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ASSESSMENT OF PHYSICO-CHEMICAL PARAMETERS AND ICHTHYOFAUNAL DIVERSITY OF RIVER TORSA - SEASONAL AND SPATIAL VARIATIONS

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Abstract–The Torsa River is an important tributary of the Brahmaputra running through West Bengal, and it plays an important role in the ecology, biodiversity, and sustenance of the human population in the region. This study aims to evaluate the physicochemical properties and ichthyofaunal diversity of River Torsa in order to assess its sustainability and ecological health. Sampling was done at three sites along the river and during the pre-monsoon, monsoon, and post-monsoon periods. The physico-chemical parameters evaluated include temperature, pH, dissolved oxygen, free carbon dioxide, velocity, conductivity, TDS, total alkalinity, total hardness, and chloride. Using a cast net and a gill net, fish samples were collected and identified. Furthermore, the catch per unit effort (CPUE), diversity, evenness, richness, and dominance of the fish species were also calculated. The findings revealed both spatial as well as seasonal variations in the water quality; however, overall, the water was found to be suitable for supporting aquatic life. A total of 113 fish species belonging to 28 families were identified. There were no significant differences identified in the fish species among the three sampling sites. The findings of this study point towards the need for continuous monitoring of the quality and diversity of River Torsa and the implementation of conservation strategies to maintain the river's ecological balance.

INTRODUCTION

The Torsa River flows through the Cooch Behar district in West Bengal, and is extremely prone to floods. Its source is the Chumbi Valley, Tibet, China, where it is known as River Machu. From here, it flows into Bhutan as River Amo Chu and then enters Jaigaon, West Bengal, as River Torsa. It flows through tea gardens in the Terai region, the Jaldapara National Park, Cooch Behar, and Tufangunj, and finally enters Balabhut region in Bangladesh. Its total length is 358 km of which 45.06 km flows in India. As it crosses multiple countries and different types of topographical regions, it is important to assess the physico-chemical parameters of the water along with its ichthyofaunal diversity. The channel of the river in West Bengal is shallow and wide, and its slope is flat, making it an important area for drainage in the sub-Himalayan region.

The physico-chemical parameters of a river determine its suitability for sustaining the fish species present in the river (Meador and Goldstein, 2003). River water is used for various purposes such as washing clothes, bathing, and drinking. Many people living in local surrounding areas depend on the river for their livelihood. However, rivers are also used for waste discharge by the municipalities making them polluted. All these activities can affect the physical and chemical qualities of the river water which can, in turn, harm the aquatic life, the plant life in the water, the fauna that drink the water and humans who use the water for various purposes. These physico-chemical parameters are not constant, and they change with location, seasons, and the level of pollution (Eliku and Leta, 2018). The parameters include temperature, pH, velocity, dissolved oxygen, free carbon dioxide, alkalinity, hardness, chloride, conductivity, and total dissolved solids (TDS) which determine the hydrological condition of the water

(Research Scholar)

(Oyem *et al.*, 2014). Bhadra *et al*. (2003) studied the physicochemical parameters of River Torsa in different locations and reported high alkalinity and the presence of free ammonia (Bhadra *et al*., 2003). Goswami *et al.* (2018) carried out a physicochemical analysis and reported a high level of lead in River Torsa that was harmful to Boroli fish (Goswami *et al*., 2018). De *et al.* (2021) carried out a physico-chemical analysis of River Torsa to determine its suitability as a habitat for *Barilius bendelisis* (De *et al.*, 2021).

Fishes make significant contributions to the ecosystem and biodiversity; however, they are one of the most threatened species in the world (Sayer *et al*., 2025). There are currently around 36,640 species of fish present in the world, and in India, there are 3,523 fish species (Kosygin *et al*., n.d.).Of these, 872 species are found in West Bengal with 77 species being endemic to the region (Kosygin et al., n.d.). Not only do they play important ecological roles but they are also economically important. Sarkar et al. (2015) reported 24 species of indigenous ornamental fishes in River Torsa (Sarkar *et al*., 2015). A study on the ichthyofaunal diversity of River Torsa and its tributaries in the Terai region of West Bengal revealed the presence of 105 fish species (Das, 2015). Another study on the number of fish species in River Torsa in the Cooch Behar district reported the presence of 107 fish species (Dey and Sarkar, 2015). Sarkar (2021) identified 66 species of cold water fishes in River Torsa (Department of Zoology, Raiganj University, Uttar Dinajpur - 733 134, West Bengal, India and Sarkar, 2021). Sarkar (2023) identified the presence of 131 fish species in River Torsa.

The main objective of this study is to evaluate the physicochemical parameters and the ichthyofaunal diversity of River Torsa at three sampling sites and during three different seasons namely, pre-monsoon, monsoon, and post-monsoon periods. The specific physico-chemical parameters measured in this study include water quality indicators such as temperature, pH, dissolved oxygen, free carbon dioxide, velocity, conductivity, TDS, total alkalinity, total hardness, and chloride. It also assesses the diversity and abundance of fish species in River Torsa at the three sampling sites. Finally, it evaluates important diversity indices to provide a detailed description of the ichthyofaunal diversity in River Torsa.

MATERIALS AND METHODS

Study sites

In this study, samples were collected from the Torsa river from three sampling sites -Sajerpar, a village located in Pundibari; Kaminirghat, a village located in Takagachh; and No. 1 Kalighat Road end located in Guriahati. The GPS coordinates of each of these sites is given in Table 1. Sajerpar is a small village that has flat alluvial flood plains made fertile by silt deposits from the Torsa river. Kaminirghat is another small village located about 47.9 km away from Pundibari and it has fertile alluvial plains especially where River Torsa runs through the region. Kalighat road is an urban area located on the fringe of Cooch Behar district and it has a lot of residential areas.

Study duration

The study was conducted for two years from June 2022 to May 2024.

Physicochemical analysis

Water samples were collected from below 10 to 20 cm of the water surface during early morning in the first week of every month. Seasonal analysis was performed by dividing the collection periods into pre-monsoon (March- June), monsoon (July - October), and post-monsoon (November- February) periods. During the study period, the average rainfall in the region was 0.4 mm to 400 mm.

The samples were collected in sterilized acid-washed polyethylene bottles to minimize reactivity. Measurements of air and water temperatures, pH, electrical conductivity, and total dissolved solids (TDS) were performed at the time of sample collection. Temperatures were measured using a mercury thermometer. Water velocity was measured

Table 1. GPS coordinates of the three sampling sites

Site number	Site sampled	GPS coordinates	Block
1	Sajerpar	26.41°N 89.35°E	Cooch Behar II
2	Kaminirghat	26.33°N 89.42°E	Cooch Behar II
3	No. 1 Kalighat Road end	26.30°N 89.47°E	Cooch Behar I

using a current metre. TDS, conductivity, and pH were measured using the digital Deluxe water and soil analysis kit (Model-171; Electronics India). Free carbon dioxide, dissolved oxygen, total alkalinity, total hardness, and chloride were analyzed using standard methods (APHA, 2005). All samples were measured in triplicates and the means and standard deviations were determined.

Estimation of ichthyofaunal diversity

Samples were collected every month using a cast net having a mesh size of 1 cm and a gill net having a mesh size of 0.5 to 1 mm. Three efforts were done for sample collection with each effort comprising of casting the net 25 times and then calculating the mean. As soon as the fishes were captured, photographs were taken using a digital camera (Canon SX 150 IS) and the fishes were preserved separately in jars containing 8% formalin. Catch per unit effort (CPUE) was determined by counting the number of fishes captured per 100 m^2.

Fishes were identified using standard references at both genus and species levels (Jayaram, 2010; Oates and Blanford, 1889; Rainboth, 1994; Sen and Sreeraj, 2023; Shaw and Shebbeare, 1937). The conservation status of each of the fish species was assigned based on the IUCN categories (IUCN, 2017). The diversity of the fish species was measured using the Shannon diversity index (H) calculated as follows (Shannon, 1948):

$$H = -\sum \left(\frac{ni}{N}\right) \log_2 \left(\frac{ni}{N}\right)$$

Where, *ni* represents the number of samples of each fish species collected, and *N* represents the total number of samples of all fish species collected.

The species richness (R) was calculated using the Margalef's index given below(Margalef, 1958):

$$R = \frac{S - 1}{\log N}$$

Where, *S* represents the number of fish species identified, and *N* represents the total number of samples of all fish species collected.

The evenness of fish species was determined using the Pielou's Evenness Index (J') as follows (Pielou, 1966):

$$J' = \frac{H}{\log_e S}$$

Where, *H* represents the Shannon diversity index and *S* represents the number of fish species identified.

Species dominance was calculated using Simpson's Dominance Index (λ) as follows (Simpson, 1949):

$$\lambda = \sum \left(\frac{N}{ni}\right)^2$$

Where, *N* represents the total number of samples of all fish species collected, and *ni* represents the number of samples of each fish species collected.

Calculations were made for fish species identified at each of the three sampling sites and their statistical significance was determined using ANOVA.

RESULTS AND DISCUSSION

Physicochemical parameters

Seasonal variations in various physico-chemical parameters such as air and water temperature, velocity, conductivity, pH, free carbon dioxide, dissolved oxygen, total alkalinity, total hardness, chloride, and total dissolved solids (TDS) in River Torsa were recorded during pre-monsoon, monsoon, and post-monsoon periods at each of the three sampling sites (Table 2). The air temperature ranged from 15 °C to 31 °C and the water temperature ranged from 13 °C to 28.5 °C, with the lowest water temperature in site 3 and the highest in site 1. This range of water temperature is suitable for the growth and survival of a range of fish species. Temperature is an important consideration for a variety of physiological processes such as breeding (Melo *et al.*, 2022). The lowest temperature was recorded during the pre-monsoon period and the highest temperature during the post-monsoon period. The pH of the water ranged from 7.1 to 8.4 which is also suitable for the survival of fish species. pH of a river not only influences aquatic life but is also a marker for the level of pollution in the water body (Sharma *et al.*, 2020).

Both the lowest (71.6 mg/l) and the highest (79.6 mg/l) TDS were reported in site 2, the former in the pre-monsoon period and the latter in the post-monsoon period. The electrical conductivity was found to be lowest (43 µS/cm) in site 3 in the pre-monsoon period and highest (101 µS/cm) in site 2 in the monsoon period. Electrical conductivity depends on the TDS and various concentrations of mineral salts and nutrients can result in changes in the conductivity (Thirumalini and Joseph, 2009). A maximum conductivity of 467 µS/cm was reported in the Manipur river system (Singh *et al.*, 2011), while conductivity in the range of 387.65 to 570.75 µS/cm was reported in the Hindon river, Uttar Pradesh (Singh and Kumar, 2016).

In rivers, dissolved oxygen content gives an indication of the quality of water and the diversity of fish species (Kannel *et al.*, 2007). In this study, dissolved oxygen ranged from 5.2 mg/l in site 3 in the pre-monsoon period to 11.5 mg/l in site 3 in the monsoon period. In general, when the temperature of the water is lower, it has a greater capacity to hold dissolved oxygen (Stednick, 2008). In this study, the lowest temperature was recorded in the pre-monsoon period correlating with high dissolved oxygen in this period. Lower dissolved oxygen levels were reported in the Shutunga River, also located in Cooch Behar district, ranging from 3.33 mg/l to 5.56 mg/l indicating higher water temperatures (Saha, 2014). The maximum total alkalinity was 63 mg/l in site 3 and the minimum total alkalinity was 46 mg/l in site 2. A total alkalinity value between 40 and 90 mg/l has been shown to be medium productive for a river (Jhingran, 1991). The alkalinity values of River Torsa fall within the recommended range for productivity. Alkalinity values were lowest during the monsoon period owing to the dilution effect of rain water (Ravindra *et al*., 2003).

Free carbon dioxide in the river was found to be lowest (1.3 mg/l) in site 2 in the pre-monsoon period and highest (4.3 mg/l) in site 3 in the post-monsoon period. Another study also reported the lowest free carbon dioxide in February (0.5 mg/l) and the highest free carbon dioxide (18 mg/l) in December possibly due to the fact that carbon dioxide decomposes at a higher rate when the temperature is high (Simpi *et al*., 2011). The total hardness of the river ranged from 54.3 mg/l in the pre-monsoon period to 72.8 mg/l in the post-monsoon period. A minimum hardness of 20 mg/l is required for the sustenance of fish species in the river (Boyd, 1982).

Water velocity varied from 1.18 m/s in the pre-monsoon period to 3.42 m/s in the monsoon period. This is consistent with the water velocities reported for River Ganga ranging from less than 1.1 m/s when the water flow was slow to 4 m/s during floods (Lupker *et al*., 2011). Chloride levels ranged from 9 mg/l in site 2 during the monsoon period to 17 mg/l in site 2 during the post-monsoon period. The levels of chloride in rivers indicates organic pollution (Hong *et al*., 2023). Other rivers have reported higher values of chloride, for instance, Nira

Table 2. Physico-chemical parameters of River Torsa at three sampling sites during pre-monsoon, monsoon, and post-monsoon periods

S. No.	Water and quality parameters	Site 1			Site 2			Site 3		
		Pre-monsoon period (Feb – Mar)	Monsoon period (Jul – Aug)	Post-monsoon period (Oct – Nov)	Pre-monsoon period (Feb – Mar)	Monsoon period (Jul – Aug)	Post-monsoon period (Oct – Nov)	Pre-monsoon period (Feb – Mar)	Monsoon period (Jul – Aug)	Post-monsoon period (Oct – Nov)
1.	Air temperature (°C)	16	27	30	17	26	29	15	28	31
2.	Water temperature (°C)	14	24	28.5	14	23	28	13	25	27
3.	Water velocity (m/s)	1.25	3.01	1.93	1.29	3.42	1.87	1.18	2.98	1.99
4.	pH	7.9	7.31	8.1	7.7	7.1	8.4	8.1	7.6	7.8
5.	Conductivity (µS/cm)	46	98	49	49	101	47	43	95	52
6.	Free CO_2 (mg/l)	1.5	3.9	4.0	1.3	3.7	3.8	1.6	4.1	4.3
7.	Dissolved O_2 (mg/l)	5.5	11.02	7.05	5.8	11.0	6.7	5.2	11.5	7.3
8.	Total alkalinity (mg/l)	61	50	60	54	46	55	63	52	61
9.	Total hardness (mg/l of $CaCO_3$)	55.6	60.49	70.01	54.3	58.7	68.5	57.4	63.9	72.8
10.	Chloride (mg/l)	12	10	16	11	9	17	13	11	15
11.	TDS	72.5	75.8	77.8	71.6	74.9	79.6	73.8	77.5	75.3

River, Pune, had 29 to 279 mg/l of chloride (Jadhav and Jadhav, 2017); however, Narmada River had comparable chloride levels in the range of 11.92 to 16.63 mg/l (Rahi *et al*., 2025).

Ichthyofaunal diversity

A total of 113 fish species belonging to 28 families and 64 genera were identified in the three sampling sites of River Torsa during the study period (Table 3). The most dominant family was Cyprinidae contributing to 42 (37.17%) species; followed by Sisoridae (12 species, 10.62%); Bagridae and Balitoridae (7 species each, 6.19%); Channidae, Cobitadae, and Schilbeidae (4 species each, 3.54%); Osphronemidae, Nandidae, and Siluridae (3 species each, 2.65%); Centropomidae, Mastacembelidae, Olyridae, Notopteridae, and Psilorhynchidae (2 species each, 1.77%); and Amblycepidae, Aplochelidae, Anabantidae, Anguillidae, Belonidae, Clupeidae, Clariidae, Chacidae, Gobidae, Heteropneustidae, Mugilidae, Ophihthidae, and Tetrodontidae (1 species each, 0.88%). As per their conservation status, 4 species were DD (data deficient), 8 species were NT (near threatened), 3 species were NE (not evaluated), 2 species were EN (endangered), and the remaining 96 species were LC (least concern).Cyprinidae and Sisoridae have been identified as the dominant families in other studies as well (Acharjee and Barat, 2014; Das, 2015). Cyprinidae was also found to be the dominant family in the rivers of the Western Ghats (Arunkumar and Manimekalan, 2018) and River Tamas, a tributary of River Ganga (Das *et al*., 2022). Furthermore, the total number of fish species identified in our study of River Torsa was higher than the number reported in other studies (Das, 2015) as well as the number of fish species found in other rivers (Department of Biology, Jenkins School, Coochbehar-736 101, West Bengal , India & Debnath, 2015). In contrast, Rivers Ganga and Mahanadi have been reported to have a higher number of fish species than the number identified for River Torsa (A. M. *et al*., 2023; Das *et al*., 2022).

The average CPUE was between 46 to 48 individuals per 100 m^2 at the three sites with no statistically significant difference between the monthly values (Table 4). This value of CPUE indicates that the quality of water sampled was adequate for analysis. In Wular Lake of Watlab Ghat, a major landing centre for fishes, the CPUE was

Table 3. Fish species identified from three sites in River Torsa during the study period along with their conservation status (LC – Least Concern; DD – Data Deficient; NT – Near Threatened; NE – Not Evaluated; EN – Endangered)

S. No.	Family	Fish species	Site 1	Site 2	Site 3	Conservation status
1.	Amblycepidae	*Amblyceps mangois*	+	+	+	LC
2.	Aplochelidae	*Aplocheilus panchax*	+	+	+	LC
3.	Anabantidae	*Anabas testudineus*	+	-	-	DD
4.	Osphronemidae	*Trichogaster chuna*	+	+	+	LC
5.	Osphronemidae	*Trichogaster fasciatus*	+	+	+	LC
6.	Osphronemidae	*Trichogaster labiosus*	+	+	+	LC
7.	Anguillidae	*Anguilla bengalensis*	+	-	+	NT
8.	Bagridae	*Batasio batasio*	+	+	+	LC
9.	Bagridae	*Batasio tengana*	+	+	+	LC
10.	Bagridae	*Hemibagrus menoda*	+	+	+	LC
11.	Bagridae	*Mystus bleekeri*	+	+	+	LC
12.	Bagridae	*Mystus tengra*	+	+	+	LC
13.	Bagridae	*Sperata seenghala*	+	+	-	LC
14.	Bagridae	*Sperata aor*	+	+	+	LC
15.	Balitoridae	*Acanthocobitis botia*	+	+	+	LC
16.	Balitoridae	*Nemacheilus botia*	+	+	+	LC
17.	Balitoridae	*Nemacheilus devdevi*	+	+	+	LC
18.	Balitoridae	*Nemacheilus corica*	+	+	+	LC
19.	Balitoridae	*Schistura rupecula*	+	+	+	LC
20.	Balitoridae	*Schistura savona*	+	+	+	LC
21.	Balitoridae	*Schistura bevani*	+	+	+	LC
22.	Belonidae	*Xenentodon cancila*	+	+	+	LC
23.	Channidae	*Channa punctata*	+	+	+	LC

24.	Channidae	*Channa striata*	+	+	+	LC
25.	Channidae	*Channa marulius*	+	+	+	LC
26.	Channidae	*Channa stewartii*	+	+	+	LC
27.	Clupeidae	*Gudusia chapra*	+	+	+	LC
28.	Cobitadae	*Botia dayi*	+	-	+	NE
29.	Cobitadae	*Botia dario*	+	+	+	LC
30.	Cobitadae	*Botia lohachata*	+	+	+	LC
31.	Cobitadae	*Somileptes gongota*	+	+	+	LC
32.	Clariidae	*Clarias batrachus*	+	-	-	EN
33.	Cyprinidae	*Amblypharyngodon mola*	+	+	+	LC
34.	Cyprinidae	*Amblypharyngodon microlepis*	+	+	+	LC
35.	Cyprinidae	*Aspidoparia morar*	+	+	+	LC
36.	Cyprinidae	*Aspidoparia jaya*	+	+	+	LC
37.	Cyprinidae	*Barilius barila*	+	+	+	LC
38.	Cyprinidae	*Barilius barna*	+	+	+	LC
39.	Cyprinidae	*Raiamas bola*	+	+	+	LC
40.	Cyprinidae	*Barilius shacra*	+	+	+	LC
41.	Cyprinidae	*Barilius vagra*	+	+	+	LC
42.	Cyprinidae	*Barilius bendalesis*	+	+	+	LC
43.	Cyprinidae	*Barilius tileo*	+	+	+	LC
44.	Cyprinidae	*Bengala elanga*	+	+	+	LC
45.	Cyprinidae	*Catla catla*	+	+	+	LC
46.	Cyprinidae	*Chagunius chagunio*	+	+	+	LC
47.	Cyprinidae	*Chela laubuca*	+	+	+	LC
48.	Cyprinidae	*Cirrhinus reba*	+	+	+	LC
49.	Cyprinidae	*Crossocheilus latia*	+	+	-	LC
50.	Cyprinidae	*Devario devario*	+	+	+	DD
51.	Cyprinidae	*Danio rerio*	+	+	+	LC
52.	Cyprinidae	*Danio dangila*	-	+	+	LC
53.	Cyprinidae	*Esomus danricus*	+	+	+	LC
54.	Cyprinidae	*Rasbora daniconius*	+	+	+	LC
55.	Cyprinidae	*Garra gotyla*	+	+	+	LC
56.	Cyprinidae	*Garra annandalei*	+	+	+	LC
57.	Cyprinidae	*Garra lamta*	+	+	+	LC
58.	Cyprinidae	*Labeo bata*	+	+	+	LC
59.	Cyprinidae	*Labeo boga*	+	+	+	LC
60.	Cyprinidae	*Labeo calbasu*	+	+	+	LC
61.	Cyprinidae	*Labeo dero*	+	+	+	NE
62.	Cyprinidae	*Labeo dyocheilus*	+	+	+	LC
63.	Cyprinidae	*Labeo gonius*	+	+	+	LC
64.	Cyprinidae	*Labeo rohita*	+	+	+	LC
65.	Cyprinidae	*Osteobrama cotio*	+	+	+	LC
66.	Cyprinidae	*Puntius conchonius*	+	+	+	LC
67.	Cyprinidae	*Puntius gelius*	+	+	+	LC
68.	Cyprinidae	*Puntius phutunio*	+	+	+	LC
69.	Cyprinidae	*Puntius stigma*	-	+	+	NE
70.	Cyprinidae	*Puntius sophore*	+	+	+	LC
71.	Cyprinidae	*Puntius sarna*	+	+	+	LC
72.	Cyprinidae	*Puntius ticto*	+	+	+	LC
73.	Cyprinidae	*Tor putitora*	-	+	-	EN
74.	Cyprinidae	*Tor tor*	+	+	+	DD
75.	Centropomidae	*Pseudambassis baculis*	+	+	+	LC
76.	Centropomidae	*Pseudambassis ranga*	+	+	+	LC
77.	Chacidae	*Chaca chaca*	+	-	+	LC
78.	Gobidae	*Glossogobius giuris*	+	+	+	LC
79.	Heteropneustidae	*Heteropneustes fossilis*	+	+	+	LC
80.	Mastacembelidae	*Mastacembelus armatus*	+	+	+	LC
81.	Mastacembelidae	*Mastacembelus pancalus*	+	+	+	LC

82.	Mastacembelidae	*Rhynchobdella aculeate*	+	+	+	LC
83.	Mugilidae	*Rhinomugilcorsula*	+	+	+	LC
84.	Nandidae	*Badisbadis*	+	+	+	LC
85.	Nandidae	*Badiskanabos*	-	+	+	LC
86.	Nandidae	*Nandusnandus*	+	+	+	LC
87.	Ophihthidae	*Psidonophisboro*	+	+	-	LC
88.	Olyridae	*Olyrakempi*	+	+	+	LC
89.	Olyridae	*Olyralongicaudata*	+	+	+	LC
90.	Notopteridae	*Notopterusnotopterous*	+	+	+	LC
91.	Notopteridae	*Chitalachitala*	-	-	+	NT
92.	Psilorhynchidae	*Psilorhynchusbalitora*	+	+	+	LC
93.	Psilorhynchidae	*Psilorhynchussucatio*	+	+	+	LC
94.	Schilbeidae	*Ailiacoila*	+	-	-	NT
95.	Schilbeidae	*Clupisomagarua*	+	+	+	LC
96.	Schilbeidae	*Eutropiichthysmurius*	+	+	+	LC
97.	Schilbeidae	*Eutropiichthysvacha*	+	+	+	LC
98.	Siluridae	*Ompokbimaculatus*	-	+	+	NT
99.	Siluridae	*Ompakpabda*	-	-	+	NT
100.	Siluridae	*Wallagoattu*	+	+	-	NT
101.	Sisoridae	*Bagariusbagarius*	+	+	+	NT
102.	Sisoridae	*Contaconta*	+	+	+	DD
103.	Sisoridae	*Glyptothoraxcavia*	+	+	+	LC
104.	Sisoridae	*Glyptothoraxhorai*	+	+	+	LC
105.	Sisoridae	*Glyptothoraxstiatus*	+	-	+	NT
106.	Sisoridae	*Glyptothoraxtelchitta*	+	+	+	LC
107.	Sisoridae	*Hara horai*	+	+	+	LC
108.	Sisoridae	*Hara jerdoni*	+	+	-	LC
109.	Sisoridae	*Gagatacenia*	+	+	+	LC
110.	Sisoridae	*Nangrapunctata*	+	+	+	LC
111.	Sisoridae	*Pseudolaguviaribeiroi*	+	+	+	LC
112.	Sisoridae	*Pseudolaguviashawi*	+	+	+	LC
113.	Tetrodontidae	*Tetrodoncutcutia*	+	+	+	LC

Table 4. Values of diversity indices of fish species identified in the three sites

Diversity index	Site 1	Site 2	Site 3	ANOVA	
				F-value	P-value
Catch per unit effort (CPUE)	48	46	47	0.06	0.80
Species diversity index (H)	3.63	3.67	3.61	1.38	0.23
Species evenness index (J')	0.99	0.97	0.98	2.6	0.11
Margalef's species richness index (R)	9.83	9.82	9.79	0.004	0.91
Species dominance index (ë)	0.026	0.021	0.025	0.93	0.36

found to range from 115 to 2827.5 g/h (Mushtaq *et al.*, 2018). The CPUE was found to be 5.6 to 6.1 kg/day in Bhini Stream, a tributary of River Ravi (Gupta *et al.*, 2022), while it was found to be 0.02 to 5.24 kg/hr in the Alaknanda River (Pandey *et al.*, 2020).The Shannon-Wiener diversity index (H') was found to range from 3.61 to 3.67 at the three sites. The monthly values did not show any statistically significant difference. In general, values of 3.50 and above for Shannon-Wiener index indicates high diversity while values below 2.0 indicate low diversity (Baliton *et al.*, 2020). In our study, the values of the diversity index are above 3.50 indicating high ichthyofaunal diversity in the Torsa river. The species evenness index was found to be 0.97 to 0.99 at the three sampling sites with no significant difference between the monthly values. Values in the range of 0.96 to 1.0 indicate balanced representation of the various species (Napaldet, 2023). In our study, River Torsa demonstrated balanced distribution of species evident from the species evenness values.The Margalef's species richness index varied from 9.79 to 9.83 at the three sites. Values of Margalef's index greater than 5 indicate high species richness (Napaldet, 2023). As values in our study are greater than 9.5, it indicates that River Torsa has relatively high species richness. The species dominance index ranged from 0.021 to 0.026 at the three sites. A dominance index value of below 0.50 indicates that no single species dominates while higher values are indicative of species dominance (Paryantini *et al*., 2023). Values obtained in our study indicate that there is a well-distributed representation of species without any dominance.

CONCLUSION

This study carried out a comprehensive assessment of the physicochemical parameters and the ichthyofaunal diversity during three seasons and at three sampling sites of River Torsa, Cooch Behar District, West Bengal. There were both spatial as well as seasonal variations in the physicochemical parameters likely influenced by natural phenomena and anthropogenic activities. Overall, all parameters were within permissible limits and the quality of the water was found to be suitable for the sustenance of aquatic life in the river. The ichthyofaunal diversity was also evaluated and 113 fish species were identified in River Torsa. However, some of them had the conservation status of endangered and near-threatened, indicating that conservation measures need to be implemented in a timely manner to maintain the diversity in this ecosystem.

Conflict of Interest - None

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