of Phytoplankton

A total of 23 phytoplankton species were identified under 4 classes. A total of 8 species of Bacillariaophyceae, 9 species of Chlorophyceae, 3 species of Cyanophyceae and 3 species of Euglenophyceae classes were listed from the study area (Table 2).

Qualitative Analysis of Zooplankton

A total of 3 groups of zooplankton were identified, i.e. Rotifera, Cladocera and Copepoda in Kishoreganj haor region. A total of 5 species of Rotifera, 4 species of Copepoda and 4 species of Cladocera were identified during the study period in Kishoreganj haor region. (Table 2)

Diversity Indices of Fish and Plankton

The values of diversity indices of fish were fluctuated from 1.1 to 4.3 with mean value of 2.8±1.0. Phytoplankton diversity indices were fluctuated from 2.9 to 3.2 and 1.7 to 2.6 with mean value of 3.10±0.17 and 2.10±0.41 during wet and dry seasons, respectively while zooplankton diversity indices were fluctuated from 3.1 to 3.2 and 1.6 to 1.7 with mean value of 3.13±0.58 and1.63±0.12 during wet and dry seasons, respectively.

Discussion

Fish Diversity in the Study Area

Freshwater fisheries sector plays an important role in the economy of Bangladesh. Diversity of fishes is the key to meet ecological balance. Fisheries resources in Kishoregong haor are characterized by a very high degree of endemism. This region is considered as home of many freshwater fish species. Among them, most of the fish are commercially important. This haor supports several rare and threatened fish species. For example, some critically endangered species like *Anguilla bengalensis*, *Monopterus cuchia*, *Osteobrama cotio*, *Labeo gonius*, *Puntius sarana*, *Botia dario*, *Corica soborna*, *Rita rita*, *Bagarius bagarius,* and *Colisa chuna* are available in Kishoreganj haor region. The diversity indices of these fish species were from 1.1 to 1.9 while the diversity index was above 4.0 for some available fish species and the average value of Kishoreganj haor was 2.8±1.0. Khanom *et al.* (2016) found that the average value of diversity index of fish in Shiba river of Bangladesh was 1.86 while Iqbal *et al* (2015) found the range of diversity index of fish in Konoskhai haor at Northeast Bangladesh was from 2.9 to 3.1. Considering the diversity index of fish, Kishoreganj haor is rich in fish. Iqbal *et al.* (2015) listed 83 species of fishes in the Hakaluki haor belonging to 55 genera, 28 families and 10 orders where Cypriniformes was found to the most dominant order comprising 73% followed by Siluriformes (13%) and Perciformes (9%). Trina *et al.* (2016) found 74 fish species where 8 were critically endangered, 17 were endangered, 9 were vulnerable and 39 were not threatened in Dekhar haor under Sunamganj, which is quite similar with the present

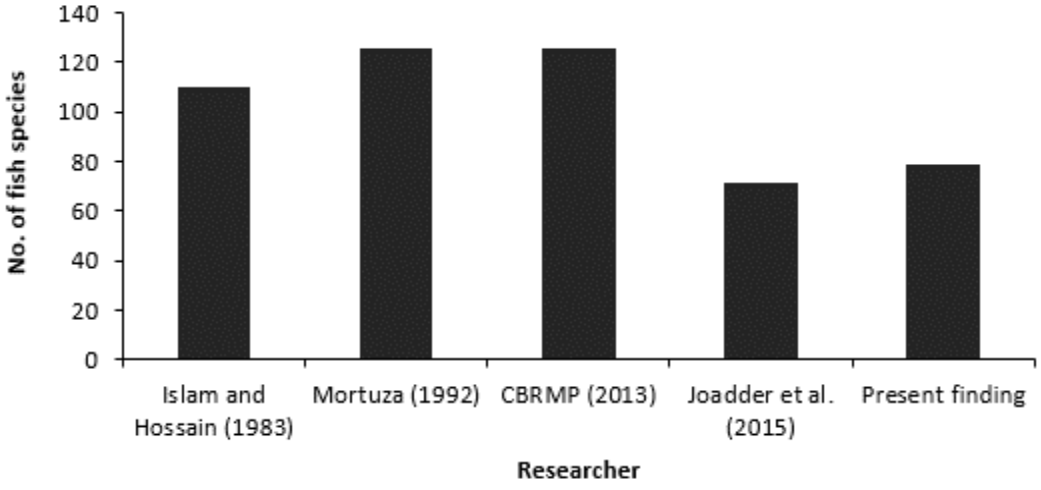

Figure 3. Comparison between the present and past status of fish species richness in the Kishoreganj haor.

Table 2. List of plankton genera found in the Kishoreganj haor during 2017-2018

Plankton	Group	Wet season Genera/species	Diversity Index (H´)	Dry season Genera/species	Diversity Index (H´)
Phytoplankton	Bacillariaophyceae	*Navicula* sp.	3.3	*Navicula* sp.	2.6
		Gyrosigma sp.		*Gyrosigma* sp.	
		Nitzschia sp.		*Nitzschia* sp.	
		Synedra sp.		*Synedra* sp.	
		Cyclotella sp.		*Bacillaria* sp	
		Bacillaria sp.			
		Rhizosolenia sp.			
		Chaetoceros sp.			
	Chlorophyceae	*Spirogyra* sp.	3.1	*Spirogyra* sp.	2.2
		Ulothrix sp.		*Ulothrix* sp.	
		Volvox sp.		*Volvox* sp.	
		Spirulina sp.			
		Chlorella sp.			
		Coleochaete sp.			
		Microspora sp.			
		Melosira sp.			
		Cosmarium sp.			
	Cyanophyceae	*Oscillatoria* sp.	3.0	*Oscillatoria* sp.	1.8
		Anabaeca sp.			
		Microcystis sp.			
	Euglenophyceae	*Euglena* sp.	2.9	*Euglena* sp.	1.7
		Phacus sp.		*Phacus* sp.	
		Trachelomonas sp.			
Average			3.10±0.17		2.10±0.41
Zooplankton	Rotifera	*Brachionus* sp.	3.2	*Brachionus* sp.	1.7
		Keratella sp.		*Keratella* sp.	
		Filinia sp.			
		Asplanchna sp.			
		Polyarthra sp.			
	Cladocera	*Moina* sp.	3.1	*Moina* sp.	1.6
		Daphnia sp.		*Daphnia* sp.	
		Bosmina sp.			
		Diaphanosoma sp.			
	Copepoda	*Cyclops* sp.	3.1	*Cyclops* sp.	1.7
		Diaptomus sp.		*Diaptomus* sp.	
		Macrocyclops sp.			
		Mesocyclops sp.			
Average			3.13±0.58		1.63±0.12

findings. Islam *et al.* (2008) have recorded 108 species under 29 families of 10 orders from Tanguar Haor. Moreover, Pandit *et al.* (2015) listed 84 fish species from Dekhar haor of Sunamganj. Most of their findings are very similar to the present study. In the present study, the abundance of nandina (*L. nandina*), elong (*Bengala elanga*), batasi (*Batasio tengana*), rita (*Rita rita*), kajoli (*Ailia unctate*), garua (*Clupisoma garua*) and shilong (*Silonia silondia*) were found to be very low probably due to over exploitation and habitat degradation. Fish population is decreasing due to over exploitation and other anthropologic activities; and habitats of the Meghna, Laukhati and Galachipa rivers are degraded as well as livelihood of fishermen is below standard (Rahaman *et al.* 2019 and 2020; Hossain *et al.* 2018). It is clearly indicated that the abundance of fishes is decreased sharply. Probably because, fishermen capture a large number of fish specimens by small mesh sized nets in Kishoreganj haor. The fish species diversity was also decreased by rising temperature in Kishoreganj haor region. The abundance and distribution of fish species is controlled by water quality and primary productivity in rivers of Kishoreganj. However, fish availability has also been reduced for overfishing effort and blocking fish migration route.

Primary Productivity in the Kishoreganj Haor Region

Plankton plays an important role as a primary producer in haor ecosystem and it is an important source of food for fish. Phytoplankton is an important primary producer and constitutes the basis of nutrient cycle of an ecosystem (Singh *et al.,* 2013). Plankton growth, biomass and productivity are influenced by the nutrients, light and water temperature. Phytoplankton and zooplankton abundance varies from one water system to another. In the present study, a total 23 phytoplankton genera under 4 groups was identified.

Bacillariophyceae, Chlorophyceae were the dominant and common group in the present study area. Other recorded common genera were: *Navicula* sp*., Gyrosigma* sp., *Nitzschia* sp*., Synedra* sp*., Cyclotella* sp*., Bacillaria* sp*., Rhizosolenia* sp*., Spirogyra* sp., *Ulothrix* sp*., Volvox* sp*.,* and *Euglena* sp*.*. Azher *et al*. (2006) listed 60 genera of phytoplankton in Kishoreganj haor region where Chlorophyceae was the major group. Ahsan *et al.* (2012) listed a total 19 taxa (32.76%) of phytoplankton where Chlorophyceae (7 taxa) was the most dominant group in the Meghna river. In addition, Rahaman *et al*. (2016) and Rahaman *et al*. (2018) reported data quite similar to the present study. In Kishoreganj haor region, *Nitzschia* sp*., Synedra* sp*.* and *Oscillatoria* sp*.* were found in wet and dry seasons. These species indicate the pollution of water in the study area (Singh *et al.,* 2013). In addition, *Microcystis* sp*.,* and *Euglena* sp*.* were also found in the study area, which indicate the eutrophic condition in the water body (Singh *et al.,* 2013). In Kishoreganj haor, phytoplankton diversity indices were fluctuated from 2.9 to 3.2 and 1.7 to 2.6 with mean value of 3.10±0.17 and 2.10±0.41 during wet and dry seasons, respectively. It indicated that Kishoreganj haor was a productive water body during study period. Ekhator and Alika (2016) reported the phytoplankton diversity of the Osse river, Edo State, Nigeria was ranged from 1.8 to 3.4. Similarly, Miao (2019) found the fluctuation of phytoplankton from 1.44 to 3.08 in the Backshore Wetland in Shanghai, China.

Zooplanktons do not depend directly on nutrients to survive. Zooplanktons play important roles in food chain by linking primary producers and higher trophic levels (Xu *et al.,* 2001). In the present study, a total of 12 zooplankton genera under 3 groups (Rotifera, Cladocera and Copepoda) were identified. Rotifera (*Brachionus* sp*., Keratella* sp*., Filinia* sp*., Asplanchna* sp*., and Polyarthra* sp.) was the dominant group in the present study area. Other recorded common species were *Brachionus* sp*., Keratella* sp*., Moina* sp*., Daphnia* sp*., Bosmina* sp*., and Cyclops* sp.. Ahmed *et al.* (2003) was also found quite similar results mentioned 13 zooplankton genera in the Meghna river. In additiona, 15 genera (*Daphnia* sp*., Ceriodaphnia* sp*., Diaphanosoma* sp*., Bosmina* sp*., Moina* sp*., Cyclops* sp*., Diaptomus* sp*., Brachionus* sp*., Keratella* sp*., Filinia* sp*., Tiichocera* sp*., Filinia* sp*., Lecane* sp*.* and *Polyarthra* sp*.)* of zooplankton were listed in Kishoreganj haor (Rahman *et al*., 2005 and Azher *et al*., 2006) . In the present study, *Moina* sp. and *Cyclops* sp*.* were also found in both dry and wet season, which indicate the pollution of water body in the Kishoreganj haor (Jha and Barat, 2003). In Kishoreganj haor, zooplankton diversity indices were fluctuated from 3.1 to 3.2 and 1.6 to 1.7 with mean value of 3.13±0.58 and 1.63±0.12 during wet and dry seasons, respectively. Ismail and Zaidin (2015) found that the zooplankton diversity indices were changed from 1.07 to 1.21 in different types of water bodies in Indonesia. These results indicated that Kishoreganj haor was rich with zooplankton during the study period.

Conclusion

Considering the data of the present study, it can be concluded that the fish and plankton diversity in Kishoregonj haor is good even though abundance of some fish species are declining day by day. The use of destructive nets, indiscriminate fishing, ban of fishing during breeding season will be the effective actions to save the biodiversity in Kishoregonj haor.

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