Studies on fish diversity concerning Hydro-ecology of Kangsabati river in Purulia district, West Bengal, India

Manab Kumar Saha

Department of Zoology,
Ramananda Centenary College,
Laulara, PURULIA-723151 (W.B.), INDIA.
Email- manabsaha5@gmail.com

Received : 18.10.2020; **Accepted** : 16.11.2020

ABSTRACT

Fish diversity depends both on various physicochemical parameters and the biological components of the riverine ecosystem. During the study period from January 2017 to December 2019 the highest fish diversity and density were observed in post-monsoon and lowest in pre-monsoon season in the Kangsabati River, Purulia District of West Bengal. Twenty five fish species, associated with 19 genera, 10 families and 5 orders have been identified. It was recorded that the Cyprinidae was the predominant family, which represented 56% of the entire fish catch.

Figures : 01

References : 26

Tables : 06

KEY WORDS : Ecological integrity, Fish diversity, Kangsabati River, Physicochemical parameters, West Bengal.

Introduction

In aquatic ecosystem, the water serves as the lifeline for all the aquatic organisms²¹. The fishes are considered as indicator species to check the aquatic health (Physiochemical property of water) of a particular aquatic ecosystem¹³. Over the past few decades, changes in ecological and environmental conditions show a negative impact on river diversity. Many fish species have become endangered^{8,11}. For that reason, the conservation of river fish diversity has become more essential and gets the maximum priority²³. There was no previous record regarding the ichthyofaunal diversity of river Kangsabati in Purulia district. For this study, several attempts were made to collect, classify and identify fish of river Kangsabati to document the fish diversity, abundance and richness concerning different water parameters viz. Temperature, Conductivity, Transparency, dissolved oxygen, pH, salinity, conductivity and zooplankton density, etc^{4,6,9,11}.

Study Area:

The River Kangsabati is also known as the 'Kasai / Kansai' originates at Jabor Pahar (Gayalikota),

23°16'49"N 86°08'23"E) from the Chhota Nagpur plateau in Purulia district, state of West Bengal, India.

Materials and Methods

During the survey period, sampling was done bimonthly viz. pre-monsoon (March–May), monsoon (June–September), and post-monsoon (October–November) and, winter (December–February). The average annual 'species-wise fish' catch value was determined by adding the bimonthly average value for each season⁸. From each site (sub site) data were collected regarding fish fauna and physicochemical parameters of river water (Table-5). Fishes were collected from each sampling station and different fishing gears viz. scoop net, drag net, cast net, gill net, hooks and lines were used for sampling⁵. The fish samples were photographed immediately before release them into the river at same place. Only few 'indicative specimens' from captured fishes were fixed in 8% formalin solution for further identification⁸. The fish specimens were identified with the help of key^{18,19,25}. The zooplankton was identified (Rotifera, Cladocera, Copepoda, Protozoa) with the help of a microscope and compared with the identification

ACKNOWLEDGEMENT : The author would like to thank the riverside local people and fishermen of the Kansabati River for data collection during the research period and to Mr. Dibyendu Majhi, Guest Lecturer, Centenary College, Purulia for map imaging of the study area. Sincere. Thanks to Professors Bidhan Chandra Patra, Aquaculture Research Unit, Department of Zoology, Vidyasagar University, for his inspiration and valuable suggestions.

TABLE-1. 'Sampling sites and their physical attributes parameters at Kangsabati River, Purulia district'.

S. No.	Sampling sites	Position	Land use patterns	Distance (Km.)	
Site I	Haranama river bank	23°18'39"N 86°17'57"E	Rural, Agriculture	21.39	104.75
Site II	Anai river bank	23°16'20"N 86°26'36"E	Rural, Agriculture, domestic sewage	21.72	
Site III	Kaira/Bansa bridge	23°10'17"N 86°36'6"E	Rural, Agriculture, domestic sewage, temple in the river bank, sand mining.	26.85	
Site IV	Pairachali bridge	23°4'52"N 86°42'32"E	Rural, Agriculture, domestic sewage, temple in the river bank, sand mining.	19.83	
Site V	Darasol river bank	23°02'29"N 86°43'22"E	Rural, Agriculture	14.96	

keys³.

Fish diversity index (relative abundance, Species Richness, Shannon-wiener index, Evenness index, Simpson's dominance index), the Pearson Correlation matrix (r) between the physicochemical parameter and ichthyofaunal diversity was done using Stat Plus software¹² to observe the correlation among them.

Result

During the study period a total of 1655 fishes were recorded. According to the record (Table-2) fish specimens were distributed in 19 genera, 10 families and 5 orders. The statistical analysis shows that order Cypriniformes (60%) was highest in value, where-as Perciformes (24%) and Siluriformes (8%) subsequently occupy the next position (Table-2). Most of the individual fish species of the river showed the relatively rare abundance distribution, but nine species among them showed good relative abundance viz., *Puntius ticto* (15.4%), *Amblypharyngodon mola* (15.34%), *Osteobrama cotio cotio* (12.99%), *Salmophasia bacaila* (12.8%), *P. sophore* (8.58%), *Mystus tengara* (4.71%), *Chanda nama* (4.59%), *Labeo bata* (4.47%), *C. ranga* (3.26%) were recorded at all the sites. It was also observed that the family Cyprinidae (56%) was very common and dominant, followed by Ambassidae and Osphronemidae of the total fish catch.

According to the trophic utilization by fishes, herbivores (56%) showed the highest number followed by omnivores (32%) and carnivores (12%). The present study did not record any exotic species in entire stretch.

As per IUCN Red list 80% of the fish species of Kangsabati River belong to least concern category²⁴, while 12% is noted as near threaten. The Shannon-wiener index (H') within the 5 sites of the river varied from 2.52-2.62; Evenness index (J) varied from 0.44-0.45; Simpson's dominance index (D) varied from 0.09-0.10; Simpson's diversity index (1-D) varied from 0.9-0.91 (Table 3).

Table 2. **IUCN Red list**- DD: Data Deficient, LC: Least Concern, VU: Vulnerable, NE: Not Evaluated, EN: Endangered, NT: Near Threatened; Population Trend- DE: Decreasing, UN: Unknown, ST: Stable; HEV: Herbivore, OMV: Omnivore, CAV: Carnivore.

Pearson's r correlation between different parameters (Biotic and abiotic factors) is presented in (Table-4). To analyse the outcome of the Pearson's r correlation, it was clear that they were either positively or negatively correlated between them. A strong and significant correlation was reported among the concentration of Dissolved Oxygen and the zooplankton density ($r = 0.592$, $p < 0.05$), a very strong positive significant correlation ($r = 0.747$, $p < 0.05$) was observed between the zooplankton density and the level of pH. And two more relations were reported very significant, which were Salinity and the zooplankton density ($r = 0.681$, $p < 0.05$), the zooplankton density and Species Richness of fishes ($r = 0.666$, $p < 0.05$). The other Positive correlations were also found between pH level Dissolved Oxygen ($r = 0.974$) along the river¹⁸.

On the other hand, significant negative correlations were found between the Transparency and Water

TABLE-2 : 'Fish species, their local name, conservation status (IUCN), population status and feeding habit in Kangsabati River of Purulia district during the study period'.

Order	Family	Scientific name	Local name	IUCN	Population	Feeding habit	Abundance					
							I	II	III	IV	V	Total
Beloniformes	Belontiidae	1. <i>Xenentodon cancila</i>	Kakia	LC	DE	OMV	02	01	02	02	01	08
Cypriniformes	Cyprinidae	2. <i>Amblypharyngodon mola</i>	Mourola	LC	ST	HEV	54	52	51	49	48	254
		3. <i>Catla catla</i>	Catla	LC	ST	HEV	08	05	05	04	05	27
		4. <i>Cirrhinus mrigala</i>	Mrigal	LC	UN	OMV	04	05	04	03	04	20
		5. <i>Danio devario</i>	Techokha	LC	ST	HEV	02	02	01	01	01	07
		6. <i>Danio rerio</i>	Techokha	NT	UN	HEV	01	02	01	01	01	06
		7. <i>Esomus danricus</i>	Darkina	LC	DE	HEV	03	02	02	02	01	10
		8. <i>Labeo calbasu</i>	Kalbose	LC	ST	HEV	03	03	02	02	01	11
		9. <i>Labeo bata</i>	Bata	LC	ST	HEV	16	15	15	14	14	74
		10. <i>Labeo rohita</i>	Rui	LC	ST	HEV	09	08	08	07	05	38
		11. <i>Osteobrama cotio cotio</i>	Keti	LC	DE	HEV	46	44	42	42	41	215
		12. <i>Puntius ticto</i>	Punti	LC	DE	HEV	54	52	51	50	48	255
		13. <i>Puntius sophore</i>	Punti	LC	ST	HEV	32	31	29	26	24	142

		14. <i>Puntius conchonius</i>	Punti	VU	DE	HEV	05	04	04	03	03	19
		15. <i>Salmophasia bacaila</i>	Chel	LC	UN	HEV	46	44	42	42	38	212
	Cobitidae	16. <i>Lepidocephalichthys guntea</i>	Guntey	LC	DE	OMV	05	04	04	02	03	18
Osteoglossiformes	Notopteridae	17. <i>Notopterus chitala</i>	Chital	NT	ST	OMV	06	04	03	02	02	17
Perciformes	Ambassidae	18. <i>Chanda ranga</i>	Chanda	NE	ST	OMV	14	12	11	09	08	54
		19. <i>Chanda nama</i>	Chanda	LC	ST	OMV	18	16	16	14	12	76
	Channidae	20. <i>Channa punctata</i>	Lata	LC	UN	CAV	02	02	01	01	02	08
	Gobiidae	21. <i>Glossogobius giuris</i>	Bele	LC	DE	CAV	03	05	03	03	01	15
	Osphronemidae	22. <i>Colisa fasciata</i>	Khalisa	LC	DE	OMV	09	12	11	09	08	49
		23. <i>Colisa lala</i>	Khalisa	LC	DE	OMV	07	09	09	08	06	39
Siluriformes	Bagridae	24. <i>Mystus tengara</i>	Tangra	LC	ST	CAV	18	16	16	15	13	78
	Sisoridae	25. <i>Bagarius bagarius</i>	Bhagha aor	NT	UN	HEV	02	01	00	00	00	03
		Total					369	351	333	311	291	1655

TABLE-3 : 'Diversity index of fish assemblages among the five different sampling stations of Kangsabati River, Purulia district during the study period'.

Site	Species Richness (D)	Shannon-wiener index (H')	Evenness index (J)	Simpson's dominance index (D)	Simpson's diversity index (1-D)
I	1.30	2.67	0.45	0.09	0.91
II	1.31	2.65	0.45	0.09	0.91
III	1.31	2.60	0.45	0.09	0.91
IV	1.36	2.55	0.44	0.10	0.9
V	1.40	2.52	0.44	0.10	0.9
Total	0.61	2.61	0.35	0.09	0.91

Temperature ($r = -0.861$, $p < 0.05$), level of Conductivity ($r = -0.881$, $p < 0.05$), Total Dissolved Solid and Water Temperature ($r = -0.878$, $p < 0.05$)¹⁶, the zooplankton density and Water Temperature ($r = -0.794$, $p < 0.05$), between the Species Richness of fishes and Conductivity

($r = -0.944$, $p < 0.05$), the Species Richness of fishes and Water Temperature ($r = -0.958$, $p < 0.05$). Negative correlations were also found between the Dissolved Oxygen and the Water Temperature ($r = -0.932$). The Correlation between water parameters and biotic factor

TABLE-4 : 'Pearson's r correlation matrix between abiotic and biotic parameters at Kangsabati River, Purulia district during the study period'.

	WT	DO	PH	TRA	CON	TDS	SAL	ZD	SR
WT	1.000								
DO	-0.932	1.000							
PH	-0.958	0.974	1.000						
TRA	-0.861*	0.986	0.935	1.000					
CON	0.974	-0.934	-0.912	-0.881*	1.000				
TDS	-0.878*	0.985	0.921	0.992	-0.916	1.000			
SAL	-0.984	0.941*	0.928	0.885*	-0.998	0.916	1.000		
ZD	-0.794*	0.592*	0.747*	0.466	-0.649*	0.450	0.681*	1.000	
SR	-0.958*	0.995	0.990	0.967	-0.944*	0.965	0.954	0.666*	1.000

* represent the level of significance 0.05 ($p < 0.05$).

TABLE-5 : 'Mean values (Mean $\pm$ SE) of water physicochemical parameters in selected sites along the Kangsabati River, Purulia district from January 2017 to December 2019'

Parameters		Winter (Dec-Feb)	Pre-Monsoon (Mar-May)	Monsoon (June-Sept)	Post-Monsoon (Oct-Nov)	STRD
Water Temperature ($^{\circ}$ C)	WT	18.46 $\pm$ 0.29	30.8 $\pm$ 0.78	28.24 $\pm$ 0.16	24.83 $\pm$ 0.46	20-32
Dissolved Oxygen (mg/L)	DO	6.8 $\pm$ 0.36	7.6 $\pm$ 0.17	8.6 $\pm$ 0.24	5.1 $\pm$ 0.18	> 1e" 5
pH	pH	7.8 $\pm$ 0.08	6.8 $\pm$ 0.14	8.1 $\pm$ 0.06	7.2 $\pm$ 0.9	6.5 -9
Transparency (cm)	TRA	56.44 $\pm$ 1.23	42.74 $\pm$ 1.84	29.47 $\pm$ 2.09	48.64 $\pm$ 1.15	> 30 -60
Conductivity (iS /cm)	CON	251.47 $\pm$ 4.34	282.16 $\pm$ 3.46	182.62 $\pm$ 2.69	242.34 $\pm$ 3.95	20-1500
Total Dissolved Solid (mg/L)	TDS	124.26 $\pm$ 2.38	139.31 $\pm$ 2.12	92.34 $\pm$ 1.06	121.61 $\pm$ 2.24	d" 400
Salinity (ppt)	SAL	0.25 $\pm$ 0.01	0.29 $\pm$ 0.02	0.24 $\pm$ 0.04	0.22 $\pm$ 0.02	d" 0.5
zooplankton density (ind/L)	ZD	1028 $\pm$ 42.01	884 $\pm$ 38.69	762 $\pm$ 28.26	972 $\pm$ 38.26	NA

Legend: SE: Standard Error; **STRD:** Standards of water quality^{1,7}.

Distribution of different fish Order and Species

Fig. 1 : 'Relative Abundance (RA) of fish species habit in Kangsabati River of Purulia district during the study period'.

(zooplankton/fish population) during the study period shows at a glance in (Table-6).

Discussion

Studies of ecological diversity are essential to understand the species richness or taxonomic diversity, community structure, species assemblages in a given area, to understand the environmental conditions²². According to the observation, water quality shows the majority, of the components, were within the range. That can create a sustainable and favourable environment for the growth and propagation of ichthyofaunal diversity. Although, the fish diversity and abundance was high in the upstream segment but progressive decline in the lower part of the Kangsabati River (Site IV: Pairachali bridge & Site V: Darasol river bank). But according to the local fishermen 'two to three decades ago there was huge fish diversity in this area of the river. This arises a question, why it is so? The water of these two sites carried high quantity of Total Dissolved Solid and level of Conductivity compared to upstream (site I, II and III). The two sites accumulate runoff from upriver, which increases the sediment loads and organic matter from the nearby agricultural wastes, domestic pollutant, burning ghat effluents, dumped solid wastes, during monsoon and post-monsoon period, domestic sewage *etc*^{2,10}. It was also noted that during the study period the extensive sand mining, siltation on the river bed has a strong negative impact on ichthyofaunal diversity. So, the answer is - Global climate change, pollution, soil erosion, overfishing and other anthropogenic activities are common factors and threats to fish biodiversity.

Conclusion

Fish is an economical source of protein and an important cash crop in West Bengal. Thus, the demands of fish cross the carrying capacity (K) of the aquatic system. Subsequently, the lotic ecosystems are under constant pressure. According to the observation during the study period, the following steps are recommended for the restoration of declining fish diversity in the Kansabati River : (i) To control and manage the use of chemical fertilizers and harmful pesticides' in riverside agricultural activities (ii) water quality parameters should

TABLE-6: 'Correlation between water parameters and biotic factor (zooplankton/ fish population) during study period'.

Parameters		Zoopla-nkton	Fish population
Water Temperature (°C)	WT	-0.794*	-0.958*
Dissolved Oxygen (mg/L)	DO	0.592*	0.995
pH	PH	0.747*	0.990
Transparency (cm)	TRA	0.466	0.967
Conductivity (iS /cm)	CON	-0.649*	-0.944*
Total Dissolved Solid (mg/L)	TDS	0.450	0.965
Salinity (ppt)	SAL	0.681*	0.954
zooplankton density (ind/L)	ZD	-	0.666*

be monitored regularly (iii) strictly prevent the deforestation surrounding the river bank (iv) Harvesting of fingerling/fry should stop (v) strictly ban the harvesting of mature female fishes in breeding seasons (vi) selective area (high anthropogenic stress) of the river should be declared as an aquatic sanctuary. Last but not the least, organize the maximum number of community awareness programs among the riverside common people for active participation in the conservation strategies and therefore ensure the sustainable ecological balance of the River. The work will provide a platform for the future researcher, to make a sustainable conservation plan for this region.

References

1. Ali M, Salam A, Azeem A, Shafique M, Khan BA. Studies on the effect of seasonal variations on physical and chemical characteristics of mixed water from Rivers Ravi and Chenab at union site in Pakistan. *J. Res. BZ Univ. Multan*. 2000; **2**:1-7.
2. Arthington AH, Dulvy NK, Gladstone W, Winfield IJ. Fish conservation in freshwater and marine realms: status, threats and management. *Aquatic Conservation: Marine and Freshwater Ecosystems*. 2016 Sep; **26**(5):838-57.
3. Battish SK. Freshwater zooplankton of India Oxford & IBH Publishing Co. Pvt Ltd., New Delhi, India. 1992.

4. Bera A, Bhattacharya M, Patra BC, Sar UK. Ichthyofaunal diversity and water quality in the Kangsabati Reservoir, West Bengal, India. *Advances in Zoology*. 2014; **3**(12):28-32.
5. Bhat A. Diversity and composition of freshwater fishes in river systems of Central Western Ghats, India. *Environmental biology of fishes*. 2003; **68**(1):25-38.
6. Bonjoru R, Abubakar KA, Hassan EI, Jerry TJ. Diversity and Abundance of Fish Species in Some Selected Riverine Wetlands of Upper Benue River Basin, Nigeria. *Journal of Environmental Science, Toxicology and Food Technology*. 2019; **13**(8): 14-18.
7. Boyd CE, Tucker CS. "Ecology of aquaculture ponds." *Pond aquaculture water quality management*. Springer, Boston, MA, 1998. 8-86.
8. Das MK, Samanta S, Sajina AM, Sudheesan D, Naskar M, Bandopadhyay MK, Paul SK, Bhowmick S, Srivastava PK. Fish diversity, community structure and ecological integrity of river Brahmani. *Journal of the Inland Fisheries Society of India*. 2016; **48**(1):1-3.
9. Eisenhauer N, Barnes AD, Cesarz S, Craven D, Ferlian O, Gottschall F, Hines J, Sendek A, Siebert J, Thakur MP, Türke M. Biodiversity–ecosystem function experiments reveal the mechanisms underlying the consequences of biodiversity change in real world ecosystems. *Journal of Vegetation Science*. 2016; **27**(5):1061-7100.
10. Fu C, Wu J, Chen J, Wu Q, Lei G. Freshwater fish biodiversity in the Yangtze River basin of China: *patterns, threats and conservation*. *Biodiversity & Conservation*. 2003; **12**(8):1649-85.
11. Guo Q, Liu X, Ao X, Qin J, Wu X, Ouyang S. Fish diversity in the middle and lower reaches of the Ganjiang River of China: *Threats and conservation*. *PloS one*. 2018; **13**(11):e0205116.
12. Hammer Ø, Harper DA, Ryan PD. PAST: Paleontological statistics software package for education and data analysis. *Palaeontologia electronica*. 2001; **4**(1):9.
13. Heal GM, Barbier EB, Boyle KJ, Covich AP, Gloss SP, Hershner CH, Hoehn JP, Pringle CM, Polasky S, Segerson K, Shrader-Frechette K.. National Research Council. Valuing ecosystem services: toward better environmental decision-making. *National academies Press*; 2005 May 14.
14. <https://www.analystsoft.com/en/>
15. <https://www.google.com/earth/>
16. Hu B, Hu X, Nie X, Zhang X, Wu N, Hong Y, Qin HM. Seasonal and inter-annual community structure characteristics of zooplankton driven by water environment factors in a sub-lake of Lake Poyang, China. *PeerJ*. 2019; **7**:e7590.
17. IUCN (International Union for Conservation of Nature and Natural Resources) (2008) Available at www.iucnredlist.org
18. Jayaram KC. The freshwater fishes of the Indian region. *Narendra Publishing House*, New Delhi; 1999.
19. Jhingran VG. Fish and Fisheries of India, Hindustan Publ. Co., New Delhi; 1991.
20. Kar A, Bhattacharya M, Ghorai M, Patra S, Patra BC. Ichthyofaunal Diversity of Kangsabati River at Paschim Medinipur District, West Bengal, India. In *Proceedings of the zoological society, Springer India*. 2017; **70**(2):165-173.
21. Manjare SA, Vhanalakar SA, Muley DV. Analysis of water quality using physicochemical parameters Tamdalg tank in Kolhapur district, Maharashtra. *International Journal of Advanced Biotechnology and Research*. 2010; **1**(2):115-119.
22. Negi RK, Mamgain S. Species diversity, abundance and distribution of fish community and conservation status of Tons River of Uttarakhand State, India. *Journal of Fisheries and Aquatic Science*. 2013; **8**(5):617-26.
23. Siligato S, Böhmer J. Using indicators of fish health at multiple levels of biological organization to assess effects of stream pollution in southwest Germany. *Journal of Aquatic Ecosystem Stress and Recovery*. 2001; **8**(3-4):371-86.
24. Suresh, V. R., Sahu, S. K., Manna, S. K., Roy, S., Karnatak, G., Ekka, A., and Chandra, G. *ICAR-Central Inland Fisheries Research Institute Barrackpore, Kolkata-700 120, West Bengal, Annual report 2015-16*. 2016.
25. Talwar PK. Inland fishes of India and adjacent countries. CRC Press; 1991.
26. Yuan Y, Jiang M, Liu X, Yu H, Otte ML, Ma C, Her YG. Environmental variables influencing phytoplankton communities in hydrologically connected aquatic habitats in the Lake Xingkai basin. *Ecological Indicators*. 2018; **91**:1-2.