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Catfish Diversity and Conservation Status in the River Teesta, West Bengal, India

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ABSTRACT
A survey on catfish diversity in the River Teesta was carried out from March 2014 to February 2016. Three sampling sites were selected, and sampling was done with different fishing nets. Diversity indices were then calculated with software. A total of 37 catfish belonging to 8 families were recorded. The most dominant family was Sisoridae (38%) with 14 species, followed by Bagridae (27%, with ten species), Schilbeidae (11%, with four species), Siluridae (8%, with three species), Clariidae and Olyridae (5%, with two species) and Heteropneustidae and Chacidae (3%, with one species each). Out of 37 catfish species, one is Endangered (EN), five species are Near Threatened (NT) and 28 are Least Concern (LC). The highest species diversity index and Margalef's species richness index were recorded in September and the lowest in January. The highest evenness index (J') was recorded in April and the lowest in July.

Key words: Catfish, Endangered, species diversity index, Margalef's species richness index and evenness index

INTRODUCTION

The river Teesta originates from the Jemu glacier (Sikkim) and passes through the districts of Darjeeling, Jalpaiguri, and Coochbehar in India and meets the Brahmaputra in Bangladesh. The river Teesta is the lifeline of North Bengal. The total length of the river Teesta is 315 km and the total catchment area of the river Teesta is 12,540 km^2. Previously, the river Teesta was part of the Ganga drainage system, but destructive floods that occurred in 1787 changed the courses of the river, and the river became part of the Brahmaputra drainage system. One barrage for irrigation purposes was constructed on the river Teesta at the village Gajoldoba. The government of West Bengal established an ecotourism spot near the Gajoldoba village at the river Teesta, which badly polluted the river water.

Fish constitute almost half of the total number of vertebrates in the world. A total of 2,500 fish species are found in India, among which 930 are fresh water fish (Talwar and Jhingran 1991). Fish are important sources of protein, and native fish species are a good indicator of the health of the aquatic ecosystem. The fish diversity in water bodies has great importance in terms of the livelihood of the people living around it. Fish diversity is very important ecologically as well as economically. Human demands on river water and biodiversity have been increasing steeply over the last few decades, which have led to the threat of biodiversity (Dudgeon 2006). The Eastern Himalaya is a biodiversity 'Hot spot', also rich in ichthyofaunal diversity.

North Bengal is crisscrossed by many rivers such as Teesta, Jaldhaka, Torsa, and Kaljani. Barman (2007) considered North Bengal as 'Hot spot' of the fish resource. The River Teesta is rich in ichthyofaunal diversity, many of which are rheophilic and cold-water fishes. The River Teesta is also rich in catfish diversity. Catfish don't have any scales on their bodies but have bony scutes or plates and possess four pairs of barbels and a flattened head (Bruton 1996). Several anterior vertebrae (atlas, axis, 3rd and 4th) are ossified and form a complex vertebra (Patra 2011). In many catfish, the dorsal and pectoral spines possess glandular cells that produce stinging protein (venom), and this venom may serve as defense. The strong and hollow dorsal and pectoral spines are usually used to deliver venom (Nelson and Joseph 2006). Catfish have consumable value and are also used as ornamental fish.

Many workers studied the fish diversity of North Bengal. Shaw and Shebbeare (1937) reported 34 species of catfish from the rivers and streams in the hills and plains of the Darjeeling district and the adjoining Dooars. Jayaram and Singh (1977) found 26 catfish from the river Tengan-Mahananda confluence, the Atrai, Purnabhasa, Dharla , Kalindri,

Mahananda, Jamuna, Teesta, Karotayar, Panga, Balasan, and Jaldhaka. Sarkar and Pal (2009) reported a total of 28 catfish from the river and reservoir of the Terai region. Patra et al. (2011) found a total of seven catfish from the river Karala. Acherjee and Barat (2014) recorded a total of three catfish from the hill stream Relli, a tributary of the river Teesta. So far, no such extensive study has been done on catfish diversity in the river Teesta. The present study aimed at to know the biodiversity of catfish in the river Teesta and evaluate their conservation status.

MATERIALS AND METHODS

Sampling

The study was conducted from March 2014 to February 2016 on catfish diversity in the river Teesta. Three sampling sites were selected for the survey (Fig 1), i.e., site 1 at Sevoke (District Darjeeling, latitude $26^0$86'8799''N, longitude $88^0$48'5096'' E, altitude 194 meters), site 2 at Gajoldoba (District Jalpaiguri, latitude $26^0$44'55.4''N and longitude $88^0$35'37.0''E, altitude 90 meters) and site 3 at Haldi Bari (District Cooch Behar, latitude $26^0$23'01.2''N and longitude $88^0$50'38.0''E, altitude 57 meters). Site 1 is situated at the foot hill of Himalaya where the river enters from hill to plain and the river bed is covered with sand and stone. Geomorphology at site 1 is closely related with the Himalaya. The water depth varied from 1.5 to 6 meters at site 1, and the water current was high. The distance from site 1 is 23 km from Siliguri city. Site 1 was selected to determine how catfish of the river Teesta closely resemble streams and rivers in the Himalaya. The River Teesta bifurcated the Mahananda wild life sanctuary at site 1. At site 2, the river bed is covered with sand, stone, pebbles, and soil and the water depth varied from 1 to 5 meters. Site 2 was chosen to assess the impact of damp on catfish diversity. The water current is moderate. The north site of the river Teesta is bordered by Baikunthapur forest at site 2. Site 2 is located 24 km from Siliguri city and 31 km from Jalpaiguri city. At site 3, the river bed is

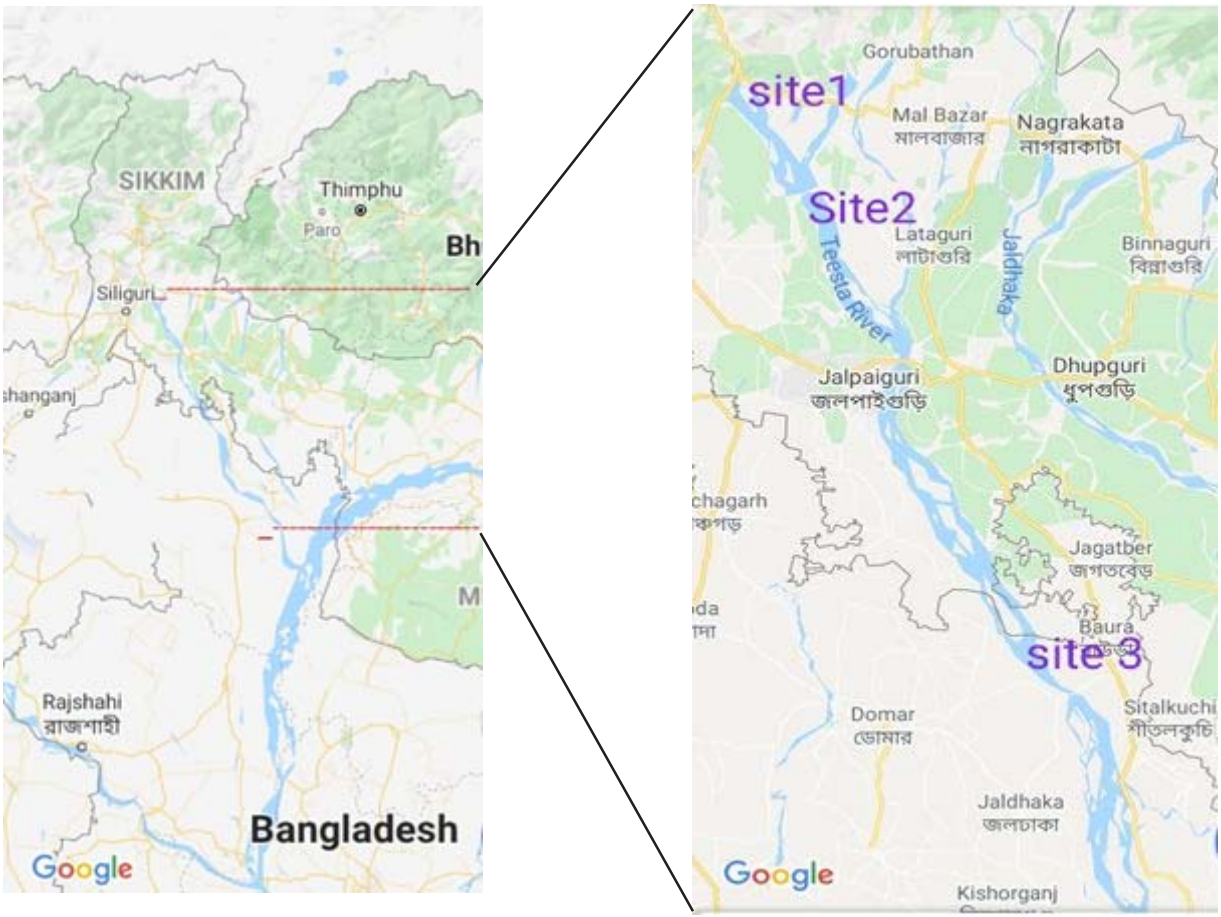

Figure 1. Sampling sites of the river Teesta

covered with mud and a little sand, and the water depth varied from 0.5 to 5 meters. Water current is low at site 3 in comparison to sites 1 and 2. The distance between site 3 and Jalpaiguri city is 26 km. To assess the diversity of catfish before the river enters Bangladesh, Site 3 was selected.

Samplings were done at the monthly interval at early morning. Fish were collected with different types of net with the help of fishermen, and then catfish were separated from other fish. The total number of catfish species and the number of individuals in each species at every site were counted. Monthly diversity indices at every site were calculated separately. Photographs of fish were taken with the help of a digital camera (Canon SX420 IS). Fishes were identified with the help of Day (1889), Shaw and Shebbeare (1937), Hora and Gupta (1940) and Jayram and Singh (1977). Catfish were separated and then preserved in 8% formalin for further study. All the fish specimens are preserved in the aquatic faunal biodiversity museum of the department of Zoology, Raigani University, Raiganj, West Bengal, India.

Biodiversity analysis

Fish diversity index, species richness index, and evenness index were calculated with the help of PAST 3.0 software (Hammer et al. 2001). The threat categories were assessed on the basis of the IUCN Red List of threatened species categories and criteria (2017).

The type of diversity used here is α diversity which is the diversity of species within a community or habitat. The diversity was calculated by using the Shannon diversity index (Shannon 1948). Margalef's index was used as a simple measure of species richness (Margalef 1958). The Pielou's Evenness Index (J') is used to calculating the evenness of species (Pielou 1966).

RESULTS AND DISCUSSION

A total of 37 catfish belonging to 8 families were reported from the river Teesta (Table 1 and Fig. 2). The most dominant family was Sisoridae with 14 species, followed by Bagridae with 10 species, Schilbeidae with 4 species, Siluridae with 3 species, Amblycipitidae and Clariidae with 2 species, and Heteropneustidae and Chacidae with 1 species each. The maximum numbers of catfish were reported at site 2 (35 species), followed by site 1 (26 species) and site 3 (24 species). Sisoridae (14 species) was the most prevalent family at site 1, followed by Bagridae (6 species), Schilbeidae (4 species), and Amblycipitidae (2 species). At site 2, the Sisoridae family dominated with 14 species, followed by Bagridae (9 species), Schilbeidae, Siluridae, Amblycipitidae (2 species), Clariidae, and Chacidae (1 species). The most dominant family was Sisoridae (7 species), followed by Bagridae (6 species), Schilbeidae and Siluridae (3 species), Clariidae (2 species), and Heteropneustidae , Amblycipitidae, and Chacidae (1 species) at site 3. At site 1, the Clariidae, Heteropneustidae, Siluridae, and Chacidae families were absent. Sites 1 and 2 are dominated by coldwater catfish.

Batasio batasio (Hamilton), *Bagarius bagarius* (Hamilton), *Conta conta* (Hamilton), *Erethistes horai* (Misra) and *Pseudolaguvia shawi* (Hora) are endemic in this region, but their numbers are decreasing day by day due to anthropogenic effects. A big catfish, *Bagarius bagarius* (45 kilogram) was recorded at site 2 during the study period. One Endangered (EN) catfish, such as *Clarias magur* (Hamilton), was reported from this river. Out of 37 catfish, five are near threatened (NT) namely *Ailia coila* (Hamilton), *Ompok bimaculatus* (Bloch), *Ompok pabda* (Hamilton), *Bagarius bagarius* (Hamilton) and *Wallago attu* (Schenider) and 28 catfish are Least Concern (LC).

The highest species diversity index (H') was recorded during the month of September (2.79) and the lowest in January (1.25). Similar results were reported by Kar et al. (2006) in the Sone beel of Assam, Acherjee and Barat (2014) in the hill stream, Relli and Das (2018) in the Bochamari Beel. Patra (2011) recorded the species diversity index ranged from 1.04 to 1.218 in the river Karala, a tributary of the river Teesta which was less than that recorded in the present investigation. The highest Margalef's species richness index (R) was observed during the month of September (4.26) and the lowest in January (3.00). Similar findings were reported by Acherjee and Barat (2014) in the hill stream Relli. The highest species diversity index and Margalef's species richness index were recorded during September

Table 1 Check list of catfish in the river Teesta from March 2014 to February 2016.

Family	**Species**	IUCN category	Site 1	Site 2	Site 3
Bagridae	*Batasio batasio* (Hamilton,1822) **END**	LC	+	+	+
	B. tengana (Hamilton1822)	LC	+	+	-
	B. fasciolatus Ng, 2006	NE	+	-	+
	Hemibagrus menoda (Hamilton,1822)	LC	+	+	+
	Mystus vittatus (Bloch, 1794)	LC	+	+	-
	M. bleekeri (Day, 1877)	LC	-	+	+
	M. tengra (Hamilton, 1822)	LC	-	+	+
	Sperata seenghala (Sykes, 1839)	LC	+	+	-
	S. aor (Hamilton, 1822)	LC	-	+	+
	Rita rita (Hamilton, 1822)	LC	-	+	-
Clariidae	*Clarias magur* (Hamilton, 1822)	EN	-	+	+
	C. gariepinus (Burchell, 1822)		-	-	+
Heteropneustidae	*Heteropneustes fossilis* (Bloch,1794)	LC	-	-	+
Amblycipitidae	*Amblyceps mangois* (Hamilton, 1822)	LC	+	+	+
	A. apangi Nath & Dey, 1989	LC	+	+	-
Schilbeidae	*Ailia coila* (Hamilton, 1822)	NT	+	+	+
	Clupisoma garua (Hamilton, 1822)	LC	+	+	+
	Eutropiichthys murius (Hamilton,1822)	LC	+	+	-
	E. vacha (Hamilton,1822)	LC	+	+	+
Siluridae	*Ompok bimaculatus* (Bloch,1794)	NT	-	+	+
	O. pabda (Hamilton)	NT	-	+	+
	Wallago attu (Bloch & Schenider, 1801)	NT	-	+	+
Sisoridae	*Bagarius bagarius* (Hamilton,1822) **END**	NT	+	+	-
	Conta conta (Hamilton,1822) **END**	DD	+	+	-
	Glyptothorax indicus Talwar, 1991	LC	+	+	+
	G. cavia (Hamilton, 1822)	LC	+	+	-
	G. pectinopterus (McClelland, 1842)	LC	+	+	+
	G. telchitta (Hamilton,1822)	LC	+	+	-
	Erethistes horai (Misra, 1976) **END**	LC	+	+	+
	E. jerdoni, Day, 1870	LC	+	+	-
	Gagata cenia (Hamilton, 1822)	LC	+	+	+
	Gogangra viridescens (Hamilton,1822)	LC	+	+	+
	Pseudolaguvia ribeiroi (Hora, 1921)	LC	+	+	-
	P. shawi (Hora, 1921) **END**	LC	+	+	+
	P. sulcatus (McClelland, 1842)	LC	+	+	-
	Sisor rhabdophorus Hamilton, 1822	LC	+	+	+
Chacidae	*Chaca chaca* (Hamilton, 1822)	LC	-	+	+

END- Endemic to the region
EN-Endanger, NT-Near Threatened, LC-Least Concern, DD- Data Deficient, NE-Not Evaluated,
'+' indicates presence and '-' indicates absence of fish species

Figure 2. Fish diversity in the river Teesta, (a) *Pseudolaguvia shawi* (Hora), (b) *Erethistes jerdoni* (Day), (c) *Mystus tengara* (Hamilton), (d) *Amblyceps mangois* (Hamilton), (e) *Clupisoma garua* (Hamilton), (f) *Erethistes horai* (Misra), (g) *Chaca chaca* (Hamilton), (h) *Sisor rhabdophorus* (Hamilton), (i) *Ailia coila* (Hamilton), (j) *Gogangra viridescens* (Hamilton), (k) *Nangra punctata* (Day), (l) *Bagarius bagarius* (Hamilton), (m) *Wallago attu* (Schenider), (n) *Rita rita* (Hamilton), (o) *Glyptothorax cavia* (Day), (p) *Glyptothorax telchitta* (Hamilton), (q) *Pseudolaguvia ribeiroi* (Hora), (r)*Glyptothorax pectinopterus* (McClelland)

because of the huge volume and food content in the water, and the lowest values in January due to the low volume of water in winter. In flowing waters, the numbers of fish species were greater with increasing water depth (Bain 1999). The highest evenness index (J') was recorded during April (0.988) and the lowest in July (0.879). Similar findings were reported by Patra (2011) in the river Karala, Acherjee and Barat (2014) in the hill stream Relli and Das (2018) in the Bochamari Beel. The species evenness index (J'), more or less similar throughout the year, indicates an equal distribution of catfish throughout the year (Table 2).

Site 1 has a diverse fish population that is adapted to high water currents, and the fish can attach themselves to the rocks and pebbles. Site 1 is also rich in coldwater catfish. The numbers of coldwater catfish are very low at site 3. Fishes which are

adapted to high water currents along with attachment devices are rare at site 3. The Teesta River is renowned for its wide variety of catfish, including a large number of coldwater, rheophilic, and tropical catfish. There are catfish in this river, and they are used for food, sport, and ornamentation. So, the catfish in the river Teesta could change the economy of fishermen in the near future.

All three sampling sites are affected by siltation and over flooding during the rainy season. Sites 2 and 3 are affected by many anthropogenic activities such as pollution, disposal of waste material, and run-off pesticide from agricultural fields. The Gajoldoba barrage at site 2 prevents the migration of fish upwards to downwards and vice versa. At Gajoldoba, there are many professional fishermen, and their only profession is collecting fish from the river Teesta, where sometimes they use mosquito nets for fishing purposes. Many illegal fishing methods, such as the use of dynamite, pesticides, and mosquito nets, are adopted at all the sites. Mining of sand and stone for construction purposes is another problem throughout the river course. At site 3, water levels are drastically reduced in the winter season because the Gajoldoba barrage blocks the water flow and drains the water in the Teesta feeder canal. The fish diversity decreased in the winter season at site 3. The low diversity of catfish at site 3 may be due to Gajoldoba damp. Catfish have high market demand due to their delicious test, so fishermen indiscriminately catch catfish, even fingerlings and broods. The present investigation may supply baseline data on ichthyofauna for comparison in future studies. The present investigation on the catfish diversity and conservation status will be helpful in the development of a future strategy for the conservation of catfish.

CONCLUSIONS

A total of 37 catfish belonging to 8 families were recorded. The most dominant family was Sisoridae (with 14 species), followed by Bagridae (with ten species), Schilbeidae (with four species), Siluridae (with three species), Clariidae and Olyridae (with two species each) and Heteropneustidae and Chacidae (with one species each). One catfish species is Endangered (EN), five are Near Threatened (NT), and 28 are of Least Concern (LC).The highest numbers of catfish were recorded at site 2, compared to sites 1 and 3. The Gajoldoba barrage on the Teesta River near Site 2, which prevents catfish from migrating from the Himalayas to the plains and vice versa. The highest species diversity index was recorded in the post monsoon due to the high volume of water, which is suitable for fish growth. The numbers of catfish gradually decrease day by day due to pollution and anthropogenic activities. If we don't take immediate measures in the near future, many catfish will disappear from this river.

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Conflict of interest: Author declares no conflict of interest

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Table 2. Average monthly biodiversity indices (Mean ± SD, N=6) of catfish from March 2014 to February 2016.

Diversity Index	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	January	February
Species Diversity Index (H')	1.67 ± 0.15	1.48 ± 0.085	1.50 ±0.27	2.01 ±0.35	2.71 ±0.18	2.16 ±0.13	2.79 ±0.46	2.1 ± 0.59	1.80 ±0.18	1.49 ±0.27	1.25 ±0.59	1.34 ±0.11
Species Evenness Index (J')	0.98 ±0.006	0.99 ±0.004	0.98 ± 0.005	0.98 ±0.005	0.87 ±0.007	0.98 ±0.005	0.98 ±0.006	0.9 ±0.007	0.97 ±0.003	0.97 ±0.004	0.92 ±0.005	0.97 ±0.013
Margalef's Species Richness Index (R)	3.57 ±0.34	3.38 ±0.36	3.60 ±0.27	4.01 ±0.60	3.61 ±0.52	4.20 ±0.60	4.26 ±0.69	3.26 ±0.44	3.60 ±0.64	3.29 ±0.49	3.00 ±0.58	3.14 ±0.34

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