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Present status of fish biodiversity and abundance in Shiba river, Bangladesh

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Abstract: The study was conducted to investigate the abundance and present status of fish biodiversity in the Shiba river at Tanore Upazila of Rajshahi district, Bangladesh. The study was conducted from November, 2016 to February, 2017. A total of 30 species of fishes were recorded belonging to nine orders, 15 families and 26 genera. Cypriniformes and Siluriformes were the most diversified groups in terms of species. Among 30 species, nine species under the order Cypriniformes, nine species of Siluriformes, five species of Perciformes, two species of Channiformes, two species of Mastacembeliformes, one species of Beloniformes, one species of Clupeiformes, one species of Osteoglossiformes and one species of Decapoda, Crustacea were found. *Machrobrachium lamarrei* of the family Palaemonidae under Decapoda order was the most dominant species contributing 26.29% of the total catch. In the Shiba river only 6.65% threatened fish species were found, and among them 1.57% were endangered and 4.96% were vulnerable. The mean values of Shannon-Weaver diversity (H), Margalef's richness (D) and Pielou's (e) evenness were found as 1.86, 2.22 and 0.74, respectively. Relationship between Shannon-Weaver diversity index (H) and pollution indicates the river as light to moderate polluted. Whereas Margalef's richness index (D) and water pollution shows the pollution level of Shiba river as moderate to serious.

Key words: Biodiversity, Shiba river, Bangladesh, richness, evenness, threatened species

Introduction

Biodiversity is often used as a measure of the health of biological system (Alam *et al*., 2013). Bangladesh is very rich in fish diversity. It has endowed with the diverse inland waterbodies (floodplain, lakes, canals, ditches, ponds). In addition, coastal and marine fisheries also have a large biodiversity by its own natural environmental resources. A fairly large numbers of big rivers with their tributaries and branches criss-cross the country and act as a drainage outlet for a vast river basin complex made up of the Ganges-Brahmaputra-Meghna river system and rich in various fisheries resources (Joadder, 2012). There are about 700 rivers in Bangladesh and each river has its own geographical, hydrological, sedimentary and biological characteristics (Alam *et al*., 2013). The rivers offer immense scope and potentiality for augmenting fish production and socio-economic security of the people living around (Rahman *et al*., 2015). The Shiba River flows south for about 45km and creates a great meander near Nowhata, Rajshahi where it is renamed as the Barnai and flows northeast. The total length of the Shiba-Barnai-Gur Nodi river is about 130km and the course is free of tidal influence (Murshed, 2003). Reduction of biodiversity of fresh water fish species in Bangladesh is a major concern. A total of 253 fish species were assessed by IUCN Bangladesh (2015), of which 64 species (25.3%) have been found threatened. The threatened fishes comprise nine species as critically endangered, 30 species endangered, and 25 species as vulnerable. Critically endangered species showed a decrease by 25% whereas the endangered and vulnerable species showed increases by 21.4% and 78.5%, respectively, compared to the year of 2000. Trend of decreasing fisheries biodiversity is well documented in Bangladesh and has been reported by Islam *et al.* (2016) in the Sibsha river in South-Western Bangladesh; Alam *et al*. (2013) in Upper Halda River; Rahman *et al*. (2012) in Padma Distributary of the Ganges River, Northwestern Bangladesh; Mia *et al.* (2015) in Meghna River; Rahman *et al*. (2015) in Talma River at Northern part of Bangladesh; Galib *et al*. (2013) in Choto Jamuna River; Mohsin *et al*. (2013) in the Padma River and so on. Fisheries species diversity status of

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the Shiba river is still unreported, so the present study was taken with a view to assess the fisheries species diversity and abundance in the Shiba River of Rajshahi, Bangladesh.

Materials and Methods

Study area

The Shiba river is a branch of the Padma river which flows south for about 45 km and creates a great meander near Nowhata, Rajshahi where it is renamed as the Barnai and flows northeast (Bashar *et al.* 2009). The present study was carried out within 3km starting from Burujghat to Kaligong Bridge Ghat at Tanore Upazilla of Rajshahi district (Fig. 1).

Study period

The study was carried out for a period of four months from November, 2016 to February, 2017. The river was full to the brim from the month of June to October as a result fishing was limited.

Collection and identification of fish species

The fishermen those using seine net (Berjal) were selected for collection of catch information. Data were collected fortnightly. It took approximately 3 hours for one haul. After each haul fishes were counted and weighed using pan balance, species wise. The collected fish samples were identified by evaluating their morphometric and meristic characteristics as well as the colour of the specimens. The taxonomic analysis was performed according to Rahman (2005), Talwar & Jhingran (1991) and IUCN Bangladesh (2015). Then fish species were systematically classified according to Nelson (2006). Recorded data were sorted, tabulated and analyzed to calculate different diversity indices and percent composition of fish species.

Species assemblage and fish diversity analysis

In this study, the Shannon- Weaver diversity index (**H**), Pielou's evenness index (***e***) and Margalef's richness index (**D**) were calculated for evaluating the status of fish diversity using the following formulae:

Shannon- Weaver diversity index,

H = – Σ Pi ln Pi (Shannon and Weaver, 1949)

Here, **H** is the diversity index and **Pi** is the relative abundance (s/N).

Margalef's richness index,

$$D = \frac{s-1}{\ln N}$$ (Margalef, 1968).

Here, ***s*** is the number of individual for each species, **N** is the total number of individuals and **D** is the richness index

Pielou's Evenness index,

$$e = \frac{H}{\ln S}$$ (Pielou, 1966).

Here, **S** is the total number of species, ***e*** is the similarity or evenness index, **ln** is the natural logarithm and **H** is the diversity index.

Results

Species assemblage and distribution in the Shiba River

A total of 1533 fish individuals comprising 30 species belonging to 16 families and 9 orders were sampled throughout the entire study period (Table 1). The order Perciformes (with 4 species), Cypriniformes (with 9 species) and Decapoda, Crustacea (with 1 species), each contributed about 26% of the total fish catch followed by Siluriformes 11.09%(with 9 species), Clupeiformes 4.37% (with 1 species), Channiformes 2.41%(with 2 species), Mastacembeliformes 2.15% (with 2 species) Beloniformes 0.52% (with 1 species) and Osteoglossiformes 0.13%(with 1 species) respectively (Fig. 2). In the study, one species of Decapoda (*Machrobrachium lamarrei*) under Palaemonidae was observed.

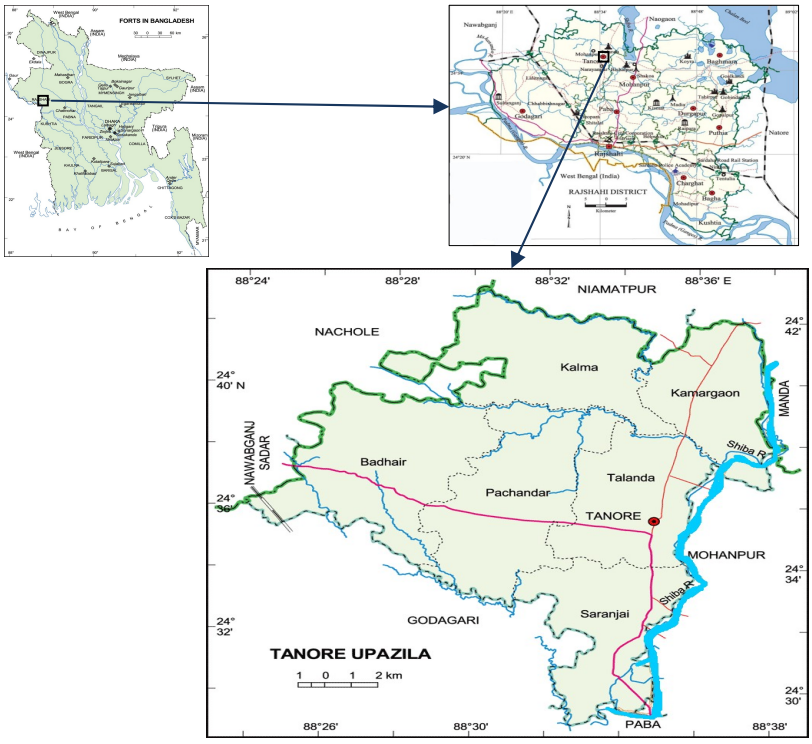

Fig. 1. Map of Tanore Upazila indicating the Shiba river (☐)

This single species contributed about 26.29% of the total catch. Though Cypriniformes, Perciformes and Decapoda each contributed about 26% of the total fish catch in number but Siluriformes (36.30%) was the dominant order followed by Cypriniformes (34.34%) and Channiformes (17.59%) in weight of total catch. While Decapoda comprised only 2.09% of weight of total catch (Fig. 3).

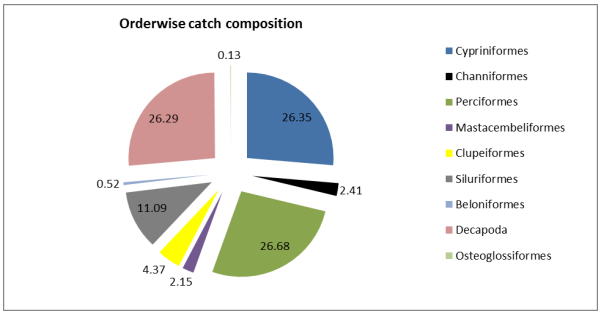

Fig. 2. Order wise fish species composition of individual number in the Shiba river

Biodiversity status of fish species

A total of 30 fish species were recorded. According to IUCN Red Book of threatened fishes of Bangladesh, 2015 among the recorded individuals 18 fishes were widespread and abundant (least concern), 4 species were near threatened, 3 species were endangered, 4 species were vulnerable and 1 species was not evaluated (Table 2). Order wise threatened fish species are shown in Fig. 4.

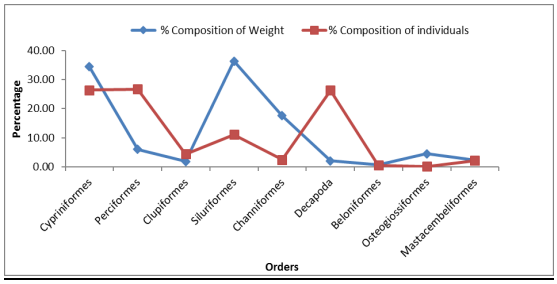

Fig. 3. Relationship between order wise fish species composition of individual number and weight by total catch (%) in Shiba river

Table 1. Fish diversity of the Shiba river with their status and percentage of total catch

Order	Family	Sl no	Scientific name	Local name	English Name	Status (IUCN Bangladesh 2015)	% of total catch
Cypriniformes	Cyprinidae	1	*Puntius sophore*	Punti	Pool barb	LC	22.70
		2	*Salmophasia bacaila*	Chela	Large razor belly minnow	LC	1.44
		3	*Systomus sarana*	Sarputi	Olive barb	NT	0.26
		4	*Amblypharyngodon mola*	Moa, Mola	Molacarplet	LC	0.52
		5	*Cirrhinus cirrhosus*	Mrigel, Mirka	Mrigal carp	NT	0.13
		6	*Lebeo calbasu*	Kalibause	Orange-fin labeo	LC	0.46
		7	*Cirrhinus reba*	Rikhor	Reba	NT	0.46
		8	*Labeo rohita*	Rui	Roholabeo	LC	0.33
		9	*Osteobrama cotio*	Dhela	Cotio	NT	0.07
Perciformes	Ambassidae	10	*Chanda nama*	Chanda	Elongate glass-perchlet Asian Glass Fish	LC	21.92
	Gobiidae	11	*Glossogobius giuris*	Baila, Bele	Gangetic Tank goby, Freshwater Goby	LC	2.02
	Anabantidae	12	*Anabas testudineus*	Koi	Climbing perch, Walking Fish	LC	0.07
	Osphronemidae	13	*Trichogaster fasciata*	Boro Kholisa	Banded gourami, Giant gourami	LC	2.67
Beloniformes	Belonidae	14	*Xenentodon cancila*	Kakila	Freshwater Garfish	LC	0.52
Clupeiformes	Clupeidae	15	*Gudusia chapra*	Chapila, Khaira	Indian river shad	VU	4.37
Siluriformes	Bagridae	16	*Mystus cavasius*	Gulsha Tengra	Gangetic mystus	NT	1.96
		17	*Mystus tengara*	Tengra	Tengara mystus	LC	3.91
		18	*Sperata aor*	Ayre	Long whiskered catfish	VU	0.13
		19	*Rita rita*	Rita	Rita	EN	0.20
	Heteropneustidae	20	*Heteropneustes fossilis*	Shing	Stinging catfish	LC	2.67
	Siluridae	21	*Ompok pabda*	Pabda	Pabda catfish	EN	1.04
		22	*Wallago attu*	Boal	Freshwater shark	VU	0.33
	Schilbeidae	23	*Pseudeutropius atherinoides*	Patasi, Batashi	Indian Potasi	LC	0.72
	Arridae	24	*Arius gagora*	Gagor	Gagora catfish	NE	0.13
Channiformes	Channidae	25	*Channa striatus*	Shol	Snakehead murrel	LC	0.59
		26	*Channa punctatus*	Taki	Spotted snakehead	LC	1.83
Osteoglossiformes	Notopteridae	27	*Notopterus notopterus*	Foli	Freshwater Knife Fish	VU	0.13
Mastacembeliformes	Mastacembelidae	28	*Macrognathus pancalus*	Guchi	Stripped Spinyeel	LC	1.83
		29	*Mastacembelus armatus*	Baim	Tire-track Spinyeel	EN	0.33
Decapoda	Palaemonidae	30	*Macrobrachium lamarrei*	Gura Chingri	Kuncho River Prawn, Monsoon River Prawn	LC	26.29
Total		**30 species**					**100%**

Note: Status LC (Least concern), NT (Near threatened), VU (Vulnerable), NE (Not evaluated), based on IUCN Bangladesh (2015)

Table 2. Status and number of fish species found in the study area

Status	No. of species	Percentages (%)
Least concern (LC)	18	92.44
Near Threatened (NT)	4	0.91
Endangered (EN)	3	1.57
Vulnerable (VU)	4	4.96
Not Evaluated	1	0.13
Total	**30**	**100.00**

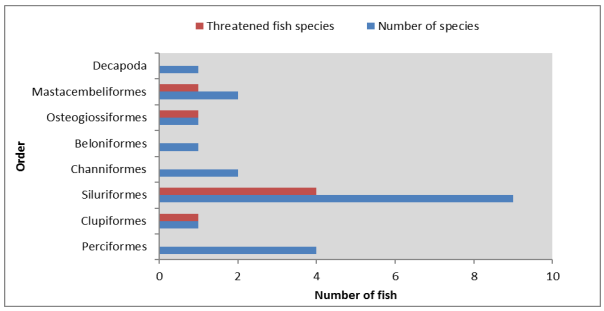

Fig. 4. Number of threatened fish species under different orders detected in the study period

Table 3. Number of studied species and individuals, and respective values of Shannon –Weaver diversity (H), Margalef richness (D) and evenness (*e*) indices in each sampling date

Sampling Date	No. of species	No. of individuals	H	D	*e*
1st Fortnight of November	13	269	1.96	2.14	0.76
2nd Fortnight of November	11	217	1.90	1.86	0.79
1st Fortnight of December	16	217	2.13	2.79	0.77
2nd Fortnight of December	13	225	2.10	2.22	0.82
1st Fortnight of January	16	180	1.89	2.89	0.68
2nd Fortnight of January	13	173	1.89	2.33	0.74
1st Fortnight of February	11	114	1.60	2.11	0.67
2nd Fortnight of February	08	138	1.45	1.42	0.70
Total	**30**	**1533**	**Mean 1.86±0.23**	**Mean 2.22±0.47**	**Mean 0.74±0.05**

Fish species diversity indices

The bimonthly values of Shannon-Weaver diversity (**H**), Margalef's richness (**D**) and Pielou's evenness (***e***) are shown in Table 3. The value of H fluctuated from 1.45 (in 2nd fortnight of February) to 2.13 (in 1st fortnight of December) (Table 3) with mean value of (1.86±0.23). Significant difference was observed among January and February (F= 2.157, F critical= 1.88; *P* = 0.023). Relationship between Shannon-Weaver index (H) and pollution level is shown in Table 4.

The tiniest Margalef's richness index was observed in 2nd fortnight of February (1.42) and highest in 1st fortnight of January (2.89) presented in table 3 with mean value of (2.18±0.38). **H** and **D** values was the lowest in 2nd fortnight of February. The minimum number of fish species was also recorded during this time. The minimum number of fish species was also recorded during this time. The peak mean evenness value (0.82) was observed in 2nd fortnight of December and lowest (0.68) in 1st Fortnight of January with mean value of (0.74±0.05). Relationship between Margalef'srichness index (**D**) and pollution level is shown in Table 5.

The species richness (**D**) generally is a more reliable measure of biodiversity. Species richness was found highest for both Cypriniformes and Siluriformes which was 1.64. The lowest **D** value (0.18) was found in Clupiformes, Beloniformes, Osteoglossiformes and Decapoda (Table 6).

Table 4. Shannon-Weaver index (H) and pollution level given by Staubt *et al*. (1970), Biligrami (1988) and Lad (2015)

Shannon-Winner Diversity index(H')	Pollution level	Values found in the present study
3.0-4.5	Slight pollution	1.45-2.13
2.0-3.0	Light pollution	
1.0-2.0	Moderate pollution	
0.0-1.0	Heavy pollution	

Table 5. Margalef's richness index and pollution level (Lad, 2015)

Margalef's Richness Index (D)	Water pollution	Values found in the present study
0-1	More serious pollution	1.42-2.89
1-2	Serious pollution	
2-4	Moderate pollution	
4-6	Light pollution	
> 6	Clear water	

Biodiversity status of vulnerable fish species

Among vulnerable fish species Chapila (*Gudusia chapra*) contributed highest percentage 4.37%, following Boal *(Wallago attu*) *0*.33%, Ayre (*Sperata aor*) and Foli (*N. notopterus)* both contributed 0.18% on the basis of total individuals encountered in the study area.

Biodiversity status of endangered fish species

Among endangered Pabda (*Ompok pabda*) shared highest percentage 1.42% on the basis of total individuals encountered in the study area followed by Rita (*Rita rita*) 0.27% and Baim (*Mastacembelus armatus*) 0.44% (Fig. 5)

Discussion

This study on fish diversity of Shiba River, Bangladesh recorded a total of 30 fish species. No previous information on fish fauna in this river was found and thus comparison of the findings with previous one was not possible. In case of fish diversity study, this problem was also addressed by Mohsin & Haque (2009), Imteazzaman & Galib (2013) and Galib *et al*. (2013) & indicates the need of water-body specific fish diversity study in Bangladesh.The recorded fish species was much lower than some other rivers of Bangladesh. Ali *et al.* (2014) found a total of 53 species in the river Chitra in Jessore district of Bangladesh. Galib *et al.* (2013) recorded a total of 63 species of fishes in the river of Choto Jamuna at Naogaon district. But presence of similar number of fish species was also reported in Konoskhai Haor (37 species) in North-east Bangladesh (Iqbal *et al*., 2015).

Table 6. Order-wise species richness values of fishes during the study period

Order	Number of species	Species richness (D)
Cypriniformes	09	1.64
Siluriformes	09	1.64
Perciformes	04	0.73
Channiformes	02	0.37
Mastacembeliformes	02	0.37
Clupiformes	01	0.18
Beloniformes	01	0.18
Osteoglossiformes	01	0.18
Decapoda	01	0.18
Total	**30**	

In the present study, the order Cypriniformes (with 9 species), Perciformes (with 4 species), and Decapoda (with 1 species, *Macrobrachium lamarrei*), each contributed about 26% of the total fish catch followed by Siluriformes 11.09% (with 9 species). Most of the findings reported Cypriniformes as the most diversified order followed by Siluriformes and Perciformes (Galib *et al.* 2013 at river Choto Jamuna; Mohsin & Haque*,* 2009 at river Mahananda; Khan *et al.* 2013 at river Tista and Rahman *et al.* 2012 at

river Padma). Rahman *et al*. (2015) reported two prawn species of order Decapoda in Talma river, among them *Macrobrachium lamarrei* contributed only 3.03% of total catch which is much lower than present study.

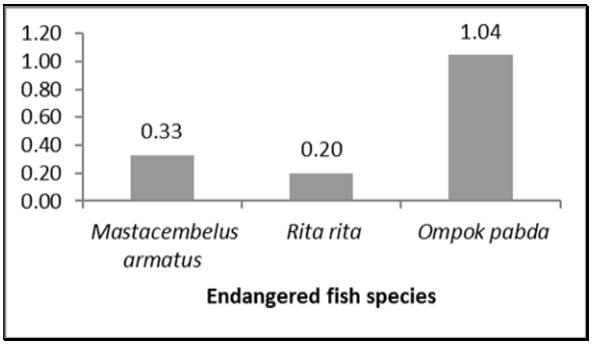

Fig. 5. Endangered fish species composition in the Shiba river

The most commonly used diversity index is Shannon – Weaver diversity index (**H**) which can be obtained for any species population.In the present study, **H** oscillated from 1.45 to 2.13. **H** was recorded as 1.017 to 4.65 from Bakkhali River (Belaluzzaman, 1995), 1.06 to 1.51 from Talma river (Rahman *et al*., 2015), 3.427 to 3.818 from Choto Jamuna river (Galib *et al*. 2013) which support the present finding. Staub *et al*. (1970) proposed a scale of pollution in terms of species diversity index and states a negative correlation between Shannon-Weaver diversity index (**H**) and pollution which indicates the river as light to moderate polluted.

Another most commonly used biodiversity index is Margalef's richness index. It is widely used in evaluating the water pollution. It can more objectively reflect the degree of water pollution and its trends (Lad, 2015). In the present study the Margalef's richness index varied from 1.42 to 2.89. The relationship between Margalef'srichness index and water pollution shows that the pollution level of Shiba river was moderate to serious.

A total of 253 fresh water fish species have been assessed and 64 of them have been declared as threatened species by IUCN Bangladesh (2015). In the Shiba river only 6.65% threatened fish species were found. Among them 1.57% were endangered and 4.96% were vulnerable. 41.27% of fish species in the river Choto Jamuna (Galib *et al*., 2013), 33.92% in Mahananda River (Mohsin & Haque, 2009), 42.5% in the river Padma (Ramman *et al*. 2012) and 32% in Talma River (Rahman *et al*., 2015) were reported as threatened. Threatened fish species observed in Shiba river was found relatively lower than the above mentioned authors. From the present study, it was found that many factors are responsible for decreasing biodiversity of fishes in Shiba river including over fishing, habitat loss, indiscriminate killing of juvenile fish due to unregulated fishing pressure and indiscriminate use of pesticides and agrochemicals in agriculture.

Conclusion: During the study periods a variety of freshwater fish species (30) were recorded belonging to 16 families and 9 orders. Gura Chingri (*Macrobrachium lamarreii*), Punti (*Puntius sophore*) and Chanda (*Chanda nama*) were found as dominant fish species in the study area contributing 26.29%, 22.70% and 21.92% respectively of the total catch. The research revealed that only 6.65% threatened fish species were present in the study area, among the threatened species 4.96% were vulnerable and 1.57% were endangered. The mean values of Shannon-Weaver diversity (**H**), Margalef's richness (**D**) and Pielou's (***e***) evenness were found as 1.865, 2.22 and 0.74, respectively. As only 30 species were identified from the study area, so proper steps should have to take for the protection and conservation of these valuable fisheries resources.

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