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INVESTIGATIONS ON WATER QUALITY PARAMETERS AND ICTHYOFAUNAL DIVERSITY OF THE RIVER TANGON AT RADHIKAPUR, UTTAR DINAJPUR, WEST BENGAL, INDIA

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AUTHORS' CONTRIBUTIONS

The work was carried out in collaboration with the authors MS and DM. Author MS managed the literature searches, performed the field work, statistical analysis and wrote the first draft of the manuscript. Author DM designed the study, wrote the protocol, analysed and supervised the whole study. Both the authors read and approved the final manuscript.

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ABSTRACT

The physicochemical parameters and ichthyofauna diversity of the water of the internationally important river Tangon at the Radhikapur village in Uttar Dinajpur district of West Bengal were studied for one year from December 2019 to November 2020. The study was done monthly from the four selected sampling sites of the Tangon river. Water temperature varied from 16.80°C to 32.60°C at all the sites during the study. pH ranged from 7.0 to 8.5, indicating the slightly alkaline nature of the water. Higher values of electrical conductivity were observed in the summer months. Free CO_2 showed a positive correlation with water temperature and total hardness during the entire study. The lowest value of dissolved oxygen was observed to be 1.80 mgL^{-1} at Site 1 and Site 2, which might be due to the use of fertilizer at the nearby agricultural field and lifting of excessive sand from the Tangon river. The sudden increase in dissolved oxygen concentrations at all the sites from March to June might be due to the lesser anthropogenic activities during the lockdown in India because of the Covid-19 Pandemic situation. Total hardness (57.40 mgL^{-1} to 125.00 mgL^{-1}) had a significant negative correlation with transparency at Site 2. Chloride (3.00 mgL^{-1} to 24.14 mgL^{-1}) had a significant correlation with pH and total hardness at Site 1. BOD was varied between 1.00 mgL^{-1} and 11.04 mg L^{-1}. The highest BOD was found in December at Site 4, which was much greater than the drinking and bathing water standard set by CPCB. It may be due to the higher level of pollution due to the increasing level of anthropogenic activities. The study on ichthyofauna diversity revealed a total of 40 species of fish belonged to seventeen families from the different sites of the Tangon river during the entire study period. Cyprinidae was found to be the most dominant family throughout the study period. Eight species of fishes were under the vulnerable category (20%) and three species

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were under a near threatened category (7%). The present study will help formulating the future policy for conservation and proper management of the fish diversity in the Radhikapur village of the Tangon river. Public awareness is very much important for the conservation of the river.

Keywords: Tangon river; DO; BOD; correlation; CPCB; anthropogenic activities; ichthyofauna diversity; conservation status.

1. INTRODUCTION

Water is necessary for all living organisms; there would be no life without it. Water is the medium from where life originated and the foundation of life, the protoplasm, which is also a colloidal solution of complex organic molecules in a water medium (70% to 90%). The majority of the biological processes take place in a medium of water.

The river Tangon is an International river between India and Bangladesh. It is a tributary of the mightly river Mahananda, rising in Bangladesh and flows through the North Dinajpur Districts and Malda of West Bengal, India. The river is also called the Tongon River after the Zamindar Tankonath of Ranisankail Upazila in Thakurgain district of Bangladesh, recorded by Saleheen [1]. After originating in West Bengal, it travels through Panchagarh District, Sadar Upazilla in Thakurgaon District, Pirganj in Thakurgaon District, Bochaganj, and Biral of Dinajpur District of Bangladesh before it flows through the two community development blocks, Kushmandi and Bansihari of Dakshin Dinajpur district of West Bengal. It again enters Bangladesh and meets the Punarbhava river near Rahanpur in Naogaon Districts recorded by Chowdhury and Hasan [2]. The river Tangon flows in Radhikapur village of Uttar Dinajpur district within 6 km. Radhikapur is a small village and a gram panchayat in Kaliyaganj block at Raiganj subdivision of Uttar Dinajpur district of West Bengal, India. It is a border checkpoint of the Bangladesh-India border and is situated at 25.6427'N, 88.4469'E.

The river Tangon is one of the most important freshwater sources in Radhikapur as well as West Bengal, India. This is one of the river in Radhikapur village that flows through the upper portion of the western part of Kaliyaganj CD Block. It is about 267 km in length [3]. Raiganj is the District headquarter of Radhikapur village. The total geographical area of the village is 137.3 hectares. Radhikapur has a total population of 1057 (2011 census) of which the female population is 49.9% and the female literacy rate is 27.8%. Agriculture and fishing are the main professions of the villagers. This village is still waiting for industrial development, the education system, drinking water, communication system, and electricity. The rivers of India play a vital role in the lives of the people providing drinking water; affordable transportation, electricity, and employment for many people all worldwide were investigated by Vaidyanathan [4]. The Tangon river is an important economic resource for our country. It plays a significant role in connecting two different neighboring countries recorded by Haque [5]. In Radhikapur, the water of the Tangon river is used mainly for agriculture and different human activities like washing, bathing, disposal of solid wastes. Agriculture and fishing are the main professions of the villagers. The water provides fertility to the soil adjacent to the river and provides excellent habitat for different organisms. Many rare and valuable plants have grown along the river. The water of the river is also used as an important source of drinking water for the local animals.

Diversity of ichthyofauna is a good indicator of the health of aquatic ecosystems [6]. In India, a considerable amount of studies have been done to find out the fish diversity of different water bodies [7,8,9,10]. In West Bengal also quite a large number of research studies have been carried out to find out the diversity of fishes in different water bodies [11,12,13].

Although many investigations on different water quality parameters and diversity of Ichthyofauna have been done throughout India and West Bengal, studies on the water of Tangon river are scanty. In Bangladesh different water quality parameters of Tangon river were investigated by Roy [14]. Jayaram & Singh [15] studied the freshwater fish diversity of river Tangon with Mahananda, Atrai, Punarbhava, Dharla at Changrabandha, Kalindi and Mahananda river at Malda Town, etc of North Bengal.

Till date, no report has been found on the physicochemical parameters and the ichthyofauna diversity of Tangon river of Radhikapur village of Uttar Dinajpur, West Bengal. Therefore, the main objective of the present study was to study some physicochemical parameters of the river Tangon at the selected sites of the village Radhikapur and investigate the ichthyofauna diversity of the river Tangon at village Radhikapur, Uttar Dinajpur, West Bengal, India.

2. MATERIALS AND METHODS

2.1 Site Selection

For the present investigation, four sampling sites were selected in the Tangon river, considering the length of the river and different sources of pollution. The water samples were collected every month at regular intervals from the surface of the four sampling sites of the river. The brief descriptions of the sites (Fig. 1) are as follows:

2.1.1 SITE 1–BOGDUAR (25.6682, 88.4227)

This Site is situated near the Bangladesh border, where fishing is done. There is a significant bridge named Bogduar Bridge which is connecting India and Bangladesh. Some agricultural fields and plants near the site and human populations are very lesser at this site (Fig. 1).

2.1.2 SITE 2–MIRJAGAR (25.6587, 88.4297)

This spot is 2 km away from Site 1. Some tribal community people reside near the site. Fishing is done regularly at this site. Here the water of the river Tangon was used for different activities like cleaning utensils, clothes, washing of pet animals, bathing etc. (Fig. 1).

2.1.3 SITE 3–RADHIKAPUR PICNIC SPOT (25.6405, 88.4339)

This Site is 1.5 km away from Site 2. During winter, many visitors come here to see the Tangon River and India-Bangladesh border. This site is used for picnic purposes and boating is one of the main attractions of this site. Fishing and bathing are also done at this site (Fig. 1).

2.1.4 SITE 4–NARAYANPUR (25.634753, 88.426450)

This site is 1.5 km away from Site 3. The water of this site is used mainly for domestic purposes, including bathing of pet animals. Fishing is done regularly. This is the ending part of river Tangon at Radhikapur village (Fig. 1).

2.2 Physico-chemical Parameters

Different physicochemical parameters of the Tangon river at Radhikapur village were studied for one year from December 2019 to November 2020. The water samples were collected from the four selected sites of the river, once every month between 6.00 A.M. to 10.00 A.M. at regular intervals. The air and water temperature, pH and transparency were recorded in the field with the help of ACETEQ digital Celsius thermometer (Model KT-908) with an external sensing probe. The hydrogen Ion concentrations (pH) of water were determined with the help of a portable pH meter (Model-HI96107, HANNA instrument, Italy). Secchi disk was used to measure the transparency and depth of the water [16]. For the other physicochemical parameters, water samples were collected & brought to the laboratory in plastic bottles (1500mL.). Samples for BOD tests were incubated for 5 days at 20°C in BOD incubator of the laboratory of Raiganj University. The other physicochemical parameters like DO, free carbon dioxide, total alkalinity, total hardness, chloride and BOD were analyzed following standard methods APHA [17]. The values were compared with the standard values of WHO [18] and CPCB [19].

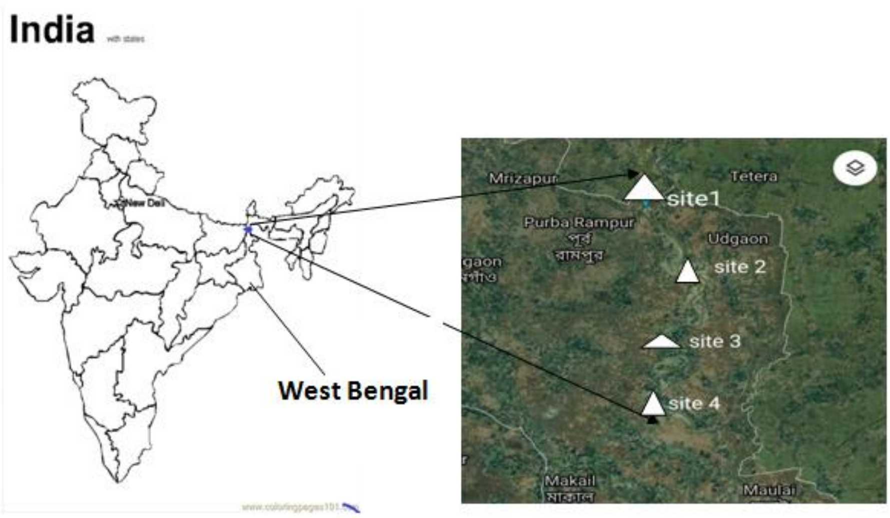

Fig. 1. Satellite view of Tangon river with four selected water sampling Sites at Radhikapur village
SITE 1= BOGDUAR, SITE 2= MIRJAGAR, SITE 3= RADHIKAPUR PICNIC SPOT, SITE 4= NARAYANPUR

2.3 Ichthyofauna Diversity

Fishing is carried out with the help of local fisherman using cast net, gill net, scoop net as well as including hooks and lines according to Bose *et al.* [20]. Photographs of the fishes were taken immediately after collection using camera (Nikon D800 camera), immediately prior to preservation, as formaline (8%) decolorizes the fish color on long preservation according to Bagra [21] and Chakroborty *et al.* [22]. The collected fishes were transported to the laboratory and identified using their general body form, morphometric and meristic characteristics following Day, F. [23], Jayaram, K.C. [24] and Shaw and Shebbeare [11]. Conservation status of the fish species were given as per the Conservation Assessment and Management Plan (CAMP) [25] and International Union for Conservation of Nature (IUCN) [26].

3. RESULTS AND DISCUSSION

The monthly variations of different physicochemical parameters of water at Site 1, Site 2, Site 3, Site 4 during the whole study period are presented in Fig. (2-13).

Temperature fluctuations play a significant role in climate variability, necessitating the need to continue tracking temperature patterns even in places where a temperature pattern has been identified by Oyewole [27]. The minimum air temperature (11.10°C) was recorded in the month of December at the Site 1, and a maximum (33.10°C) was found in October at Site 3 (Fig. 2). Air temperature showed a positive and significant correlation with water temperature at all the sites ((r = 0.920 (Site 1), r = 0.918 (Site 2), r = 0.908 (Site 3), r = 0.901(Site 4)). Mondal *et al.* [28] recorded a positive correlation between air and water temperature in the Mirik lake of Darjeeling district

Among all the external factors, water temperature is one of the most important factors affecting the aquatic ecosystem and physicochemical parameters identified by Bellos and Sawidis [29], Huet [30]. At Site 4, the highest (32.60°C) and lowest (16.80°C) water temperature was found in October and December, respectively (Fig. 3). Water temperature showed a significant positive correlation with free CO_2, and negative correlation with pH at all the sites ((r = 0.846 (Site 1), r = 0.767 (Site 2), r = 0.720 (Site 3), r = 0.680 (Site 4)). A negative correlation between water temperature and pH was also observed by Mondal [31].

To measure the concentration of hydrogen ions in an aqueous solution, pH is one of the important factors. In the present study pH values varied from 7.0 to 8.6, which indicates the slightly alkaline nature of the water. The highest pH (8.5) values were recorded in December and April at Sites 2 and 3, and the lowest pH (7.0) was recorded in September and October from Sites 1 and 2 (Fig. 4). It may be due to the excess amount of rainfall at that time.

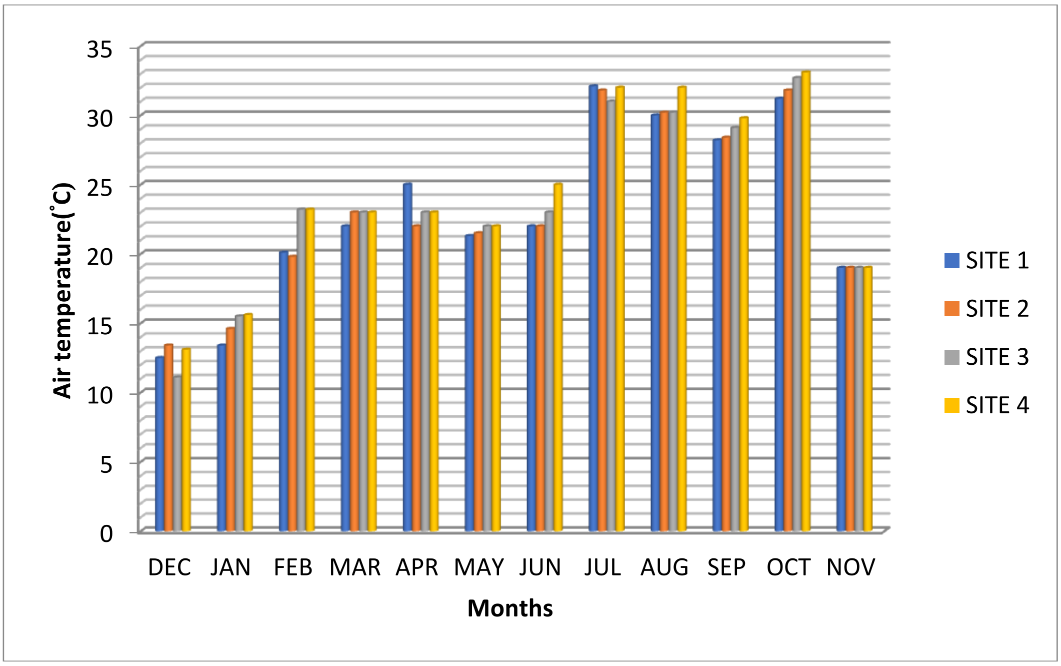

Fig. 2. Monthly variation in air temperature at four selected sampling Sites

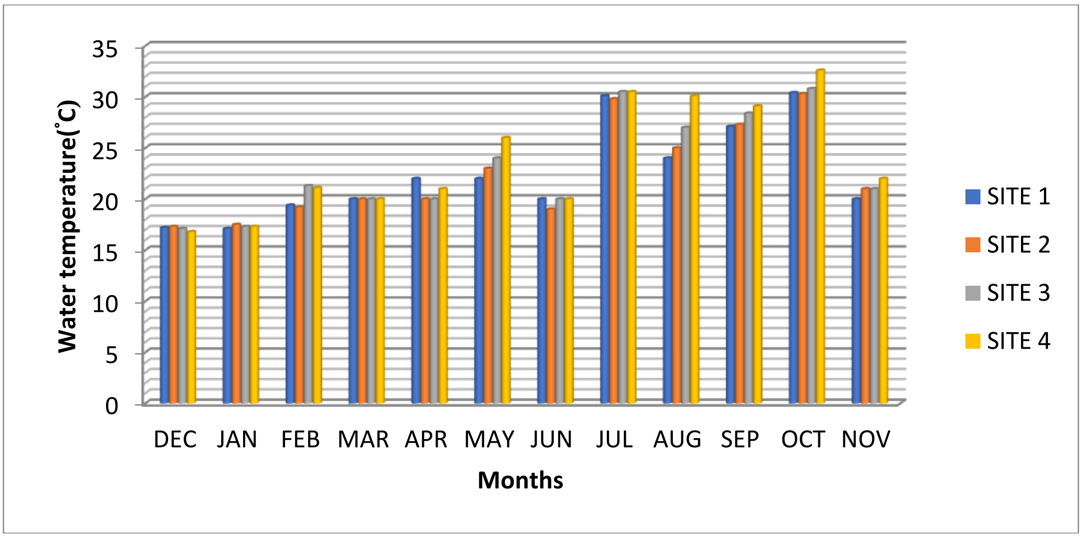

Fig. 3. Monthly variation in water temperature at four selected sampling Sites

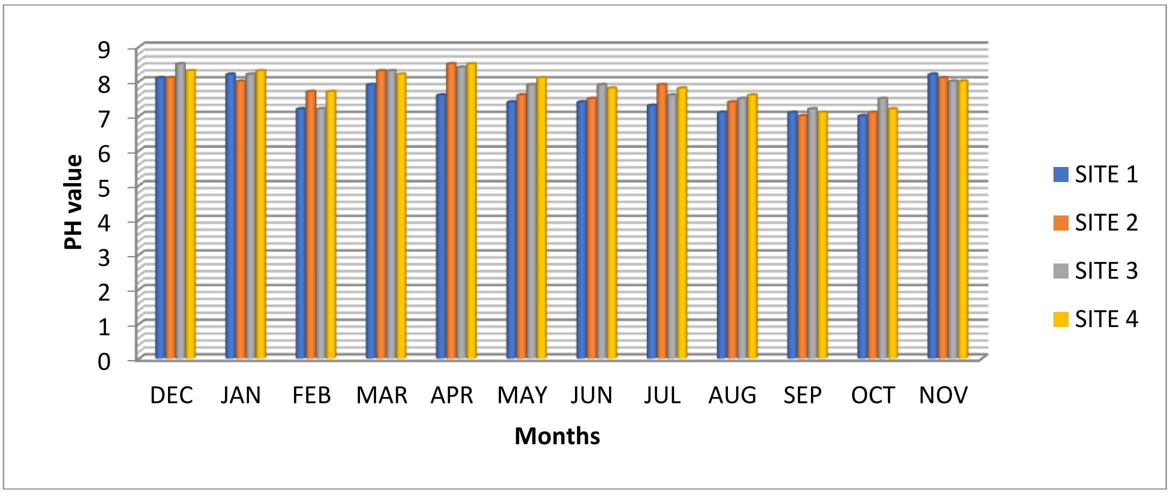

Fig. 4. Monthly variation in pH at four selected sampling Sites

Skyllberg [32] observed a significant decrease of pH with increasing depth from Northern Sweden. pH showed a significant positive correlation with chloride and BOD at Sites 1 & 3. Tajmunnaher *et al.* [33] also observed a positive correlation between pH and BOD from Kushiyara river, Sylhet, Bangladesh. It had a significant negative correlation with air and water temperature and free CO_2. Rawat *et al.* [34] also observed a similar negative correlation between pH and water temperature at Deotia Tal of Garwal Himalaya.

Depth is the dimension of the river channel. It is a basic physical characteristic of the river and an indicator of the stream dynamics related to the substrate and riverbed morphology. The highest depth (487.68cm) of the river was recorded in October from Site 1 and the lowest depth (10.00cm) of the river was recorded in April from Site 2 (Fig. 5). Depth had a significant positive correlation with air and water temperature at all the study sites and in case of Site 2 and Site 4 depth showed a positive correlation with DO. It had a negative correlation with pH from all the study sites during the whole study period.

The transparency of water depends on the amount of inorganic or organic particles present in the water. The transparency of the river's water varied from 5.00 cm to 78.00 cm during the whole study period. Transparency of water was highest in June (78.00 cm) at Site 3 and lowest in April (05.00cm) at Site 1 (Fig. 6). A transparency fluctuation between 24.00 cm to 95.00 cm in the river Tangon in Bangladesh was recorded by Fatema *et al.* [35].

Electrical conductivity is a measurement of a solution's ability to conduct electric current, and it is heavily influenced by the presence of ionic species

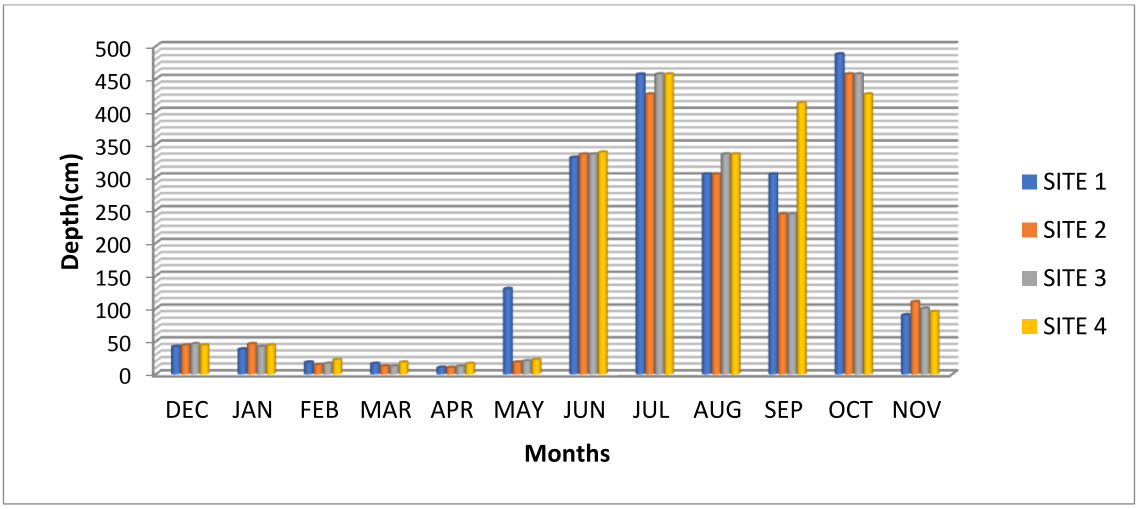

Fig. 5. Monthly variation in depth at four selected sampling Sites

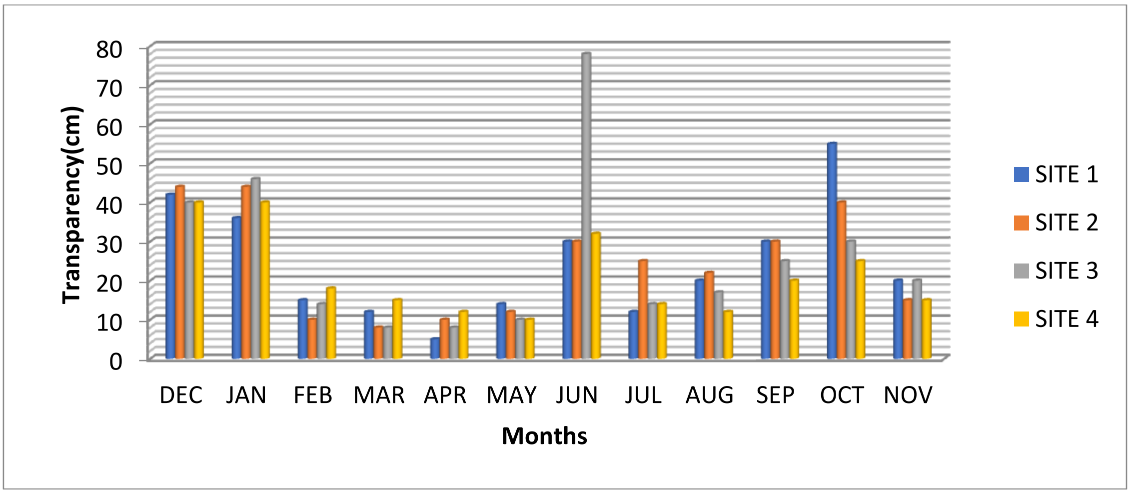

Fig. 6. Monthly variation in transparency at four selected sampling Sites

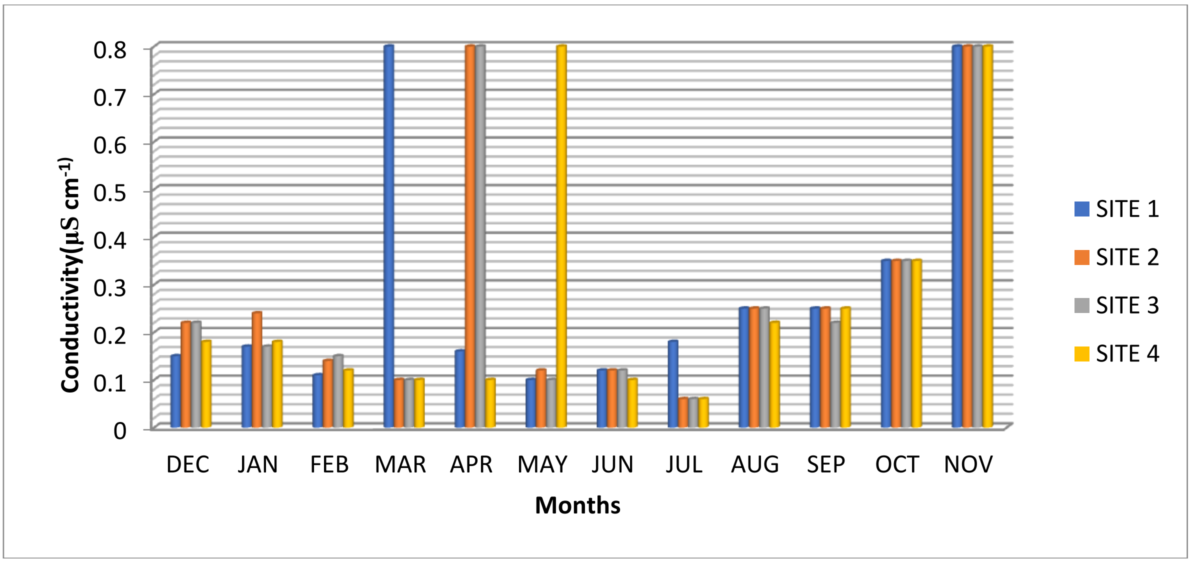

Fig. 7. Monthly variation in conductivity at four selected sampling Sites

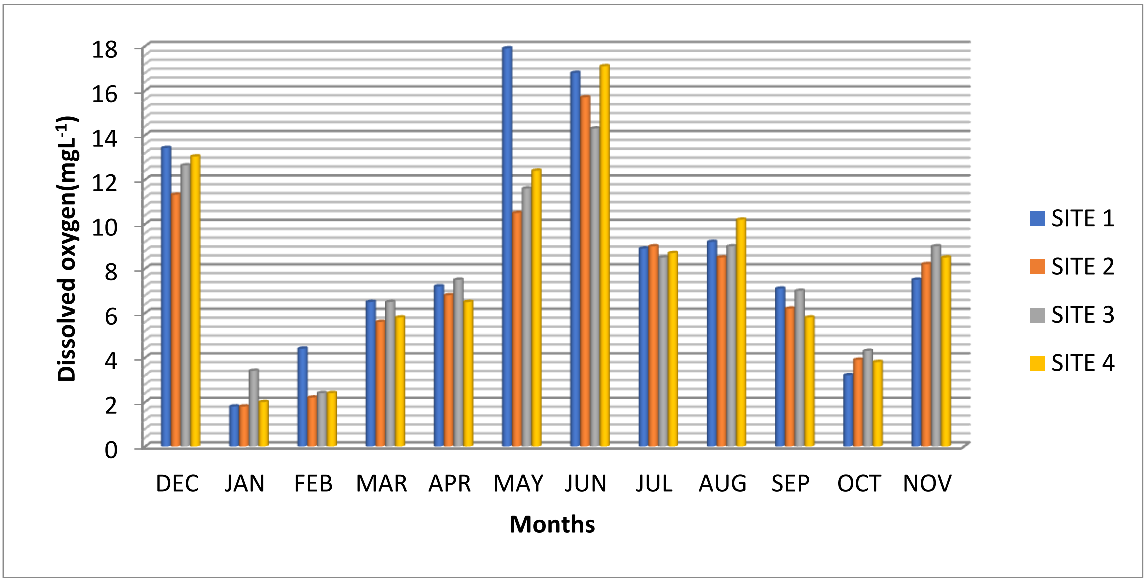

Fig. 8. Monthly variation in dissolved oxygen at four selected sampling Sites

identified by Julian *et al.* [36]. During the study period, the highest conductivity (0.80µS cm^{-1}) was observed mainly in March, April and May at Site 1, Site 2 and Site 3. Electrical Conductivity (EC) was found maximum in March, April and November at the Sites 1, 2, and 3, 4 (Fig. 7). EC range was found lowest in July at Site 2, 3, and 4. Tripathy *et al.* [37] also recorded higher values of conductivity in the summer months.

Oxygen is considered poorly soluble in water. Diffusion from the atmosphere, aeration of the water as it tumbles through falls and rapids, and as a byproduct of photosynthesis of aquatic flora are the sources of dissolved oxygen in the water. According to Khandaker [38], dissolved oxygen concentrations less than 5.00mgL^{-1} are indicative of pollution. During January and February, dissolved oxygen levels were below the range of 5.00mgL^{-1} at all the sites. DO had a significant positive correlation with chloride and BOD at Sites 1 & 2 (Fig. 8). The highest DO (17.90mgL^{-1}) was recorded from Site 1 in December during the whole study period. A similar type of observation from the Hilna beel, Bangladesh, was recorded by Alam *et al.* [39]. The lowest value of dissolved oxygen was observed (1.80mgL^{-1}) at Sites 1 and 2, which might be due to fertilizer at the nearby agricultural field and lifting of excessive sand from the Tangon river for business purposes. The lowest DO of Site 1 and Site 2 were much lower than the drinking and bathing water standard set by CPCB [19] and drinking water Standard set by WHO [18]. Higher temperature enhanced the endogenous respiration of microbes in the bioreactor. In winter and early spring, temperatures were low when DO values (14.03mgL^{-1}) were high. The dissolved oxygen levels were below the range of 5.00 mgL^{-1}at the Site 4 (2.00 mg$L^{-1)}$ in January and February, which might be due to the excess amount of algae in those months. The reduced dissolved oxygen concentration with the increasing amount of algae in the water body was observed by Haas *et al.* [40]. However, a sudden increase in the dissolved oxygen concentrations at all the sites was observed from March to June, which might be due to the lesser anthropogenic activities during lockdown in India due to Covid-19 Pandemic.

CO_2 is produced by the respiration of aquatic organisms. During the study, the highest free CO_2 (17.10mgL^{-1}) was recorded at the Site 1 in September and the lowest (2.00mgL^{-1}) was found from Site 2 in January and February (Fig. 9). Free CO_2 showed a positive correlation with water temperature, total hardness. Similar positive significant correlation with water temperature from Kumari beel, Bangladesh. Free CO_2 had a significant negative correlation with pH recorded by Alam *et al.* [39].

During the whole study period, the highest total hardness (125.00mgL^{-1}) was found in the month of May at Site 1 and observed the lowest value (59.60mgL^{-1}) in October at Site 4 (Fig. 10). The higher values of total hardness of the water of the river Tangon during May at Site 1 may be due to excessive addition of calcium and magnesium salts from detergents and soap that were used for bathing and washing of clothes and utensils and lesser amount of rainfall recorded depth of water 130cm. The total hardness had a significant negative correlation with depth (r = -0.763) at Site 1. A similar type of results was recorded by Risnera [41]. The highest total hardness was recorded by Ajmal and Raziudin [42] in summer from the rivers Hind and Kali in India, which corroborates with the present investigation. The total hardness had a significant negative correlation with transparency at Site 2. Tripathy *et al.* [37] also recorded a negative correlation between total hardness and transparency from the river Ganga at Holy place Shringverpur, Allahabad.

Total alkalinity values in the present study ranged between 14.40mgL^{-1} to 55.00mgL^{-1}. The highest (55.00mgL^{-1}) and the lowest (14.40mgL^{-1}) level of total alkalinity was recorded respectively in October & December from Site 1 and Site 4 (WHO recommending total alkalinity drinking water standards- 200mgL^{-1}) (Fig. 11). Similar observation was recorded by Tripathy *et al.* [37] from the river Ganga at Holy place Shringverpur, Allahabad. During the study, alkalinity had a significant negative correlation with DO & BOD at Site 2 and Site 4.

The chloride values varied between 3.00mgL^{-1} and 24.14mgL^{-1} during the whole study period. The highest chloride value was observed in January at Site 3 and the lowest value was recorded in February from the same Site (Fig. 12). Chloride had a significant positive correlation with pH (r = 0.697), total hardness (r = 0.659) in Site 1. Similar type of positive correlation was recorded by Tripathy *et al.* [37] from the river Ganga at Holy place Shringverpur, Allahabad. A significant positive correlation of chloride with pH from the water of Kosi river, Utarakhand recorded by Bhandari and Nayal [43].

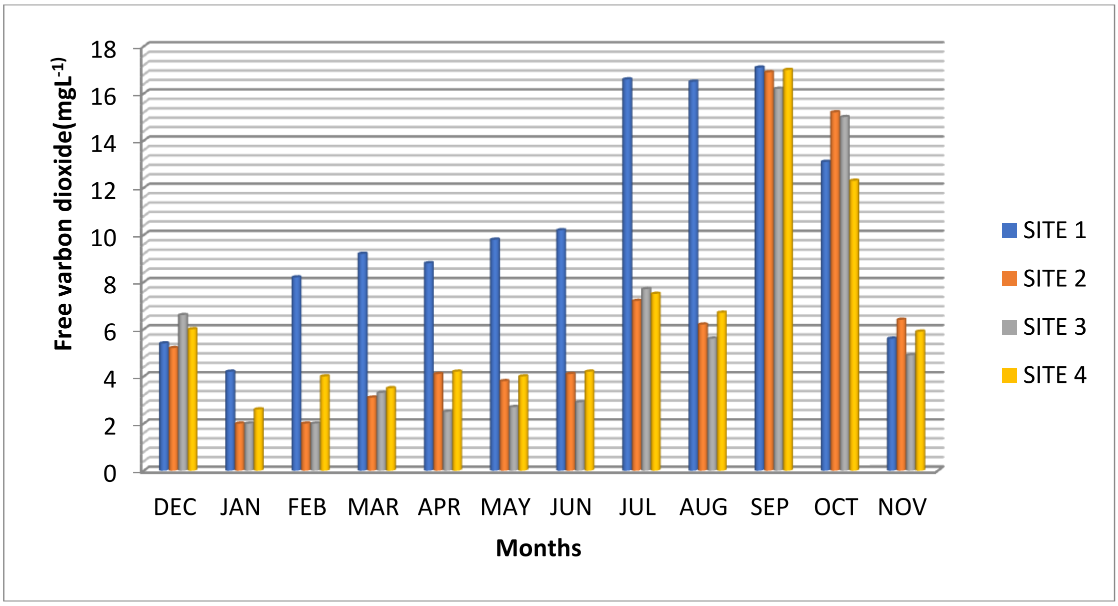

Fig. 9. Monthly variation in free carbon dioxide at four selected sampling Sites

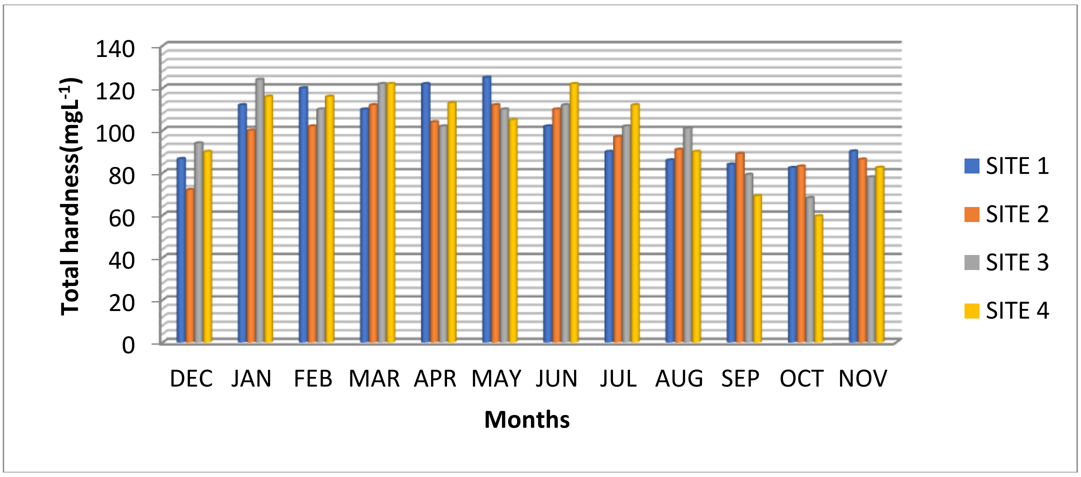

Fig. 10. Monthly variation in total hardness at four selected sampling Sites

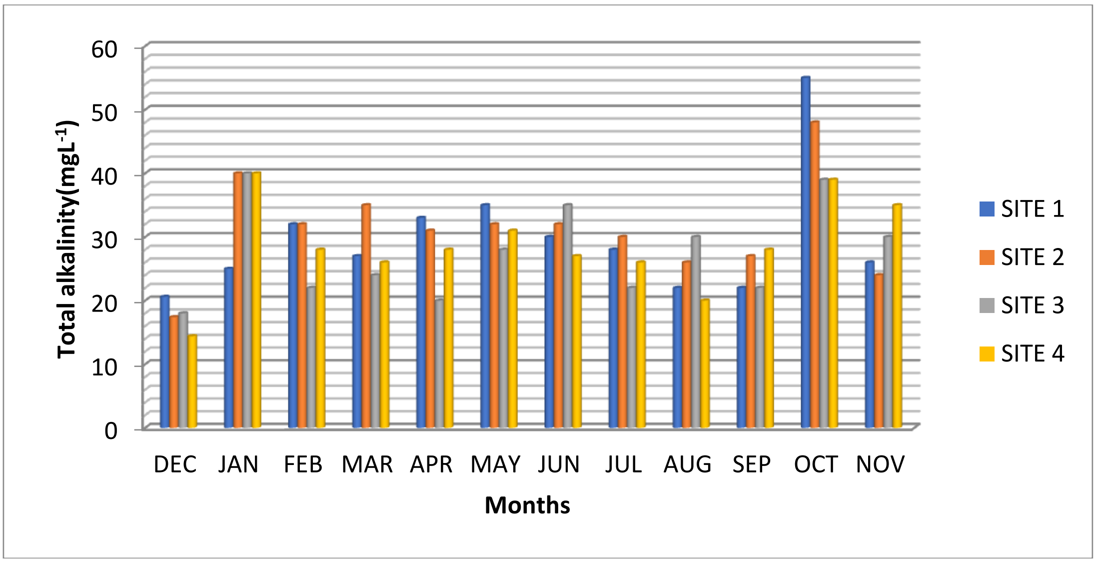

Fig. 11. Monthly variation in total alkalinity at four selected sampling Sites

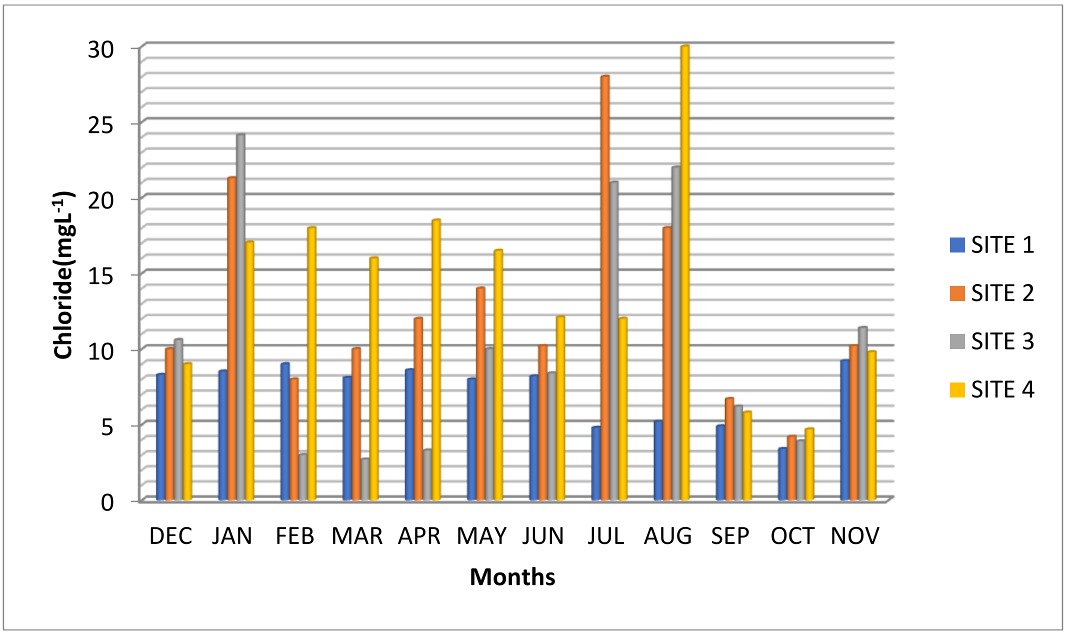

Fig. 12. Monthly variation in chloride at four selected sampling Sites

The lowest BOD (1.00mgL^{-1}) was recorded in February from Site 3 and Site 4. According to Sadhuram *et al.* [44] BOD values, less than 5.00mgL^{-1} are considered reasonable clean. The highest BOD (11.04mgL^{-1}) was found in December at Site 4 which was much greater than the drinking and bathing water standard set by CPCB [19] (Fig. 13). According to Wahid *et al.* [45], BOD value greater than 10.00mgL^{-1} is indicative of pollution. The highest recorded value of BOD in December may be due to the higher level of pollution caused by the different anthropogenic activities (picnic parties, fair, etc.) of the local people of Radhikapur Village.

A total of forty species of fish belong to seventeen families were recorded during the whole study period. Cyprinidae was the most dominant family with seventeen species followed by family Bagridae with six species Siluridae and Channidae, with two species and family Clariidae, Pangasiidae, Ambassidae, Anabantidae, Belontidae, Ailiidae, Anguillidae, Mastacembelidae, Clupeidae, Heteropneustidae, Notopteridae, Cichlidae, Sisoridae with one species each (Table 1). The maximum number of fish species (29) were recorded from the Site 1 where anthropogenic activities were minimum whereas the lowest number (23) of fish species were recorded from Site 2 where human activities were quite high.

Chakraborty and Bhattacharjee [46] stated that human activities like agricultural run–offs was one of the reason of declined fish population. construction of Dam on Tangon river in Bangladesh may be the reason of decrease in fish population at the Site 2 for which the water of the river was almost dried (10.00cm) (Fig. 5) during the month of April. Guo *et al*. [47] stated that the construction of dam and other anthropogenic activities seriously destroyed the habitat of fish leading to the decline in fish diversity in Ganjiang river of China.

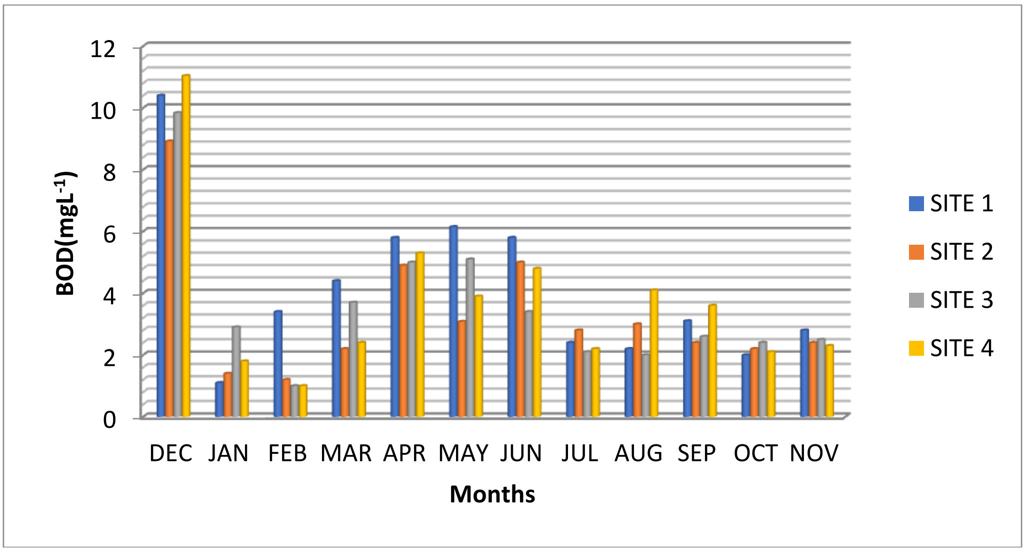

Fig. 13. Monthly variation in biological oxygen demand at four selected sampling Sites

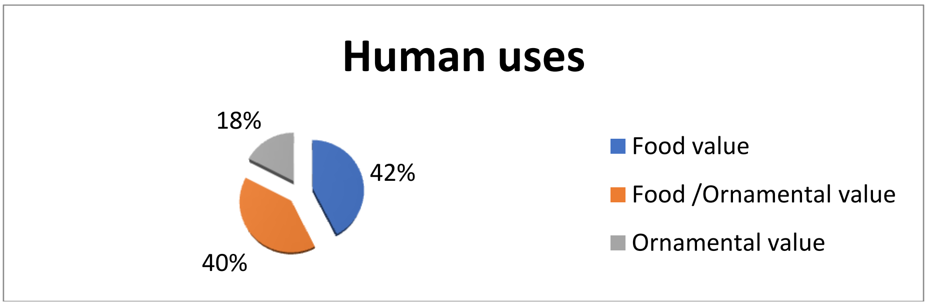

Fig. 14. Human uses status of fishes in Tangon River at Radhikapur village

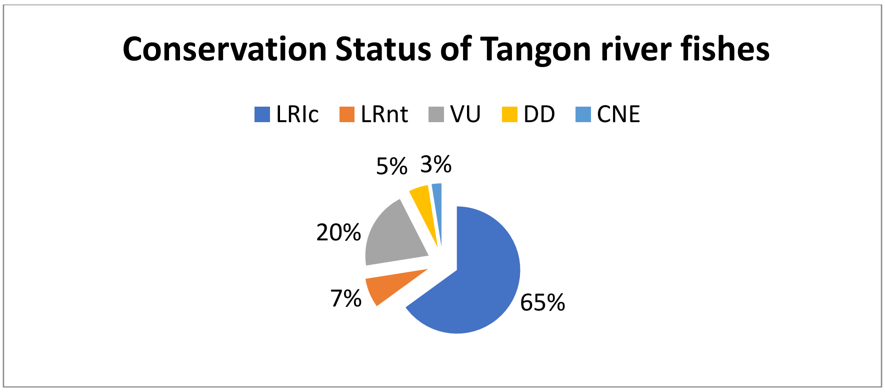

Fig. 15. Conservation status of fishes in Tangon River at Radhikapur village (IUCN Red list index 2010 [26]).

Table 1. Freshwater fishes of Tangon river with note on local name, human use, conservation status and relative abundance of Uttar Dinajpur district, West Bengal (December 2019 to November 2020), (According to IUCN [26] and CAMP [25])

Sl .no	Family	Scientific name	Local name	Consevation status	Human use	Relative abundance			
						SITE 1	SITE 2	SITE 3	SITE 4
1.	Cyprinidae	*Catla catla (*Hamilton,1822)	Catla	NE	Food	++++	++++	++++	++++
2.		*Cirrhinus mrigala* (Bloch, 1795)	Mrigal	LRIc	Food	++	0	0	++
3.		*.Labeo rohita (*Hamilton,1822)	Rui	LRIc	Food	++++	++++	+++	+++
4.		*Labeo bata (*Hamilton,1822)	Bata	LRIc	Food	++++	++++	++++	+++
5.		*Labeo kalbasu* (Hamilton, 1822)	Kalbaush	LRIc	Food	0	0	+++	++
6.		*Pintos conchonius* (Hamilton, 1822)	Kanchan puti	Vu	Food/ ornamental	++++	+++	+++	+++
7.		*Puntius saphore* (F. Hamilton, 1822).	Punti	LRIc	Food /ornamental	0	+++	++++	0
8.		*Puntius ticto* (F. Hamilton, 1822).	Tit puti	LRIc	Food /ornamental	++++	0	+++	0
9.		*Salmostoma bacaila* (F. Hamilton, 1822).	Chela	LRIc	Food	++++	0	++++	+++
10.		*.Amblypharyngodon mola* (Hamilton & Buchanan, 1822)	Moya	LRIc	Food	++++	++++	++++	++++
11.		*Barilius bendelisis (Hamilton, 1807)*	Joia	LRIc	Food	++++	++++	++++	++++
12.		*Chela cachius* (Hamilton, 1822)	Chela	LRnt	Food	++++	++++	+++	++
13.		*Ophisternon bengalense (*Hamilton,1822)	Koksa	LRIc	Food	+++	++	0	0
14.		*Devario devario (*Hamilton,1822)	Banspata	LRIc	Food /ornamental	++++	0	++	0
15.		*Esomus danrica (*Hamilton,1822)	*Darkina*	LRIc	Ornamental	++++	+++	++	++++
16.		*Labeo dyocheilus (*McClelland,1839)	Ghuramach	LRIc	Food	++	++++	++	++++
17		*Rasbora rasbora (*Hamilton,1822)	*Darkina*	LRIc	Ornamental	+++	+++	++	+++
18	Bagridae	*Sperata aor (*Hamilton,1822)	Ayre	LRIc	Food	0	+++	0	++
19		*Batasio tengana (*Hamilton,1822)	Tengra	LRIc	Ornamental	0	0	0	++
20		*Chandramara chandramara (*Hamilton,1822)	Ghura tengra	VU	Ornamental	+	0	0	0
21.		*Mystus bleekeri (F.Day,1877)*	Ghuchi tengra	VU	Food/ ornamental	++	0	0	++
22.		*Mystus vittatus (*Bloch, 1794)	Patitengra	VU	Food/ ornamental	0	0	+	0
23		*Rita rita* (Hamilton & Buchanan,1822)	Ritha	VU	Food/Ornam	+	0	0	0

Sl	Family	Scientific name	Local name	Consevation	Human use	Relative		abundance	
					ental				
24.	Siluridae	*Ompok pabda (*Hamilton.1822)	Pabda	VU	Food/ ornamental	+++	0	0	+++
25.		*Wallago attu(* Bloch and Schneider, 1801)	Boal	VU	Food	+	0	+	0
26.	Clariidae	*Clarius batrachus* (Linnaeus, 1758)	Magur	LRIc	Food /ornamental	0	0	++	+
27.	Pangasiidae	*Pangasius pangasius (*Hamilton.1822)	Panguas	LRIc	Food/ ornamental	++	+	0	0
28.	Ambassidae	*Chanda nama* (Hamilton, 1822)	Chanda	LRIc	Food/orname ntal	++++	++++	++++	+++
29.	Anabantidae	*Anabas testudineus* (Bloch,1792)	Koi	DD	Food	0	++	0	+++
30.	Belontidae	*Colisa fasciatus* (Bloch & J.G. Schneider, 1801)	Colisa	LRIc	Food/orname ntal	++++	+++	+++	++
31.	Channidae	*Channa punctatus (*Bloch, 1793*)*	Lata	LRIc	Food ornamental	+	0	0	0
32		*Channa striata* (Bloch, 1793)	Shol	LRIc	Food/orname ntal	++	0	+	0
33.	Ailiidae	*Ailiichthys punctata* (Day,1872)	Kajuli	DD	Ornamental	+++	++	+++	+++
34.	Anguillidae	*Anguilla bengalensis bengalensis(* J.E. Grey, 1831).	Bam	LRnt	Food	0	0	0	+++
35.	Mastacembelidae	*Macrognathus aculeatus* (Bloch)	Ban, Ghuchi	LRIc	Food	++	+++	0	0
36.	Clupeidae	*Gudusia chapra (*Hamilton,1822)	Chapila	VU	Food	+++	++	++	+++
37.	Heteropneustidae	*Heteropneustes fossilis (*Bloch,1794)	Shingi	LRIc	Food /Ornamental	0	++	+	0
38.	Notopteridae	*Notopterus notopterus* (Roberts, T.R, 1992)	Foli	LRIc	Food/Ornam ental	0	+	+	0
39.	Cichlidae	*Oreochromis mossambicus (*Peters,1852)	Tilapia	LRnt	Food	++	0	0	0
40.	Sisoridae	*Hara hara (*Hamilton,1822)	Tinkata	LRIc	Ornamental	+++	++++	++	+++

Note: DD= Data deficient, VU = Vulnerable, NE = Not Evaluated.
LRnt= Lower risk near threatened,
LRIc = Lower risk least concern.
++++ = Abundant species
+++ = Less abundant
+ = Rare species
0 = Absent

The most dominant families with diverse species composition were Cyprinidae with 17 species, Bagridae with 6 species and Siluridae with 2 species were recorded during the study period. Mogalekar et al. [48] also recorded family Cyprinidae as the most diverse family. Similar observation was recorded by Patra and Dutta [49] from Karala river in Jalpaiguri, West Bengal. The dominance of this Cyprinidae family among the fresh water fishes of Bangladesh was shown by Pramanik and Hasan [50] from Dhonagoda river.

Among the recorded fish species of Tangon river at Radhikapur village seventeen have food values (42%), sixteen have both food and ornamental values (40%), seven fishes have only ornamental values (18%) (Fig. 14). Out of the total fishes *Catla catla, Labeo rohita, Labeo bata, Colisa fasciotus,* were the most preferred fishes at Radhikapur village throughout the year. Fishes like *Esomus danrica, Sperata aor, Batasio tengana, Pangasius pangasius, Oreochromis mossambicus,* and *Clarius batrachus* have high market values. *Hara hara, Ailiichthys punctata, Labeo dyocheilus, Barilius bendelisis, Salmostoma bacaila, Labeo bata, Notopterus notopterus* were the fishes which generally fulfilled the daily needs of protein to the rural people of the Radhikapur village.

Conservation status of the freshwater fishes of the Tangon river, West Bengal, suggests that out of a total fourty fish species eight species (*Mystus vittatus, Mystus bleekari, Rita rita, Gudusia chapra, chandramara chandamara, Ompok pabda, Wallago attu, Pintos conchonius*) were under the vulnearable category and three species (*Chela cachius, Oreochromis mossambicus, Anguilla bengalensis bengalensis*) were under a near threatened category (Table 1 and Fig. 15). Hasan *et al.* [51] recorded similar fish species (*Ompok pabda, Wallago attu, Mystus vittatus, Mystus bleekari, Rita rita*) from the Mahananda river of Malda. Chakraborty [52] also recorded the near threatened species *Anguilla bengalensis* from the rivers of North Bengal.

4. CONCLUSION

The study revealed the present status of the physicochemical nature and ichtyofauna diversity of water of the Tangon river at Radhikapur Village of Uttar Dinajpur District. The pH values of the Tangon river were slightly alkaline at all the sampling sites during the whole study period. However, the values of water quality parameters such as pH, chloride, total alkalinity, total hardness of all the sampling sites of the Radhikapur village were within the recommended limits (drinking water standard) set by WHO [18], most of the time, although the dissolved oxygen values of Site 2 were lower than the drinking and bathing water standard set by CPCB [19] and drinking water Standard set by WHO [18]. Highest BOD was recorded from Site 4, which was much greater than the drinking and bathing water standard set by CPCB [19]. The present study also reveals that the Tangon river exhibits a rich fish diversity. Although, the number of fish species have been decreasing day by day. During the study period the distribution of fish was not uniform in the different Sites of the Tangon river of Radhikapur village. The highest number of fish species were recorded from Site 1 and the lowest number of fish species were recorded from Site 2 where the maximum anthropogenic activities and their subsequent environmental disturbances were observed that may led to the decline of fish diversity. Among the recorded fish species, 20% were under the vulnerable category and 7% were under a near threatened category. So, immediate conservation steps will be required for about 20% of fish species to save them from extinction. Otherwise the ecological balance will be disturbed. From the overall study, it can be concluded that Site 2 and Site 4 were more polluted than the other sites. The higher pollution level of these two sites may be due to the higher levels of anthropogenic activities and poor maintenance of the water. Thus the present study will help formulating the future policy for conservation as well as the management of the fish diversity of the Tangon river at the Radhikapur village. The cooperation from all sections of people concerned, government and non government agencies are needed urgently in maintaining the diversity of ichthyofauna of the river. However, it is also important to investigate other chemical compounds to determine the overall water quality of the Tangon river. Public awareness is very important to control the discharge of waste from the households and agricultural fields adjoining the river. Sand lifting should also be decreased from the river as it affects the water quality and the biodiversity of the river. This study can also be useful to evolve strategies for ecological restoration, conservation and management.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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