Variance of Ichthyofaunal Community and Species Richness of Wainganga River Basin Balaghat, Madhya Pradesh, India

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Abstract: The taxonomic constitution of ichthyofaunal community of the Wainganga River Basin in Balaghat, Madhya Pradesh, India, was investigated to assess its biodiversity, species affluence and ecological health.Preliminary analysis revealed a rich diversity of fish species representing variousfamilies and ecological niches. Result represents a total of 69 species of fresh water fish belonging to 22families and 12ordersat different seasons fromselected study sites of river. The species found in the river basin, their relative abundance, taxonomic distribution, and threat status resulting that order Cypriniformes was the most dominant order contributing about 42.02% of total assemblage of fish biodiversity followed by Siliuriformesabout 21.73% representing second highest fish diversity. Next to *it*, Anabantiformescomprises 7.240%,Synbranchiformesand Perciformes5.79%,Belonoformes, andClupeiformes comprises 4.34%, Osteoglossiformes2.89% whereasAngulliformes, Cichliformes, Cyprinodontiformes, and Mugiliformescontributes about1.44% representing least diversity solely by single species each. Common species included indigenous varieties such as *Labeorohita*, *Cirrhinusmrigala*, and *Tor tor*, alongside introduced species like *Oreochromis niloticus*. Statistical analysis was done by implying various biodiversity measures including species richness, evenness, dominance, and variance, to assess the structure and composition of the ichthyofaunal community. Additionally, environmental factors were examined to understand their influence on fish diversity and abundance.

Keywords: *Wainganga River, Ichthyofauna, Biodiversity, Abundance, diversity*

1. Introduction

Among the myriad inhabitants of river ecosystems, fish communities play a particularly significant role, serving as indicators of environmental health, biodiversity, and ecosystem dynamics. An estimated 2500 species of fish have been identified in India; of these, 930 species, representing 326 genera, have been documented in inland waters (Arunachalam*et al*. 2003;Shiv*et al.* 2005).

India is favoring the development of species-rich fish fauna with a large variety of adaptation, due to presence of large variety of water bodies and habitat to aquatic life (Olden*et al.*2010). Therefore, India is a megadiverse country in fish fauna.Fresh water ecosystem has distinguished properties which prop up and provocate many key tenets of conservation biogeography (Shivkumar *et al.*2018). Most fresh water fishes occupied only a fraction of localities thus; many researchers strongly suggest that this constrained riverine habitat is also partially responsible for the fantastic biodiversity of fresh water fishes around the world with varied population of important indigenous species of fish which form the basis of rich fisheries (Berra, 2001; Balasundaram*et al.* 1999). Beside this, faunal variation is important for ecosystem stabilization (Shivkumar *et al.*2018). The diversity of fish is mainly depending on the type of ecosystem, biotic and abiotic factor, age of water body, mean depth; water level fluctuations and its metamorphic also have great implications.

The Wainganga River Basin, situated in Balaghat, Madhya Pradesh, India, is renowned for its ecological significance, encompassing a diverse array of habitats harbouring a rich assortment of fish species, each uniquely adapted to its respective niche within the riverine ecosystem. In recent time, especially after earth summit biological diversity has presumed to be immense importance comprising species richness, species abundance and phylogenetic diversity(Bose*et al.* 2013;Singh& Pathak, 2010). However, like many river systems worldwide, the Wainganga River basin faces an array of anthropogenic pressures and altered flow regimes, which threaten the integrity of its ichthyofaunal communities. Despite the fact, that Indian Fisheries Act 1987 is a key to protect biodiversity but is incompetent to impose any deep influence on fish fauna restoration.

Fisheries is an economic activity that involves harvesting fish or any aquatic organism from the wild or raising them in confinement. India is the third largest fish producing country and the second largest aquaculture fish producer in the world. India contributes about 7% of the global fish production. Around 14 million peoples are engaged in fisheries and its allied activities. With around 20% export of fish and fish product have presently emerges as largest

group in agriculture export from India (Jayaram, 2012;Muniya*et al.* 2019) It also plays an instrumental role in socioeconomic development of country as it is a valuable source of livelihood for a huge section of economically backward population. It also generates gainful employment, alternate income and stimulates growth of new subsidiary industries (Bose *et al.* 2013; Forese & Pauly, 1998; Talwar &Jhingran, 1991).

Balaghat is a district of Madhya Pradesh state in central India located in southern part of Jabalpur division M.P. It occupies south east portion of Satpura Range and the upper valley of Wainganga River. The district extended from 21º 19’ to 22º 24’ north latitude and 79º 31’ to 81º 3’ east longitude (https://en.wikipedia.org/wiki/Balaghat_district). The Wainganga River is originated from the Mahadeo hills of Seonidistrict,M.P. and flows south from M.P. to Maharashtra in a winding course of approximately 360 miles. The river has high banks 10 to 15 meters on either side.Moreover, its basin is located between longitude 76°E and 80° 53' E and latitude 18° 48' to 22° 43' Nand contributes as key tributary of Godavari(Gadekar, 2015). Wainganga River is life line of city Balaghat. This river is believed to be an important feeding and spawning ground and conserve a variety of species which supports commercial fisheries throughout the year. Thus, fishes hold crucial position for socioeconomically point of view for fisher folk.

By elucidating the factors driving spatial and temporal fluctuations in fish populations, researchers can identify key ecological processes and prioritize conservation interventions aimed at preserving freshwater biodiversity and ecosystem services(Shiv *et al.* 2015). This study seeks to investigate the variance of the ichthyofaunal community and species affluence within the Wainganga River Basin in Balaghat, Madhya Pradesh, India. Through comprehensive surveys and analyses, we aim to assess the spatial and temporal dynamics of fish populations, elucidate the drivers of variability, and provide insights into the ecological health, tool for conservation planning and resilience of this vital riverine ecosystem.

2. Materials and Methods

2.1 Study Area

River Wainganga is the lifeline of Balaghat district because it is subjected to all forms of human activities including for fishing, irrigation, agriculture, drinking purpose etc. During the southwest monsoon, which lasts from June to October, most of the rainfall occurs. Balaghat is located between 900 and 1600 mm, in the medium rainfall zone. The Mean annual precipitation of it is 1294.5mm. The goal of the current study of this river is to

determine the conservation status, anthropogenic activities, and variety of its Ichthyofauna. The sampling sites from where fishes were collected areSite 1 (Dhimar Toli), Site 2 (Bajrang Ghat), Site 3 (Shankar Ghat), Site 4 (Jagpur Ghat), and Site 5 (Bamhodi).The Global Positioning System (GPS) was used to locate the precise position of the sampling stations.The basin is located between 21°49"43'N to 80°10"10'E to 21°45"56'N to 80°10"29'E(Fig.1).

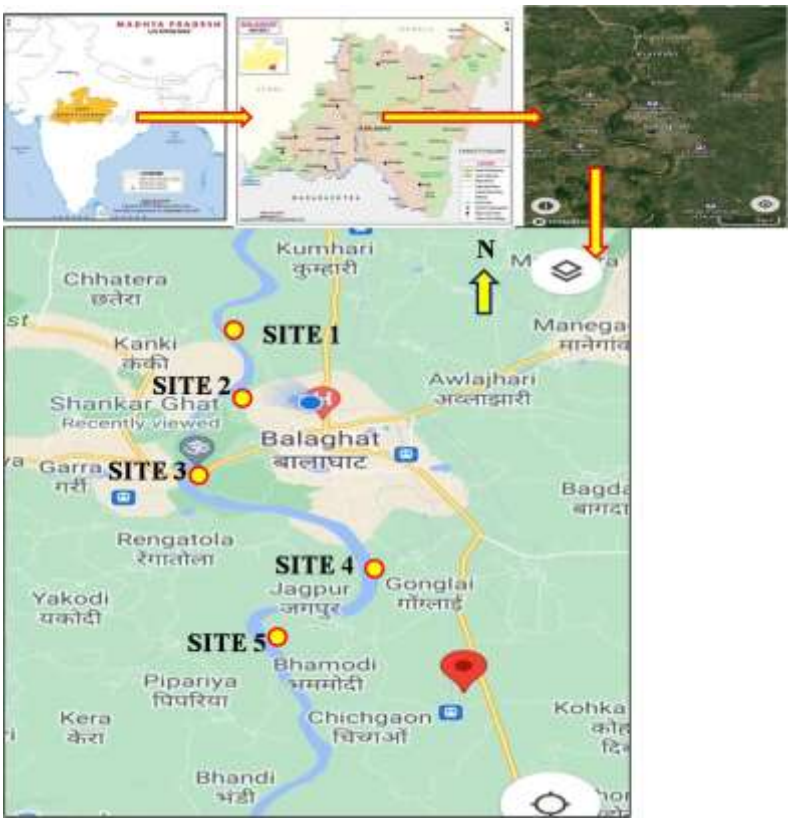

Fig 1: Map showing the geographical location of sampling area of Wainganga River basin, Balaghat. (Image: Google earth, modified after the map being downloaded).

2.2 Fish sampling and Data Collection

Sampleswere collected throughout the year from February 2023 to January 2024 in all the three season i.e., pre-monsoon from February to May, monsoon from June to September and Post-monsoon from October to January with the help of local fishermen. Experimental fishing was carried out by using the skills and expertise of local fisher folk using 8 different types of gears. For capturing fishes, fishermen used variety of nets namely hand nets, cast net (Ghagariajaal), drag nets (Bhorjaal), gill nets, rod, and lines. Fish were collected at every habitat type. They were also collected from local fishermen and local market to monitor and verify the presence of any species which were not seen during experimental fishing. Fishes were brought to laboratory, photographed immediately, subsequently fixed and preserve in

10% formalin solution in separate specimen jars depending on size of species. Small sized fishes were place in directly while the large fishes were preserved after giving an incision in abdomen before their fixation in formalin. They were well labeled with vernacular names along with serial numbers, and date of collection with assistance local skilled fisherman, color pattern of the body and fins were clearly observed for morphological identification. Identification of specimens was done with the help of fisheries department and standard taxonomic field guide with reference material given by (Jayaram, 1999; 2010; Qureshi & Qureshi 1983).Fish abundance throughout the year was used to determine the availability of fish species by questioning the fishermen using prepared questioners. IUCN Red list of threatened species followed by Gurumayum*et al*. 2016; Shrestha, 2008. The conservation status of fish species was also assessed in the present work.According to IUCN, the fish were classified as endangered (EN), vulnerable (VU), low risk (LR), least concern (LC), and data deficient (DD), near threatened (NT), and not evaluated (NE) species based on their conservation status (Muniya *et al.* 2019;Prasad *et al.* 2010).

Table 1: List of Fishes found in river Wainganga, Balaghat.

Order	Family	Species [Scientific Name]	Vernacular Name	IUCN Status
Anabantiformes	Channidae	*Channa gachua (Hamilton 1822)*	Bhunda	LC
		Channa punctatus (Bloch 1975)	Bhunda/ Samal	LC
		Channa striatus (Bloch 1975)	Bhunda/ Samal	LC
		Channa marulius (Hamilton and Buch.1822)	Bohr	LC
	Anabantidae	*Anabas testudineus (Bloch 1792)*	Kewai	LC
Angulliformes	Angullidae	*Angulla bengalensis*	Andha	NT
Beloniformes	Belonidae	*Xenentodoncancila (Hamilton 1822)*	Bama/ Suja	LC
		Belone belone	Gaar	LC
	Nandidae	*Nandus nandus (Hamilton 1822)*	Talafia/ Chamri	LC
Cichliformes	Cichlidae	*Oreochromis mossambicus (Peters 1852)*	Thilapia/Cichlid	VU
Clupeiformes	Clupeidae	*Hilshailisha (Hamilton 1822)*	-	LC
		Hilshamotius (Hamilton 1822)		LC
	Engraulididae	*Gonialosamanmina (Hamilton 1822)*	Chandaini/ Suhia/Gunguch	LC
Cyprinodontiformes	Poecillidae	*Poecilia reticulate (Peters)*	Guppy	NE
		Ambylopharyngodon Mola (Hamilton 1822)	Mohroli/ Mola	LC
		Bariliusbendelisis(Hamilton 1822)	Jori/ Gheur	LC
		Barilius modestus (Day 1865)	Jori	NE
		Cyprinus carpio(Linnaeus 1758)	Kamankaar	VU
		Cirrhinus mrigal (Hamilton 1822)	Mirgal	LC
		Catala catla (Hamilton 1822)	Katla	LC
		Cirrhinusreba (Hamilton 1822)	Lohimirgal	LC
		Ctenopharyngodon Idella (Valenciennes 1848)	Ghaskaat	LC
		Carassius auratus	Suneri	LC
		Garragotyla (Gray 1830))	Gadhira	LC
		Labeoboggut (Sykes1839)	Kannas/ Nunia	LC

Cypriniformes	Cyprinidae	*Labeocalbasu (Hamilton 1822)*	Kalbaj	LC
		Labeogonius (Hamilton 1822)	Rohu/ Kusra	LC
		Labeopungusia (Hamilton 1822)	Rohu	NT
		Labeorohita (Hamilton 1822)	Rohu	LC
		Osteobramacotiocotio (Hamilton 1822)	Kotri/ Bhoiya	LC
		Osteochilus vittatus (Valenciennes 1848)	Bhoiya	LC
		Oxygasterbacaila (Hamilton 1822)	Chelua	NT
		Oxygaster gora (Hamilton 1822)	Chelua	LC
		Puntius chola (Hamilton 1822)	Karita/ Kerrundi	LC
		Puntius sarana (Hamilton 1822)	Kotri/ Karpata	LC
		Puntius sophore (Hamilton 1822)	Kotri/ Karita	LC
		Rasbaraelonga (Hamilton 1822)	Dhera	LC
		Rasbora daniconius (Hamilton 1822)	Dhera	LC
		Rita rita (Hamilton 1822)	Rita	LC
		Salmophasiabalookee (Sykes 1839)	Sarangi	LC
		Salmophasiaorissaensis (Banarescu 1968)	Sarangi/Chelliah	NE
		Tor tor (Hamilton 1822)	Mahseer	DD
	Botiidae	*Botia rostrata (Gunther 1868)*	Botiya	VU
Mugiliformes	Mugilidae	*Rhinomugilcorsula (Hamilton 1822)*	Seli	LC
Osteoglossiformes	Notopteridae	*Notoptera chitala (Hamilton 1822)*	Chital	NT
		Notopterusnotopterus (Pallas 1769)	Chital	LC
Perciformes	Ambassidae	*Parambassisranga (Hamilton 1822)*	Chanda/Chalvi	LC
		Parambassisbaculis	Chanda/Chalvi	LC
	Badidae	*Badis badis (Hamilton 1822)*	Baheda	LC
	Bramidae	*Pampus chinensis*	Roopchanda	NT
Siluriformes	Bagridae	*Mystusbleekeri (Day 1877)*	KatuaTengra	LC
		Mystus vittatus (Bloch 1975)	Singharh	LC
		Mystuscavasius (Hamilton 1822)	Kavasi	LC
		Mystusaor (Hamilton 1822)	Kavasi	LC
	Heteropneustidae	*Heteropneustes fossil (Bloch 1975)*	Singhi	LC
	Clariidae	*Clariusbatrachus (Linnaeus 1758)*	Mangur/ Mangori	LC
		Clarias gariepinus (Hamilton 1822)	Mangur	LC
	Siluridae	*Ompokpabda (Hamilton 1822)*	Pabda	NT
		Ompokbimaculatus (Bloch 1975)	Pabda	NT
		Ompak media	Pabda	NT
		Wallago attu (Bloch and Schneider 1801)	Padhina	VU
	Aillidae	*Clupisomabastari (Dutta and karmakar1980)*	-	LC
		Alia coila (Hamilton 1822)	Pataasi	LC
	Pangasiidae	*Pangasius pangasius (Hamilton, 1822)*	Pangas/Ponga	EN
		Pangasianodonhypophthalmus	Pangas/Ponga	EN
Synbranchiformes	Mastacembelidae	*Mastacembelus armatus (Lacepede)*	Baam	LC
		Mastacembeluspanculas (Hamilton 1822)	Baam	LC
		Macrognathuspancalus (Hamilton 1822)	Baam	LC
		Macrognathusaral (Bloch 1975)	Aral/Baam	LC

Abbreviations:*(EN) endangered, (VU) vulnerable, (LR) low risk, (LC) least concern, (DD) data deficient, (NT) near threatened, and (NE) not evaluated*

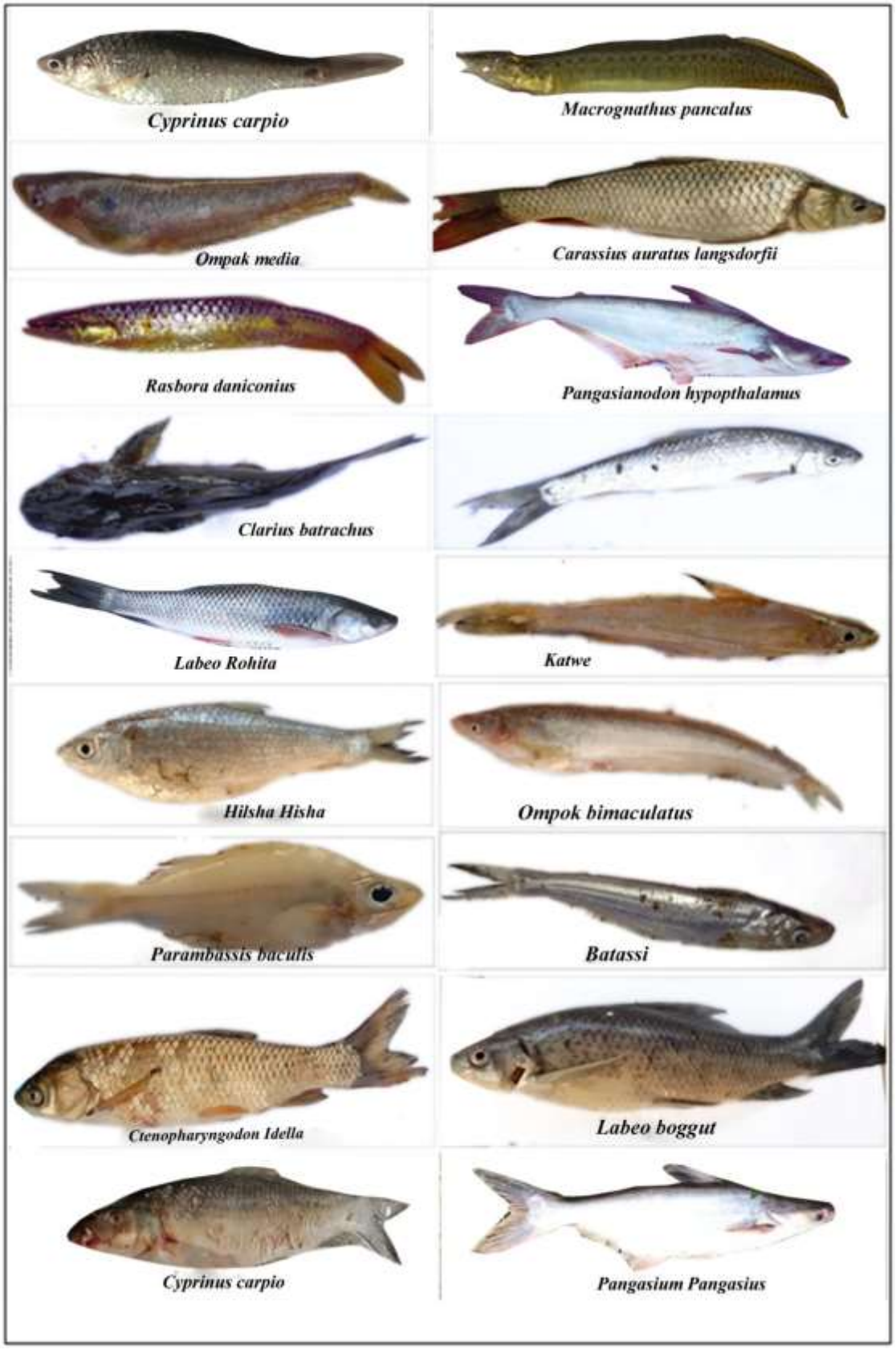

Plate 1a: Different types of fish species found in Wainganga River, Balaghat.

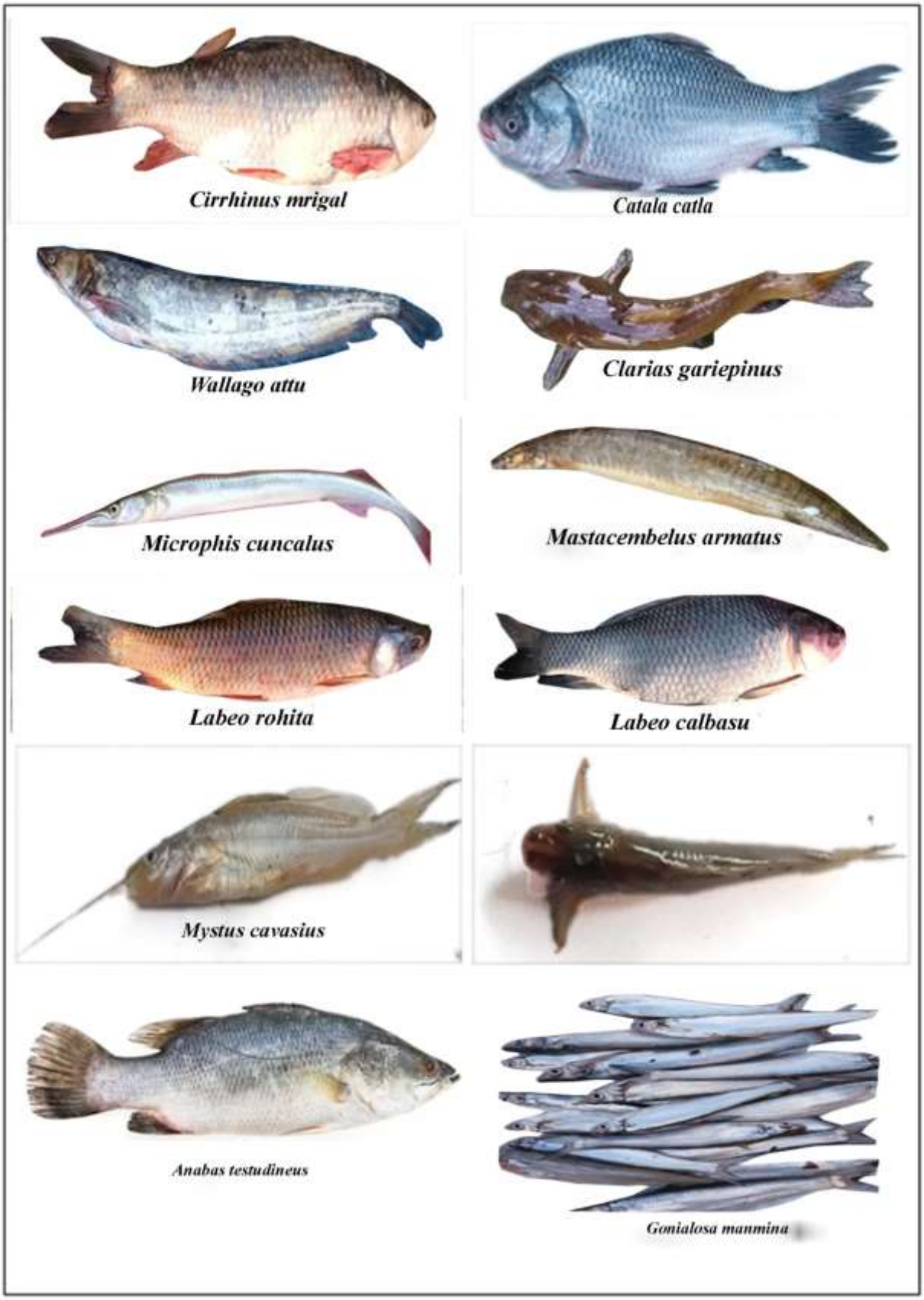

Plate1b: Different types of fish species found in Wainganga River, Balaghat

2.3 Data and Biological Index Analysis

Fish species compositions during pre-monsoon, monsoon and post-monsoon were calculated. Statistical calculations of biodiversity indices were conducted**.** The indices were computed for each species' individual population size, not its biomass. Statistical analysis of fish indices, such as richness, relative abundance, Shannon-Wiener diversity index, Menhinick's Index, Simpson's index,Berger-Parker Index, Simpson's index of diversity, Simpson's reciprocal index, and Evenness Index was done according to the reference of Magurran, 2003; Dinesh Kumar *et al.*2010 by using the following diversity index formulas:

For the purposes of this study, the number of fish species found in the river at least once was considered the species richness (S).

The following formula is used to calculate species richness.

$$SR=TS/A$$

Where SR is the species richness; TS is the total number of species;

A is the total area

For those three seasons, the Relative Abundance (RA), which corresponds to the percentage of catch, of fish across the river was calculated. The following formula is used to calculate the relative abundance of species in the sampling area

$$RA=TS/TP \text{ x } 100$$

Where, RA is the relative abundance of species (%); TS is the total number of species in an area; TP is the total sum of the populations of all species in the area.

Shannon-Weiner index (H):

$H=-\sum[(p\text{i})\times\log(p\text{i})]$

Where, *H* - Shannon diversity index; *p*i - proportion of individuals of i-th species in a whole community; ∑ - sum symbol; and log - usually the natural logarithm.

Menhinick's Index (IMn):

$M = S / \sqrt{(n)}$

Where, M = Menhinicks Diversity Index, S = Number of Species Recorded

N = Total Number of Individuals in the Sample.

Simpson's index of dominance (D):

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

Σ - Sum of all species; N - total number of organisms of all species;

n - Total number of organisms of each species

Simpson's index of diversity (1 - D)

Simpson's reciprocal index (1/D)

D- Simpson's index of dominance

Berger-Parker Index (BPI):

BPI = Nm/n

BPI- Berger-Parker Index; Nm- number of individuals in the most abundant species; n - number of individuals in the sample.

Statistical analysis

All the diversity indices were statistically determined using biodiversity calculator VIRTUE-s software.

Table 2: Ichthyofaunal species composition variance at Wainganga River Balaghat

S.No.	Family	No. of Species	Relative Abundance (%)	Species richness(Pi)
1.	*Anabantiformes*	5	7.24%	0.072
2.	*Angulliformes*	1	1.44%	0.014
3.	*Belonoformes*	3	4.34%	0.043
4.	*Cichliformes*	1	1.44%	0.013
5.	*Clupeiformes*	3	4.34%	0.043
6.	*Cyprinodontiformes*	1	1.44%	0.014
7.	*Cypriniformes*	29	42.02%	0.42
8.	*Mugiliformes*	1	1.44%	0.014
9.	*Osteoglossiformes*	2	2.89%	0.028
10.	*Perciformes*	4	5.79%	0.057
11.	*Siluriformes*	15	21.73%	0.217
12.	*Synbranchiformes*	4	5.79%	0.057
	Total	**69**	**100%**	**1**

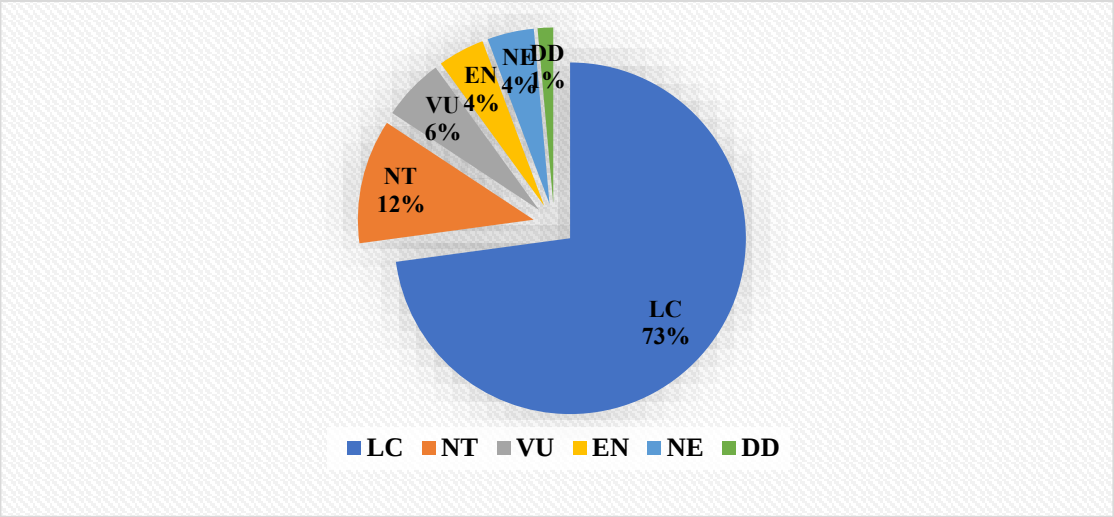

Fig.2IUCN Status of Fish Species.

Table 3: Comparative analysis of various diversity indices used to calculate diversity of fish species.

Sr.no	Indices of ecological diversity	PRM	MON	POM	Annual
1	No. of Species	312	479	573	1364
2	Shannon-Weiner index (H)	1.70	1.81	1.812	1.82
3	Menhinick's Index (IMn)	0.49	0.49	0.51	0.32
4	Simpson's index of dominance (D)	0.21	0.18	0.18	0.25
5	Berger-Parker Index(BPI)	0.30	0.23	0.22	0.24
6	Simpson's index of diversity (1 - D)	0.79	0.82	0.82	0.75
7	Simpson's reciprocal index (1/D)	4.83	5.59	5.62	4.05
8	Evenness Index (E)	0.87	0.93	0.93	0.73

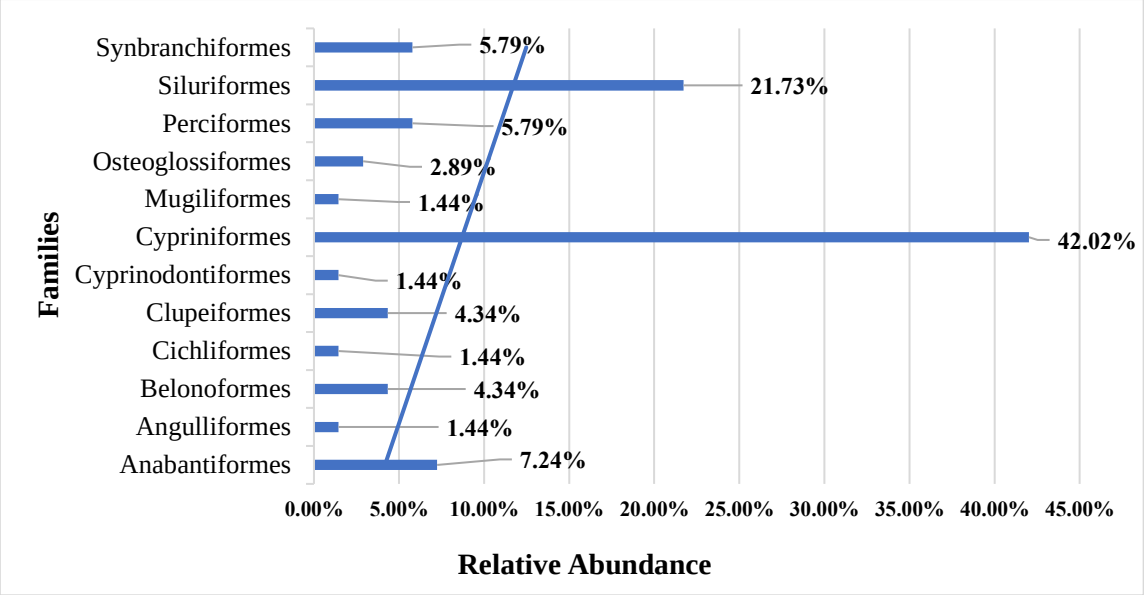

Fig.3: Relative abundance and variance of ichthyofaunal families of river Wainganga.

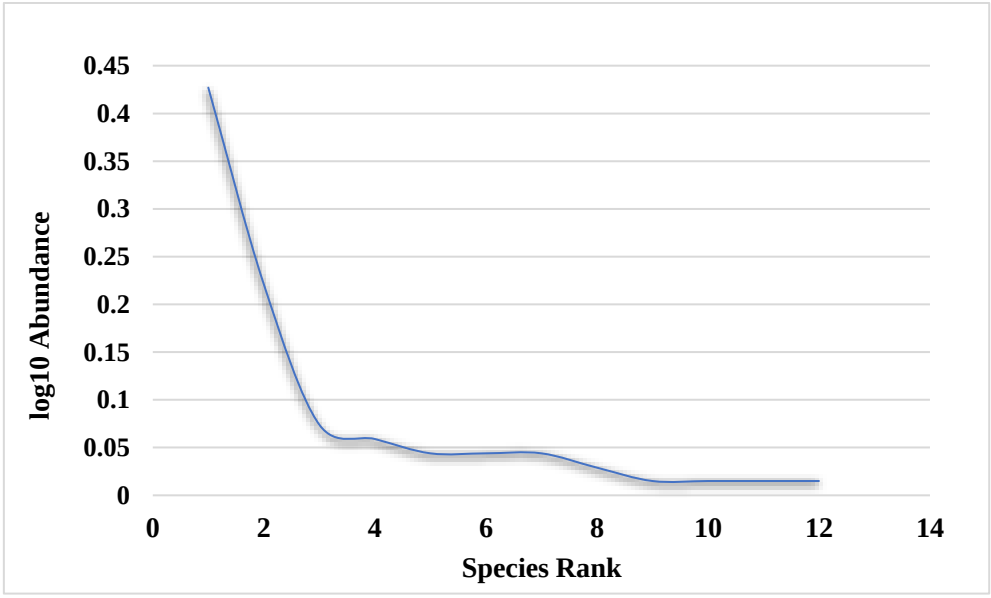

Fig. 4: Rank abundance curve of ichthyofaunal family

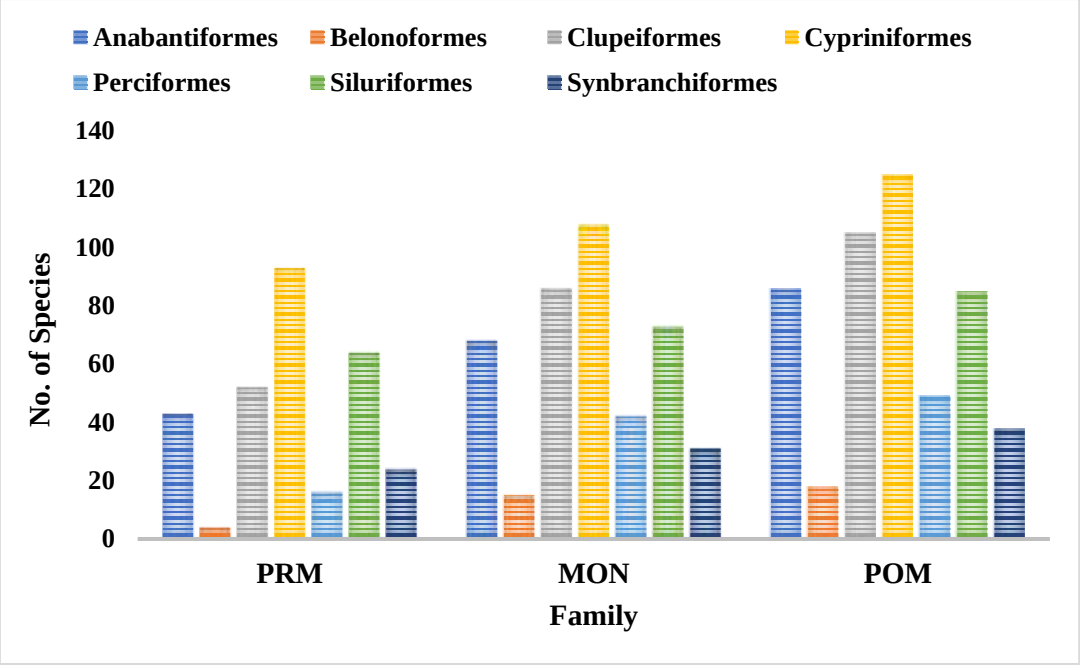

Fig.5: Abundance of fish species during different seasons

PRM: Pre-Monsoon, MON: Monsoon, POM: Post-Monsoon

3. Result and Discussion:

During the extensive study throughout the year, a total of 69 species of fresh water fish belonging to 22 families and 12 orders were recorded from study sites of WaingangaRiver(Plate1a, 1b). The species found in the river basin, their relative abundance, taxonomic distribution, and threat status is given in table 1. According to 2014, IUCN report among 69 species, 4 (6%) are vulnerable, 8 (12%) are near threatened, 51 (73%) are at lower risk and 3 (4%) species are not evaluated, 2 are in endangered position and 1 species is found to be data deficient table 1, Fig. 2. Due to the potential of occupying the entire habitat, Cyprinids are most dominating fish fauna (Berra, 2001).

Based on the analysis of relative abundance of each individual species for each order and family resulting that Cypriniformeswas the most dominant order with 29 species contributing about 42.02% of total assemblage fish biodiversity among which the family Cypriniformes retains the highest variance of 29 species followed by order Siliuriformes with 15 species representing second highest fish diversity contributing about 21.73% of total volume of fish population. Next to Siliuriformes, Anabantiformes, the snakehead fish comprises 7.24%,Perciformes,Synbranchiformes contributes about 5.79%, Clupeiformes and Belonoformescomprising 4.34%, Osteoglossiformes 2.89% whereas Angulliformes, Cichliformes,Cyprinodontiformes, Mugiliformes, with 1.44 % representing least diversity solely by single species each Table 2 & Fig. 3.

57 fish species belonging to 35 genera, 13 families and 6 orders were found in the Wainganga River in the region of Balaghat, according to a groundbreaking study conducted by Solanki *et al.* (2014). Rathod& Shinde, 2012 studied Wainganga River at Pauni Maharashtra for its Ichthyofauna variability and recorded about 41 species of 28 different genera, 15 families and 5 orders. Most recent work by Deshmukh &Bobdey, 2020 represented maximum 46% of fish species belongs to the family Cyprinidae followed by Siliuriformes, Cypriniformes, Angulliformes, Synbranchiformes, Beloniformmes and Osteoglossiformes, while notably reported 51 species of fish by Gadekar,2015.

Annual value of Shannon-Wiener Index 1.82 suggests moderate biodiversity, indicating a community with a fair number of species that are somewhat evenly distributed in table 3. Menhinick's Index value of 0.3249 suggests moderate to low species richness relative to the number of individuals in the sample. Since lower value of Simpson's Index of Dominance(D) indicate higher diversity, a value of 0.247 indicates a community with moderate diversity, where there is some degree of dominance by one or more species but also a significant presence of other species Table 3. This reflects a balanced and potentially stable ecosystem.

The steep slope of the rank abundance curve of Ichthyofaunafamily in Fig.4 suggests that other species of community are dominated by few species such as Cypriniformes species, indicating low evenness whereas long tail of the slope is indicating higher species richness.
Present study depicted that on comparing pre-monsoon and monsoon season Fig.5, the post-monsoon season is characterized by high fish abundance due to improved environmental conditions, increased food availability, optimal breeding circumstances, and expanded habitats.

The fish group estimated under study includes different groups like major carp, murrells, spiny eels, catfish and featherback etc. According to economic point of view these fishes possess immense commercial value because of their variety of applications viz. majority of them are food fish, some acts as weed controller, have medicinal value, ornamental value, and many of them are gamefish (19,23).Due to lack of knowledge, it is not easy to assess proper status and conservation policy of any species. Many disturbing tendencies are already detectable in fish diversity of river Wainganga. Consequently, several fish species either become vulnerable or extinct.

Influx of massive pollutants also alters the riverine physiochemistry thus heavily deteriorating the river water portability and destructing the lotic and lentic ecosystem. The problem becomes more severe due to settlement of these pollutants in soil which directly or

indirectly affects the ichthyofaunal biodiversity. To overcome these problems and for regulatory control of overfishing, the commercial fisheries should be supervised and mass awareness program should also be conducted for folk fisher about the importance of native fish land ethics and to avoid harmful fishing gears (Prasad, 2020). indiscriminate killing of fries, fingerlings, and gravid fishes. To protect the threatened fish fauna of this river conservational measures should be taken like stopping illegal fishing, identifying important breeding habitats, collecting the juveniles, and maintaining aquarium, artificial recruitments, and conservation of gametes through gene banking (Shrestha, 2008). are crucial to increase awareness and actively conserving the threatened species as assessed and published by IUCN Red List.

4. Conclusion:

Protection and conservation of faunal variation is crucial because of its vital role to sustain healthy ecosystem. Specially, due to threat of endemic species diversity, globally there is a serious concern, which cautions about conservation strategies to be adopted at worldwide level to verify the species extinction. Present study represents about 69 species, 22 family and 12 order of fish fauna at sites understudy of Wainganga River. Many species procured in the study area are being threatened and there is a decline in richness of species due to anthropological interventions, invasion of alien species and habitat destruction. The role of biological diversity plays a crucial part in ecosystem plasticity. Parallelly, the species which we obtained during study are of great economical and commercial importance. Such study gives a platform for documentation of variance of ichthyofaunal community, providing firsthand assessment to understand and protect the fish species affluence of Wainganga River Balaghat.

This study contributes valuable baseline data for future research and management initiatives aimed at preserving the biodiversity and ecological functions of riverine ecosystems in central India.

5. Acknowledgement:

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