

Ichthyofaunal Diversity of River Kapaleswari at Paschim Medinipur District of West Bengal, India

Arun Jana, Godhuli Sit and *Angsuman Chanda

Natural & Applied Sciences Research Centre,
Raja N. L. Khan Women's College (Autonomous),

MIDNAPUR-721102, PASCHIM MEDINIPUR, (WEST BENGAL), INDIA.

*Corresponding Author

E-mail: angsumanchanda@yahoo.in

Received : 20.03.2021; **Accepted** : 14.05.2021

ABSTRACT

The present study has been conducted on ichthyofaunal diversity of river Kapaleswari flowing through Paschim Medinipur district of West Bengal, India. Results reveal the existence of 56 indigenous fish species under 22 families of 8 orders and the order Perciformes represents the largest diversity with 8 families and 20 species. Cyprinidae is the most dominant family; contributed 26.79% species. Two species namely *Stigmatogobius sadanundio* & *Gobiopsis macrostoma* have been first time recorded from Paschim Medinipur district of West Bengal. Among the recorded fish species of Kapaleswari River, 47.07% were used as food-fish, 1.79% used as ornamental & the remaining 57.14% were used as both food and ornamental. So, maximum fish species have important socio-economic value for the development of local people proximate to the Kapaleswari River. The values of the Shannon-Weaver index (H) range from '3.58' to '3.79' & the Simpson's index (D) from '0.023' to '0.032' among the sampling sites are indicative to diverse fish population in Kapaleswari River. The result of species evenness has been concluded that individual species are near to disturb condition at Kapaleswari river. According to IUCN ver. 2020.1, status of the fishes in the river depicts, 75% are Least Concern, 3.57% are Vulnerable, 8.93% are Near Threatened, 10.71% are Not Evaluated & 1.71% are Data Deficient. As per local status 71.42% of fishes of this river are under risk and need immediate conservation to protect them from extinction. Hence, the work is a documentation of macro faunal diversity of Kapaleswari river as well as regional level for helpful for future researchers and policy planners and also helpful to formulate the future policy for conservation and management of the fish diversity in the river Kapaleswari.

Figures : 05

References : 39

Tables : 05

KEY WORDS : Conservation, Diversity, Fish, Kapaleswari river, Ornamental, Perciformes, Socioeconomic

Introduction

The fish is a large group of aquatic vertebrates; they develop enormous variations in their morphology. Body shape is mostly flattened and typical characteristics being, presence of gill as respiratory organ and paired and unpaired fins supported with fin rays. The fish meal contains vital source of protein and also a valuable source of micro-nutrients such as calcium, zinc, iron and fatty acids etc. which are essential for the growth and development of the people¹⁸. Fishes play a major role in the socio- economic development of the country, as it is a valuable resource of livelihood for a huge section of

economically backward population. It also generates gainful employment, alternate income and stimulates growth in subsidiary industries⁹. Fishes are included at or near the top of the food chain and can serve as an indicator of a balanced aquatic ecosystem⁸. Ichthyofaunal diversity refers to variety of fish species; variation of fish species in river essentially represents the fish faunal diversity and their abundance. River represents a rich source of fish species which support the commercial fisheries.

Paschim Medinipur district is one of the districts

ACKNOWLEDGEMENTS : Authors expresses their sincere gratitude to Principal, Dr. Jayasree Laha and Head of the Department of Zoology, Dr. Partha Pratim Chakravorty of Raja N. L. Khan Women's College (Autonomous) for their help, support, encouragement and providing infrastructural facilities to conduct the present work. Authors are also highly grateful to Professor Tanmay Bhattacharya (Retired), Dept. of Zoology Vidyasagar University for his critical comments and sincere suggestion during the preparation of the manuscript. Thanks, are also extended to the local fishermen who helped for collection of specimens.

TABLE-1: Study site of the Kapaleshary river

S. No.	Name	Longitude & Latitude
Site-1	Jorura	22°10'17.60"N & 87°35'11.75"E
Site-2	Uttar Bansbani	22°9'22.34"N & 87°36'9.68"E
Site-3	Narayanbargh	22°07'08.8"N & 87°36'31.8"E
Site-4	Gopal Chak	22°06'58.1"N & 87°37'32.4"E

of the West Bengal, India. It was formed on 1st January 2002 after the Partition of Midnapore into Paschim Medinipur and Purba Medinipur. This district has many flood prone areas, there are many large and small rivers, one of which is Kapaleswari, which originated from Mawa (22°18'33.4"N 87°26'23.3"E) and came to Sabang in large size and finally merged into Keleghai River at Andulia (22°06'49.2"N 87°37'40.6"E) near the border line of Purba Medinipur. Depending on the fish of this river, local people get nutrition and even many people maintain their daily livelihood by selling fish in nearby markets every day. The existing literatures^{15,17,19,26,28-31,35,36} give different fish diversity information in different rivers and water bodies of the Paschim Medinipur district but no researcher did work on fish diversity of Kapaleswari river^{14,17,19,26,28,29}. So, the present study be reported for the fish diversity of Kapaleswari River and to get enrich the database on the distribution of fish species in the Paschim Medinipur district. During present study investigators have also followed the works on fish diversity^{2,9,11,23,24,27,33,34} which are very important and helpful to compare results^{2-9,12,23,24,27,32}.

The objective of the present study is to report the fish diversity of the Kapaleswari River and to make a baseline tool for conservation-planning of the aquatic environments of the river as well as other similar aquatic systems of Paschim Medinipur district. Different indigenous, commercially important, and economically viable with ornamental value aided fishes were found in this river. This diversity is being destructed every day mainly because of different anthropogenic pressure. So, some quick steps are required to protect the biodiversity of the river.

Material and Methods

Study Site:

The study was conducted in river Kapaleswari ruvers through Paschim Medinipur district covering an area of about 10 km, a major part in the river, that is, from

Jorura to Gopal Chak. The sampling areas has been divided into 4 sites included Table- 1. Distance among the sample sites was 3 km.

Collection& preservation of specimens:

The survey work has been conducted over a period of two years (June 2018 to February 2020). Specimen have been collected from selected four sites with the help of fishermen using different types of nets namely, gill nets, cast nets, dip nets, drag nets *etc.* Specimens were immediately preserved in 4% formaldehyde and brought to laboratory of PG Dept. of Zoology, Raja N. L. Khan Women's College (Autonomous) in preserved condition. Then fish specimen were washed, identified and finally preserved in 6% formaldehyde in separate container for each species.

Identification:

The specimens were identified morphometrically and meristimatic system such as body length, depth, colour, colour band, shape, size, fin number, fin shape, fin rays number, lateral line scale *etc.* on the basis of existing literature^{15,16,37}.

Data analysis:

For assessment of abundance and biodiversity status, the observed fishes were categorized as different levels of threatened condition such as Least concern (LC), Vulnerable (VU), Near threatened (NT), Not evaluated (NE), Data deficient (DD) following IUCN Red list (IUCN, 2020.1). Based on the interview and reporting of the fishermen and also depend on the availability during study period, the fishes have been further categorized below 20% Very Low (VL), 21-40% Low (L), 41-60% Medium (M) & above 60% High (H). Species richness, diversity index & evenness were calculated on the basis of the variety of species & number of specimens captured from four sampling stations. All calculations were done with the help of Microsoft Excel 2007.

The Shannon-Weaver index (H) has been a popular

TABLE-2: List of Indigenous Fishes in Kapaleswari river

Abbreviations: IUCN = International Union for Conservation of Nature; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient; NE = Not Evaluated; F = Food; O = Ornamental; LS = Local status; VL = Very Low; L = Low; M = Medium; H = High; S1 = Site 1; S2 = Site 2; S3=Site 3; S4=Site 4

Order	Family	Species	Use	LS	IUCN	S1	S2	S3	S4	TOTAL
Osteoglossiformes	Notopteridae	<i>Notopterus notopterus</i>	F ₁ O	L	LC	6	5	2	1	14
Cypriniformes	Cyprinidae	<i>Amblypharyngodon mola</i>	F ₁ O	H	LC	6	10	8	12	36
		<i>Danio rerio</i>	F ₁ O	M	LC	7	5	8	6	26
		<i>Esomus danricus</i>	F ₁ O	M	LC	7	6	9	5	27
		<i>Puntius chola</i>	F ₁ O	M	LC	4	10	9	7	30
		<i>Puntius conchoni</i>	F ₁ O	L	VU	2	3	5	4	14
		<i>Puntius ticto</i>	F ₁ O	L	LC	3	4	6	5	18
		<i>Puntius sophore</i>	F ₁ O	L	LC	3	4	7	6	20
		<i>Puntius terio</i>	F ₁ O	L	LC	-	5	4	3	12
		<i>Puntius sarana</i>	F ₁ O	VL	VU	3	2	2	-	7
		<i>Salmophasia bacaila</i>	F	L	LC	3	4	7	5	19
		<i>Labeo rohita</i>	F	L	LC	4	5	5	1	15
		<i>Labeo calbasu</i>	F	L	LC	4	5	4	3	16
		<i>Labeo bata</i>	F	L	LC	4	5	6	3	18
		<i>Catla catla</i>	F	L	LC	4	6	7	3	20
		<i>Cirrhinus mrigala</i>	F	L	LC	6	4	4	3	17
	Cobitidae	<i>Lepidocephalichthys guntea</i>	F ₁ O	VL	LC	4	3	2	1	10

		<i>Lepidocephalichthys thermalis</i>	F ₃ O	VL	LC	3	2	-	2	7
Siluriformes	Bagridae	<i>Mystus cavasius</i>	F	L	LC	3	4	3	4	14
		<i>Mystus vittatus</i>	F ₃ O	H	LC	12	15	6	10	43
		<i>Mystus tengara</i>	F ₃ O	H	LC	8	14	12	16	50
		<i>Mystus bleekeri</i>	F ₃ O	L	LC	4	4	7	4	19
		<i>Sperata aor</i>	F	VL	LC	-	3	2	1	6
	Clariidae	<i>Clarias batrachus</i>	F	L	LC	3	7	4	2	16
	Siluridae	<i>Ompok pabo</i>	F ₃ O	VL	NT	3	2	2	-	7
		<i>Wallago attu</i>	F	VL	NT	1	4	2	-	7
	Heteropneustidae	<i>Heteropneustes fossilis</i>	F ₃ O	L	LC	5	4	6	5	20
Beloniformes	Pangasiidae	<i>Pangasius pangasius</i>	F	VL	LC	1	3	1	2	7
	Belonidae	<i>Xenentodon cancila</i>	F ₃ O	VL	LC	2	4	1	3	10
	Aplocheilidae	<i>Aplocheilichthys panchax</i>	O	M	LC	8	10	6	6	30
Synbranchiformes	Oryziidae	<i>Oryzias melastigma</i>	F ₃ O	VL	LC	3	2	2	2	9
	Mastacembelidae	<i>Macrognathus aral</i>	F ₃ O	L	LC	4	5	2	6	17
		<i>Macrognathus pancalus</i>	F	H	LC	12	14	15	12	53
		<i>Mastacembelus armatus</i>	F	M	LC	9	8	6	6	29
Perciformes	Branchidae	<i>Monopterusuchia</i>	F ₃ O	VL	LC	2	3	2	3	10
	Ambassidae	<i>Chanda nama</i>	F ₃ O	L	LC	12	10	6	1	29
		<i>Parambassis baculis</i>	F ₃ O	VL	LC	3	2	3	1	9

TABLE-3: Orderwise specie richness value of fishes in Kapaleswari River

Order	Number of Species	Species richness
Osteoglosiformes	1	0.13
Cypriniformes	17	2.27
Siluriformes	10	1.33
Belonoformis	1	0.13
Cyprinodontiformes	2	0.26
Synbranchiformes	4	0.53
Perciformes	20	2.67
Clupeiformes	1	0.13

species diversity index for ecological diversity study³⁴.

$$H = - \sum P_i \ln P_i$$

Here, P_i = the relative abundance (n/N)

n = Number of individuals of each species

N = Total no of individual of all species

Simpson's dominance index (D) is used to quantify the biodiversity of habitat which takes into account the number of species, as well as the abundance of each species³⁸.

$$D = \sum n(n-1) / N(N-1)$$

Here, n = the total number of organisms of a particular species

N = the total number of organisms of all species

Margalef index (d) has been used to measure species richness in different study sites by the following formula²²:

$$d = (S-1/\ln N)$$

Here, S = the number of species

N = the number of individuals in the sample.

Menhinck's index used for the determine of species richness in order level by the following formula²⁰

$$\text{Menhinck's index} = S/N$$

Here, S = the number of different species

N = total number of species

Evenness index (E) has been used for the relative abundance of the different species making up the richness of an area³⁰

$$E = H/\ln S$$

Here, S = the total number of species

\ln = the natural logarithm

H = the diversity index.

Result and Discussion

During the study period we enlisted 56 species of fish under 37 Genera, 22 Families and 8 orders from Kapaleswari River that has been given in the Table-2. Among the collected species Order Perciformes is the most dominant group contributing 35.71%, followed by Cypriniformes 30.36%, Siluriformes 17.86%, Synbranchiformes 7.14%, Cyprinodontiformes 3.57% & Clupeiformes, Osteoglossiformes, Beloniformes each with 1.79% of the total species. Order Perciformes contributed 8 families to the list, followed by Siluriformes 5, Cypriniformes 2, Cyprinodontiformes 2, Synbranchiformes 2 and Clupeiformes, Osteoglossiformes, Beloniformes each with 1 Family (Fig.1). Cyprinidae is the most dominant family contribute 26.79% species followed by Bagridae 8.93%, Gobioidae 8.93%, Ambassidae 7.14%,

TABLE-4: Species richness, Species abundance and biodiversity index in four sampling stations of Kapaleswari River, Paschim Medinipur district.

Study site	Total specimen	Total species	Margalef index	Simpson index	Shannon-Weaver index	Evenness
Site-1	288	51	8.82	0.026	3.71	0.94
Site-2	322	53	9.00	0.023	3.79	0.95
Site-3	326	55	9.33	0.025	3.76	0.93
Site-4	303	50	8.57	0.032	3.58	0.91

TABLE-5: List of Exotic Fishes in Kapaleswari river.

Order Status	Family	S.No	Species Name	Local Name	Use	IUCN
Cypriniformes		1	<i>Ctenopharyngodon idellus</i>	Grass carp	Food	NE
		2	<i>Cyprinus carpio</i>	Common carp	Food	VU
Perciformes	Chichlidae	3	<i>Oreochromis mossambicus</i>	Tilapia	Food	NT
Siluriformes	Clariidae	4	<i>Clarias gariepinus</i>	Thai magur	Food	LC

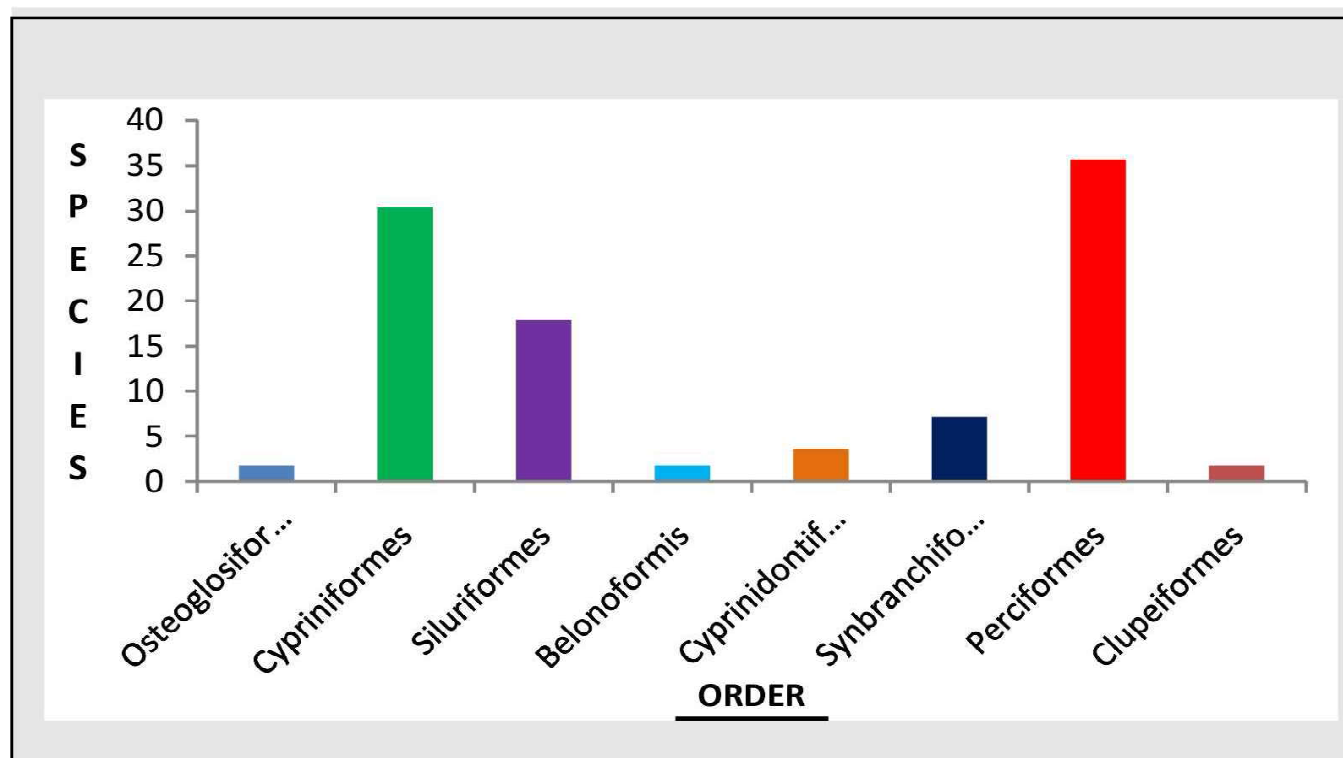


Fig. 1: Percentage of species at order level in Kapaleswari River

Mastacembelidae 5.36%, Channidae 5.36%, Siluridae 3.57%, Cobitidae 3.57%, Anabantidae 3.57%, Osphronemidae 3.57% & Notopteridae, Clariidae, Heteropneustidae, Pangasiidae, Belonidae, Aplocheilidae, Oryzidae, Branchidae, Badidae, Latidae, Clupeidae each with 1.79% among total species (Figs. 2-3). Two species namely *Stigmatogobius sadanundio* and *Gobiopsis macrostoma* have been first time recorded from Paschim Medinipur district¹⁰. There are also 4 exotic fishes have been found, listed in the Table-5. They are introduced during rainy season through different canals of river basin areas. Among the recorded fish species of Kapaleswari river, 47.07% used as food,

1.79% used as ornamental & the remaining 57.14% used as both food and ornamental. So, maximum fish species are used in both cases that are very important for socio-economic development of local villagers surrounding the Kapaleswari River.

Workers¹⁷ enlisted highest number of fish species under order Cypriniformes from Kangsabati river, others^{14,26} reported highest number of Cypriniformes fishes from Keleghai river and repoted^{19,28} highest number of Cypriniformes fishes in Paschim Medinipur district. So, previous report indicted maximum Cypriniformes fishes were found in the Paschim Medinipur district but in case of Kapaleswari River, contribute maximum percentage of

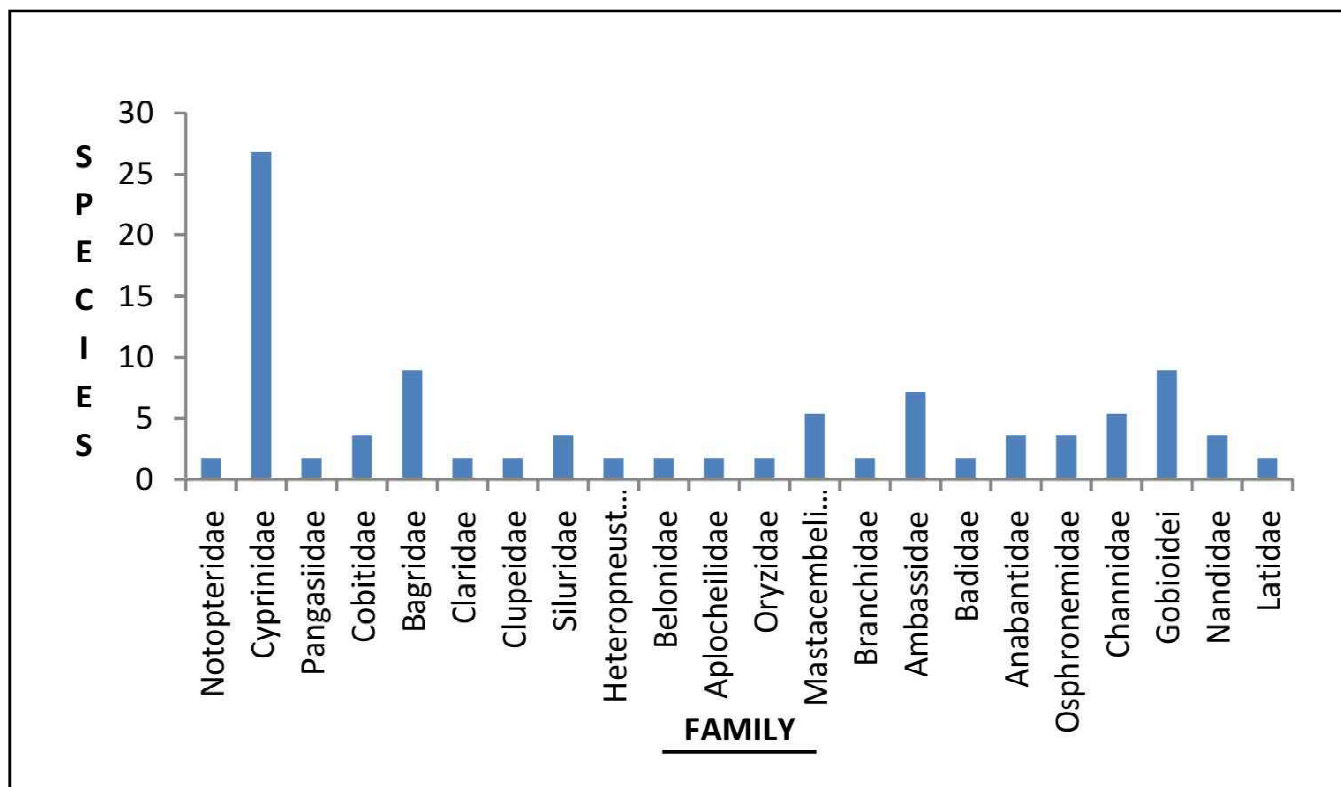


Fig. 2: Percentage of species at family level in Kapaleswari River

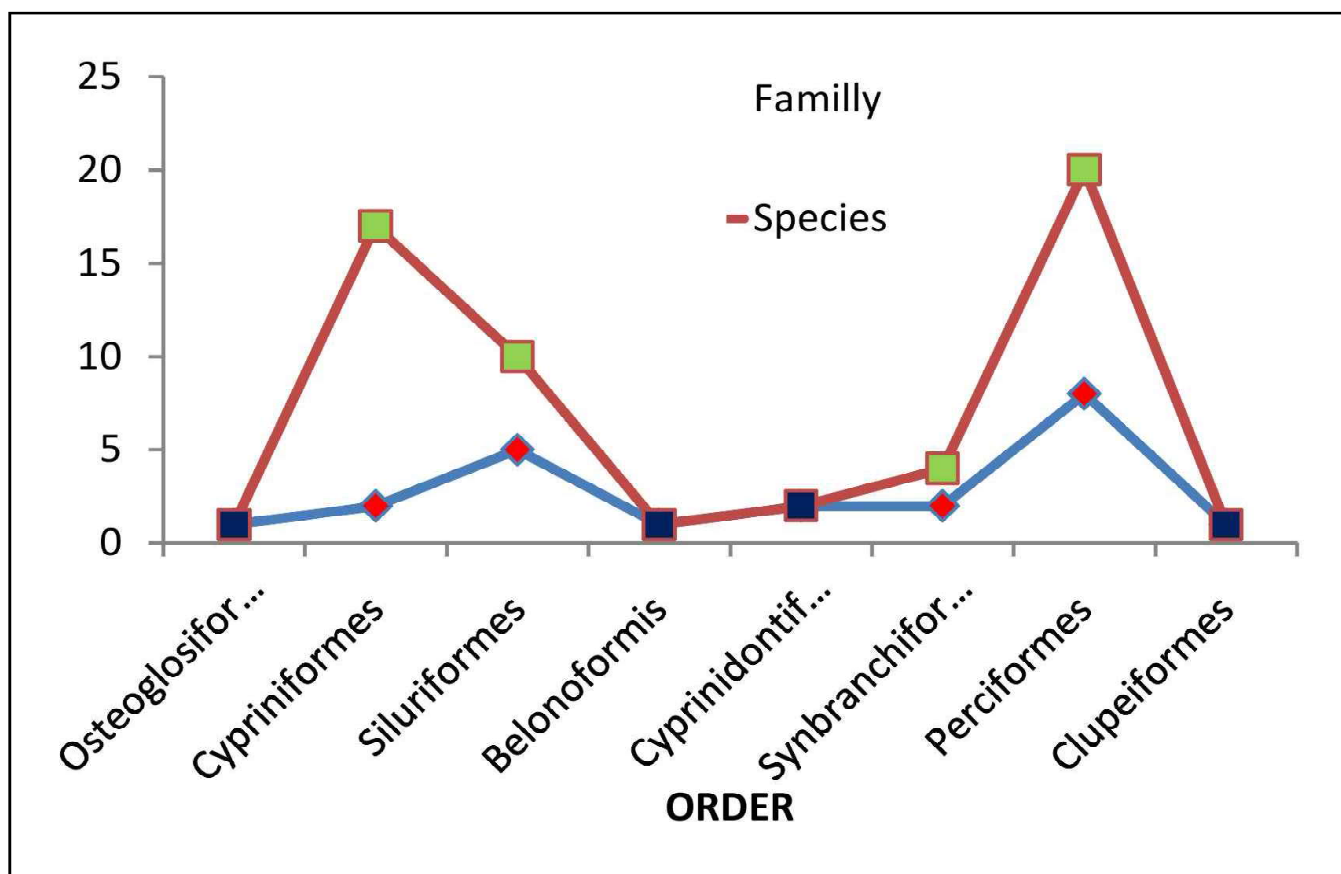


Fig. 3: Families & species under various Orders

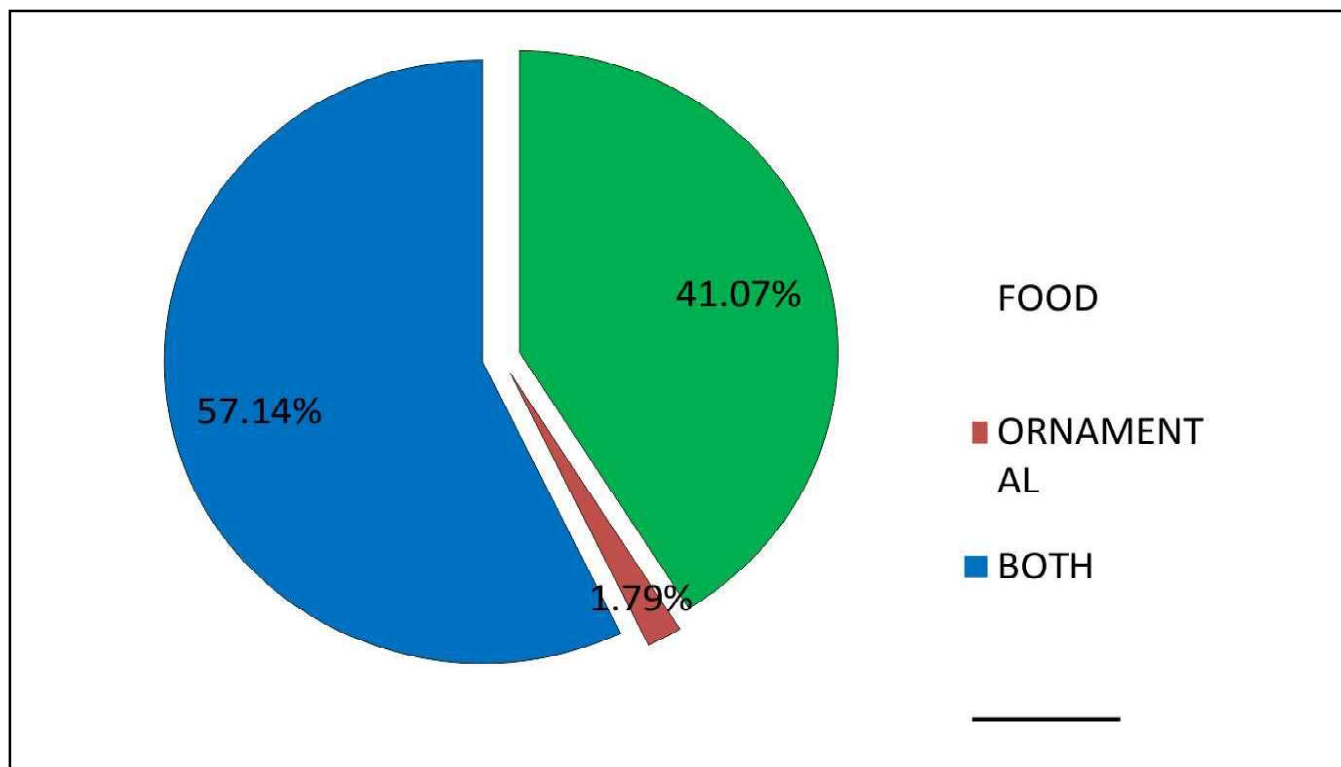


Fig. 4: Percentage of species use by local fisherman

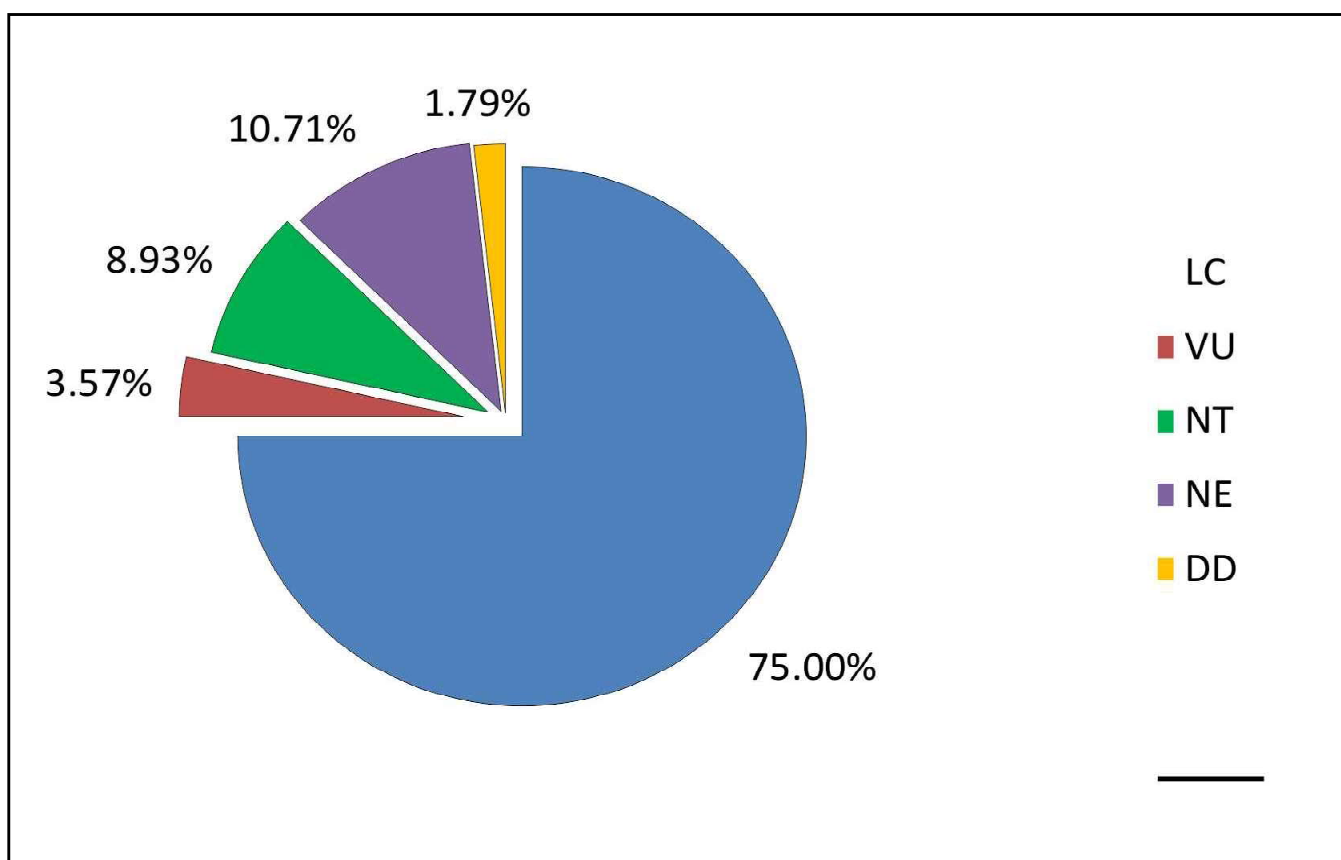


Fig. 5: Percentage contribution of species under IUCN (2020.1) categories

Perciformes fishes followed by Cypriniformes. The Perciformes fishes are maximum and belong to the high salinity water so, it is indicated that Salinity of the Kapaleswari river is high⁷.

According to agency¹³ status of the fishes has included 75% Least Concern, 3.57% Vulnerable, 8.93% Near Threatened, 10.71% Not Evaluated & 1.71% Data Deficient (Fig. 5). On the basis of local status fish species contribute 30.36 of very low, 41.07% low, 14.29% medium & 14.29% of high amount in the Kapaleswari River (Fig. 4)¹³. Several anthropogenic factors damaged the fish population such as effluence of brick industry by its temperature & fly ash, surface runoff containing various pesticides from nearby agriculture fields. Over fishing is major factor for fish diversity loss of the Kapaleswari River and also introduction of exotic species due to the predation, competition for food and habitat.

The concept of the "species diversity" involves two components: the number of species and the distribution of individuals among total species⁴. After the analysis of data, the value of Shanon-Weaver index ranges from 3.58 to 3.79; highest value was found in site-2 and lowest value found in site-4. In this study Shanon-Weaver index indicates the habitat in this river in a stable condition. Alike, Simpson's index (D) is between '0.023' to '0.032' that indicates to diverse fish population in Kapaleswari River. The highest value was found at Site-4 and the lowest value was in Site-2. The value of Margalef diversity index was highest at Site-3 (9.33) and lowest at Site-4(8.57). The variation of this index depends on the species number, so the number of individuals is less important for calculation³⁹. The values of evenness diversity index were between '0.91' to '0.95'. The lowest value was found in Site-4 and the highest value for site Site-2 as given in Table 4. According to the species evenness it can be concluded that individual species were near to disturbed condition at Kapaleswari river. The Margalef species richness value which is used as an indicator to compare

the sites generally shows deviation depending on the species number³⁹. With the highest species number, station Site-2 & S-3 show the maximum Margalef richness value where minimum value was observed at station S4 with lowest number of species. The focus of species richness generally is a more reliable measure of biodiversity³². Species richness was found highest for Perciformes (2.67) followed by Cypriniformes, Siluriformes, Synbranchiformes, Cyprinodontiformes. The lowest species richness value was found in Beloniformes, Clupeiformes & Osteoglossiformes(0.14).

The results revealed that, out of 56 species of fish found in river Kapaleswari, 17 species were found very low, 23 were found low, 8 were moderately available & 8 highly available in the river.

Conclusion

Kapaleswari is a small river but rich in ichthyofaunal diversity, this diversity drastically decreased day by day. A total of 56 fish species were found during the study period. Over and indiscriminate fishing, poisoning and invention of exotic fish are mainly responsible for decreasing fish diversity. There are 17 very high-risk fish species, 23 high risk species, 8 moderately risks and 8 low risks fishes were recorded. Therefore, 71.42% of fishes of this river were under threatened and need immediate conservation steps to protect them from extinction. However, the study helps to formulate the future policy for conservation and management of the fish diversity in the river Kapaleswari. It is recommended to avoid illegal fishing, riverine natural habited should not be disturbed; poisons or pesticide should not apply in the river bank area and increase public awareness to conservation of ichthyofaunal diversity in the River Kapaleswari.

Funding

The research was funded by state DST, Department of Science & Technology, Govt. of West Bengal, India.

References

1. Alam MS, Hossain MS, Monwar MM, Hoque ME. Assessment of fish distribution and biodiversity status in Upper Halda River, Chittagong, Bangladesh. *International Journal of Biodiversity and Conservation*. 2013; **5**(6): 349-357.
2. Barman RP. A review of the fresh water fish fauna of West Bengal, India with suggestions for conservation of the threatened and endemic species. *Records of the Zoological Survey of India*. 2007; Occasional Paper no. **263**: 1-48.
3. Chanda A. Threats and Strategies for Conservation of Indigenous Fish Fauna of Paschim Medinipur: A Review. *Biomedical Journal of Scientific & Technical Research*. 2017; **1**(1): 174-177.
4. Chowdhury MSN, Hossain MS, Das NG, Barua P. Environmental variables and fisheries diversity of the Naaf river estuary, Bangladesh. *J. Coastal Conser.* 2010; **15**(1):163-180.

5. Chatterjee TK, Barman RP, Mishra SS. Mangrove Associate Gobies (Teleostei: Gobioidae) of Indian Sundarbans. *Records of the Zoological Survey of India*. 2013; **113**(3): 59-77.
6. Das D. Ichthyofaunal diversity of river Torsa and its tributaries at terai region of West Bengal, India. *International Journal of Science and Nature*. 2015; **6**(2): 256-263.
7. Gonzalez R. The physiology of hyper-salinity tolerance in teleost fish: A review. *Journal of comparative physiology. B, Biochemical, systemic, and environmental physiology*. 2011; **182**: 321-9. 10.1007/s00360-011-0624-9.
8. Gorman OT, Karr JR. Habitat structure and stream fish communities. *Ecology*. 1978; **59**(3): 507-515.
9. Goswami UC, Basistha SK, Bora D, Shyamkumar K, Saikia B, Changsan K. Fish diversity of North East India, inclusive of the Himalayan and Indo Burma biodiversity hotspots zones: A checklist on their taxonomic status, economic importance, geographical distribution, present status and prevailing threats. *International Journal of Biodiversity and Conservation*. 2012; **4**(15): 592-613.
10. Hamilton, F. An account of the fishes found in river Ganges and its branches i–viii. Printed for Archibald constable and company, Edinburgh and Hurst, Robinson and Co-90, Cheapside London, 405; 1822.
11. Hossain MS, Sarker S. New species of leaf fish *Nandus meni* (Perciformes: Nandidae) from Noakhali, Bangladesh. *Zoology and Ecology*. 2013; **23**(3): 191-197.
12. Islam MR, Das B, Baruah D, Biswas, SP, Gupta A. Fish Diversity and Fishing Gears used in the Kulsi River of Assam, India. *Annals of Biological Research*. 2013; **4** (1):289-293.
13. IUCN. The IUCN Red List of Threatened Species. Version 2020-1. <https://www.iucnredlist.org>. 2020; Downloaded on 25 May 2020.
14. Jana A, Sit G, Maiti K. Ichthyofaunal diversity of Keleghai river at Medinipur district in West Bengal. *International Research Journal of Basic and Applied Sciences*. 2015; **1**: 24-26.
15. Jayaram KC. A handbook of the freshwater fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka. Zool. Surv. India, Calcutta. 1981; 475.
16. Jayaram KC. The Freshwater Fishes of the Indian Region (Revised second edition). Narendra publishing house, New Delhi, India. 2010.
17. 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*. 2017; **70**(2) : 165-173.
18. Khalili Tilami S, Sampels S. Nutritional value of fish: lipids, proteins, vitamins, and minerals. *Reviews in Fisheries Science & Aquaculture*. 2018; **26**(2): 243-253.
19. Kisku S, Chini DS, Bhattacharya M, Kar A, Parua S, Das BK, Patra BC. A cross-sectional study on water quality in relation to fish diversity of Paschim Medinipur, West Bengal, India through geoinformatics approaches. *The Egyptian Journal of Aquatic Research*. 2017; **43**(4): 283-289.
20. Menhinick EF. A comparison of some species individuals diversity indices applied to samples of field insects. *Ecology*. 1964; **45**(4): 859-861.
21. Menon AGK. Threatened fishes of India and their conservation. Zoological Survey of India. 2004; 1-170.
22. Margalef R. Perspectives in Ecological Theory. Chicago: University of Chicago Press. 1968; 111.
23. Mishra SS. Ichthyofaunal Diversity of Midnapore, Bankura, and Hooghly Districts, South West Bengal. Zoological Survey of India. 2003; Occ. Paper no-220.
24. Mogalekar HS, Canciyal J, Ansar CP, Bhakta D, Biswas I, Kumar D. Freshwater fish diversity of West Bengal, India. *Journal of Entomology and Zoology Studies*. 2017; **5**(2): 37-45.
25. Orr PJ, Harper DAT. Quantitative approaches to the resolution of taxonomic problems in invertebrate ichnology. Numerical Paleobiology. John Wiley and Sons, Ltd. 1999; 395-431.
26. Pahari R P, Chakraborty D, Sarkar K S, Bhattacharya T. Ichthyofaunal diversity in Keleghai river, West Bengal, India. *International Journal of Pharmaceutical Research and Bioscience*. 2017; **6**(6): 29-38

27. Patra BC, Kar A, Bhattacharya M, Parua S, Shit PK. Freshwater fish resource mapping and conservation strategies of West Bengal, India. *Spatial Information Research*. 2017; **25**(5): 635-645.
28. Paul B, Chanda A. Indigenous ornamental fish faunal diversity in Paschim Medinipur, West Bengal, India. *International Research Journal of Biological Sciences*. 2014; **3**(6): 94-100.
29. Paul B, Chanda A. A checklist of small indigenous freshwater fish fauna of undivided Paschim Medinipur, West Bengal, India. *International Journal Of Current Trends In Science And Technology*. 2017; **7**(11): 20393-20400.
30. Pielou EC. Species diversity and pattern diversity in the study of ecological succession. *Journal Theoretical Biology*. 1966; **13** : 131-144.
31. Rahman MA, Mondal MN, Hannan MA, Habib KA. Present status of fish biodiversity in Talma River at Northern Part of Bangladesh. *International Journal of Fisheries and Aquatic Studies*. 2015; **3**(1): 341-348.
32. Saha MK. Studies of fish diversity concerning hydroecology of Kangsabastri river in Purulla district, WB, India. *Flora and Fauna*, 2020; **26** (2) : 320-328.
33. Saha MK, Patra BC. Present status of Ichthyofaunal diversity of Damodar River at Burdwan District, West Bengal, India. *International journal of scientific research publications*. 2013; **3**(6): 1-11.
34. Shannon CE, Weaver W. The Mathematical Theory of Communication, by CE Shannon (and Recent Contributions to the Mathematical Theory of Communication), W. Weaver. University of illinois Press. 1949; 54.
35. Sit G, Jana A, Chanda A. Diversity of Small Indigenous Freshwater Ornamental Fish under Genus Puntius from Purba Medinipur, Paschim Medinipur and Jhargram Districts of West Bengal, India. *Advances in Zoology and Botany*. 2020; **8**(4): 334-341.
36. Sit G, Jana A, Chanda A. Gobioid fish of Paschim Medinipur and Jhargram district West Bengal, India. *Uttar Pradesh Journal of Zoology*. 2019; **40**(4): 146-153.
37. Talwar PK, Jhingran AG. Inland Fishes of India and Adjacent Countries. 1991; Vols. 1 & 2: 1-1158.
38. Vijaylaxmi C, Rajshekhar M, Vijaykumar K. Freshwater fishes distribution and diversity status of Mullameri River, a minor tributary of Bheema River of Gulbarga District, Karnataka. *Int. J. Sys. Bio*. 2010; **2**: 1- 9.
39. Vyas V, Damde V, Parashar V. Fish Biodiversity of Betwa River in Madhya Pradesh, India with special reference to a sacred ghat. *In J of Bio. Conserv*. 2012; **4**(2):71-77.