



Abundance study of fish species from Hel River of Kokrajhar, Assam, India

Arjina Parbin Sarkar^{1,2} • Sandeep Das² • Sanjay Basumatary³

¹ Department of Biotechnology, Bholanath College, Dhubri-783324, Assam, India

² Department of Biotechnology, Bodoland University, Kokrajhar-783370, Assam, India

³ Department of Chemistry, Bodoland University, Kokrajhar-783370, Assam, India

Correspondence

Sanjay Basumatary; Department of Chemistry, Bodoland University, Kokrajhar-783370, Assam, India

✉ waytosanjay12@gmail.com

Manuscript history

Received 29 December 2021 | Accepted 5 June 2022 | Published online 18 July 2022

Citation

Sarkar AP, Das S, Basumatary S (2022) Abundance study of fish species from Hel River of Kokrajhar, Assam, India. Journal of Fisheries 10(2): 102205. DOI: 10.17017/j.fish.400

Abstract

Hel River is an important river of Kokrajhar district of Assam, India, which is a great source of freshwater fish. Considering the availability of indigenous fish species in Hel River and consumption of these species by the local people, the prime objective of this study was to study the fishes in the river. The relative abundance of fishes along with the species richness and species evenness were calculated based on fish samplings from August 2014 to July 2015. A total of 1313 individuals belonging to 25 species were recorded, dominated by family Cyprinidae with nine species. The highest relative abundance was recorded for *Barilius bendelisis* (15.31%) followed by *Garra gotyla* (14.09%) and *Barilius barna* (13.78%). This study may serve as an important baseline for sustainable management of Hel River.

Keywords: Cyprinidae; freshwater fish; Hel River; relative abundance; species evenness

1 | INTRODUCTION

Biodiversity is the study of variety and variability of life that exists on earth, which includes quantity, variety and distribution, ranging through genetics to species, populations, communities and ecosystems (Gowda *et al.* 2015; Hashemi *et al.* 2015). It starts with a measure of the number of species that make up a biological community and is considered one of the most significant aspects of the community organisation and structure (Ahmed *et al.* 2018). This provides a brief idea about the species diversity and richness, which designates the key elements of biodiversity (Yadav and Mishra 2013). Omoike (2021) also mentioned that relative abundance and species richness are the key elements of biodiversity in the aquatic system and have been recommended as a tool for ecological risk assessment. Temesgen *et al.* (2021) stated that the study of relative abundance and distribution can provide more insight into the factors that affect the structures of fish species. Biodiversity is the foundation of the vast array of

ecosystem services that contribute significantly to human wellbeing (Rayal *et al.* 2021). It indicates the potential of any aquatic system and also depicts its trophic status (Kumar *et al.* 2011). Therefore, the study of biodiversity is essential for stabilisation of ecosystem and protection of overall environmental quality for understanding intrinsic worth of all species on the earth (Tessema and Mohamed 2016). However, biological diversity is the variability among living organisms at all levels and from all sources including marine, terrestrial and other aquatic ecosystem (Rayal *et al.* 2021). So, the study of biodiversity is important for sustainability of natural resources and the biological evaluation which is also a useful tool for measuring the ecological value of the aquatic ecosystems (Jafari and Gunale 2006).

The most common natural biodiversity study is fish diversity within different locations because fishes are very important from the biodiversity point of view, enjoying different ecosystems, habitats and niches of the aquatic

environment (Parvathy 2018). Abundance and richness of fishes is an important indicator of ecological health of an aquatic ecosystem. Fishes are important part of an aquatic food chain which consume plankton and small animals and also serve as food for predator animals occupying higher position in the trophic level; commercially important fishes can improve the livelihood of the people dependent on them (Thirumala and Kiran 2017). Fishes are commonly found in marine and freshwater environments of which, in the past three decades, freshwater biodiversity has been declining faster than either marine or terrestrial biodiversity (Jenkins 2003). It was also reported that biodiversity is often ambiguously misused or overused to describe population dynamics of a community or location and the rivers and streams are facing several environmental complications throughout the world and is largely connected to anthropogenic activities in their catchment areas (Tessema and Mohamed 2016).

Freshwater fishes are declining worldwide due to multiple factors including overexploitation, habitat degradation, climate change, pollution and water extraction, making them the most threatened group of vertebrates in the world (Foote *et al.* 2020). Freshwater biodiversity in particular area is currently facing a global crisis (Hu *et al.* 2019). Therefore, it is very crucial to have the idea of the diversity of fish species, distribution, and abundance for the development of conservation and management programmes. With this regard, studies of temporal and spatial patterns of diversity, composition and distribution of fish species of freshwater are important to be examined that may influence the structure of fish community (Galacatos *et al.* 2004). Biodiversity also disturbs the capability of living systems to respond in changes of the environment, supports of ecosystem function and provides the ecosystem services that sustenance the human well-being (Hooper *et al.* 2005; Diaz *et al.* 2006).

Based on the abundance of fish species, India is having one of the most diversified and the largest natural resources in the world (Vivekanandan 2013; Mohanty *et al.* 2015). The information on the abundance and diversity of the fish species is the main obligatory for management policy (Chaki *et al.* 2014; Galib 2015; Galib *et al.* 2016). The diversity of any natural community partially depends on the conditions of the environment and unfortunately, interferences of anthropogenic activities are diminishing the living resources due to degradation of coastal habitats affecting the fish diversity (Chowdhury *et al.* 2011). Many studies have been reported the diversity of freshwater fishes in India (e.g. Jayaram 1994; Mogalekar and Canciyal; Singh *et al.* 2021). Nonetheless, many aquatic habitats received no or less attention from researchers. Hel River in Bodoland Territorial Region (BTR) of Assam, India is one such river and therefore, the present work aims to describe the fish species diversity of Hel River through systematic samplings.

2 | METHODOLOGY

The fish specimens were collected from Hel River located near the Serfanguri of Kokrajhar district (26.56°N 90.13°S, altitude – 57.9 m, accuracy: 2.0 m, bearing – 48.21°), Assam. Sampling of the fish species was done on monthly basis, comprised of both morning and night samplings, from August 2014 to July 2015. For sample collection, three fishing nets including the case net (1 – 2 m diameter, mesh size of 0.05 cm), scoop net (mesh size of 0.25 cm) and fishing mosquito net were employed. The water depth of the fishing sites of the river was 0.61 to 1.5 m, measured by conventional method. The fish specimens were taken into specimen jars containing preservative (4% formalin) for morphological characterisation to confirm identification with the help of the Zoological Survey of India (ZSI), located at Shillong, Meghalaya. All the chemicals used were of analytical grade. IUCN Redlist status of fish species are based on IUCN (2021). The fish samples were counted and the relative abundance (%) was calculated using the following formula (Win and Myint 2020):

$$\text{Relative abundance (\%)} = (\text{Total number of individuals in each of a species} / \text{Total number of individuals of all the observed species}) \times 100.$$

3 | RESULTS AND DISCUSSION

3.1 Fish species and IUCN redlist status

The scientific name, local name, family and order of the fishes studied from Hel River along with the IUCN conservation status of fishes are shown in Table 1. A total of 25 fish species belonging to five orders (Cypriniformes, 17 species; Siluriformes, 5 species; Synbranchiformes, 1 species; Anguilliformes, 1 species; Perciformes, 1 species) and ten families (Cyprinidae, 12 species; Sisoridae, 3 species; Psilorhynchidae, 2 species; Botiidae, 2 species; Anguillidae, 1 species; Mastacembelidae, 1 species; Siluridae, 1 species; Cobitidae, 1 species; Ambassidae, 1 species; Bagridae, 1 species) were recorded.

Four Near Threatened species (*Labeo pangusia*, *Neolissochilus hexagonolepis*, *Anguilla bengalensis* and *Tor tor*) were recorded along with 16 Least Concern species (Table 1). In addition, one Endangered (*Tor putitora*) and three Vulnerable (*Cyprinion semiplotum*, *Wallago attu* and *Botia rostrate*) species were also recorded. Occurrence of fish species varied with time of the year which may be due to varying environmental conditions.

It was reported that the occurrence of fish species in a particular area depends on the environmental factors including water temperature, pH, salinity, dissolved oxygen and other factors (Gowda *et al.* 2015). Due to the tolerance capability in other environments, fishes were grouped into several conservation categories (IUCN 2021). Gupta and Michael (1992) recorded that physical and chemical variables such as air temperature, rainfall

and water temperature showed a fairly wide seasonal variation. They recorded a total of seventeen species belonging to five families and eight genera from Meghalaya, India. Bhat (2003) studied the diversity and composition of freshwater fish species from Western Ghats, India, and in the study, a total of 10771 individuals belonging to 92 species representing 25 families and 48 genera, excluding family Cyprinidae, were reported. Bisht *et al.* (2009) reported that the difference in availability of fish fauna is directly related to the nature of profile and slope of tributary, which affects the migration and breeding grounds of the fishes. Vijaylaxmi and Vijaykumar (2011) conveyed that the Cyprinidae family was observed to be the most dominant among all the other families in their study. Sarkar *et al.* (2012) recorded a total of 143 fish species belonging to 11 orders, 72 genera and 32 families from the river Ganges, India. Basavaraja *et al.* (2014) reported 25 fish species belonging to four orders, nine families and 18 genera and found that the order Cypriniformes was the most predominant one followed by the order Siluri-

formes, Perciformes and Osteoglossiformes.

It has been shown that the regulation of water has an impact on species richness, relative abundance and habitat heterogeneity (Rumana *et al.* 2015; Galib *et al.* 2018). Mohanty *et al.* (2015) reported that greater diversity values may be because of the abundant availability of the food resources and appropriate environmental situations. Badoni (2017) mentioned that the availability of fish fauna is directly related to the profile of the stream, the natural pattern of temperature, organic resources, discharge of water and water chemistry.

The present study also reports fish diversity of Hel River and showed that the Cyprinidae family is the dominant family. In the present investigation, a total of nine Cyprinid fish species (*Barilius bendelisis*, *B. barna*, *Garra gotyla*, *Chagunius chagunio*, *Cyprinion semiplotum*, *Tor putitora*, *Labeo pangusia*, *Raiamas bola* and *Neolissochilus hexagonolepis*; Figure 1) were authenticated by the Zoological Survey of India (ZSI) at Shillong, Meghalaya.

TABLE 1 Local name, scientific name, family, and order along with IUCN status of fish species found in the Hel River, Assam.

Order	Family	Local name	Scientific name	Conservation status ^a	
Cypriniformes	Botiidae	Rani	<i>Botia dario</i>	LC	
		Botia	<i>Botia rostrata</i>	VU	
	Cobitidae	Poia	<i>Canthophrys gongota</i>	LC	
	Cyprinidae	Cyprinidae	Kabri peri	<i>Barilius barna</i>	LC
			Elang	<i>Barilius bendelisis</i>	LC
			Pitkata	<i>Chagunius chagunio</i>	LC
			Bhangna	<i>Cirrhinus reba</i>	LC
			Vutia puthi	<i>Cyprinion semiplotum</i>	VU
			Zebrafish	<i>Danio rerio</i>	LC
			Siltoka	<i>Garra gotyla</i>	LC
			Ghoira	<i>Labeo pangusia</i>	NT
			Vuluk	<i>Neolissochilus hexagonolepis</i>	NT
			Chela	<i>Raiamas bola</i>	LC
	Jongator	<i>Tor putitora</i>	EN		
	Puthitor	<i>Tor tor</i>	NT		
Psilorhynchidae	Psilorhynchidae	Gol	<i>Psilorhynchus nudithoracicus</i>	-	
		Baluchata	<i>Psilorhynchus sucatio</i>	LC	
Siluriformes	Bagridae	Rita	<i>Rita rita</i>	LC	
	Siluridae	Boal	<i>Wallago attu</i>	VU	
	Sisoridae	Tengra	<i>Gagata cenia</i>	LC	
Telchitta		<i>Glyptothorax telchitta</i>	LC		
Pahari Tangna		<i>Gogangra viridescens</i>	LC		
Anguilliformes	Anguillidae	Nangdor	<i>Anguilla bengalensis</i>	NT	
Synbranchiformes	Mastacembelidae	Zig zak baim	<i>Mastacembelus armatus</i>	LC	
Perciformes	Ambassidae	Chanda	<i>Parambassis ranga</i>	LC	

IUCN conservation status: En, Endangered; LC, Least Concern; NT, Near Threatened; VU, Vulnerable; -, Not evaluated
^a, Source: IUCN (2021)

3.2. Abundance of fishes

A total of 25 species represented by 1313 individuals were captured from Hel River. This indicated that Hel Riv-

er is rich in fish diversity with varying numbers of species. Higher individuals (more than 100) were found from November to April (Table 2). The highest number of individ-

uals (195) was found in January whereas the lowest (58) was recorded in July. Relative abundance (RA) showed

that the species belonging to Cyprinidae family dominated Hel River.

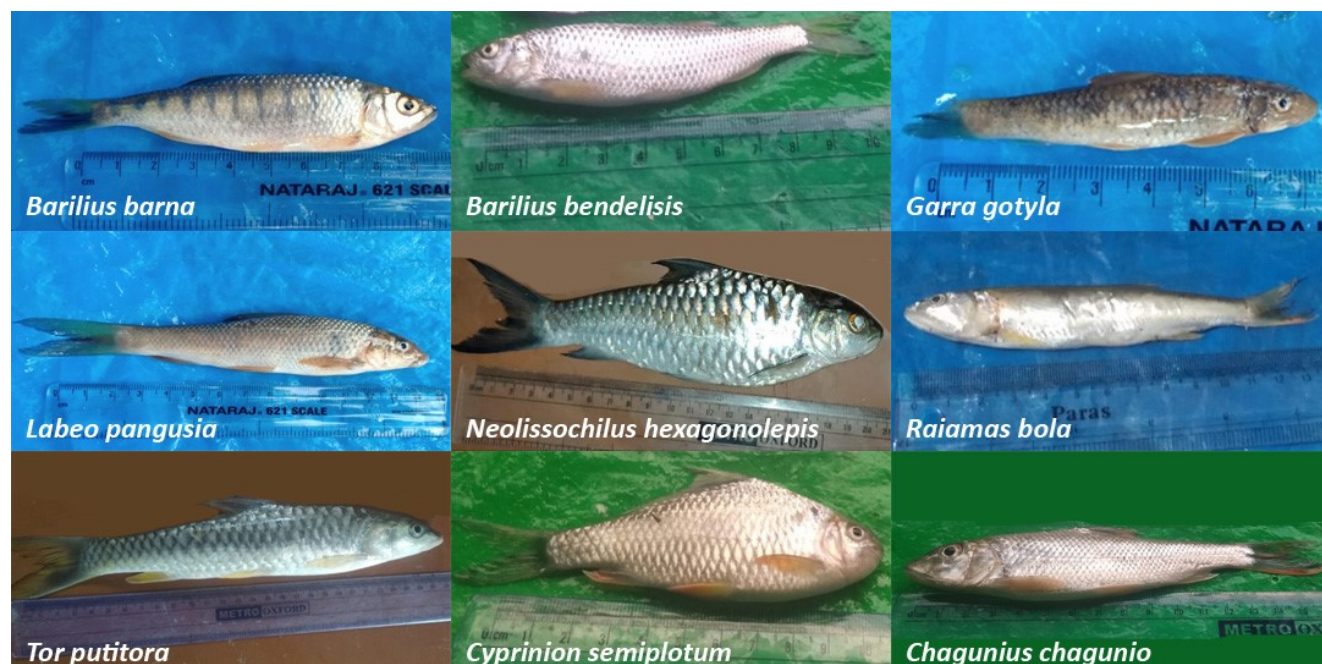


FIGURE 1 Fish species of Cyprinidae in Hel River, Assam.

TABLE 2 Month- and species-wise abundance of fish species in Hel River of Kokrajhar, Assam.

Scientific name	Sampling months												Total	RA (%)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
<i>Botia dario</i>	0	0	0	2	1	2	3	2	0	0	0	0	10	0.76
<i>Botia rostrata</i>	0	0	0	0	2	2	0	4	0	0	0	0	8	0.61
<i>Canthophrys gongota</i>	0	2	4	3	3	2	0	0	0	0	0	0	14	1.07
<i>Barilius barna</i>	9	16	13	14	13	19	23	13	20	18	13	10	181	13.78
<i>Barilius bendelisis</i>	9	5	18	12	21	40	25	35	10	9	11	6	201	15.31
<i>Chagunius chagunio</i>	6	3	9	5	10	8	12	15	10	13	9	4	104	7.92
<i>Cirrhinus reba</i>	2	4	0	6	7	9	5	2	3	0	1	0	39	2.97
<i>Cyprinion semplotum</i>	9	5	3	2	9	15	10	13	11	9	5	11	102	7.77
<i>Danio rerio</i>	0	0	0	2	1	3	2	3	2	0	0	0	13	0.99
<i>Garra gotyla</i>	10	8	10	5	11	33	31	26	20	15	9	7	185	14.09
<i>Labeo pangusia</i>	4	6	3	2	6	10	16	11	13	6	2	3	82	6.24
<i>Neolissochilus hexagonolepis</i>	2	3	6	9	8	6	8	10	5	4	3	4	68	5.18
<i>Raiamas bola</i>	7	5	6	11	6	9	10	6	4	3	3	1	71	5.41
<i>Tor putitora</i>	4	6	5	8	7	12	11	9	10	5	7	6	90	6.85
<i>Tor tor</i>	0	0	0	3	0	5	2	0	0	1	0	4	15	1.14
<i>Psilorhynchus nudithoracicus</i>	3	0	9	6	18	9	8	5	4	2	3	0	67	5.10
<i>Psilorhynchus sucatio</i>	0	0	0	2	0	1	0	0	0	0	0	0	3	0.23
<i>Rita rita</i>	0	0	0	0	0	0	1	0	1	0	0	0	2	0.15
<i>Wallago attu</i>	0	0	0	1	0	0	0	1	0	0	0	0	2	0.15
<i>Gagata cenia</i>	0	0	0	1	0	2	2	4	0	0	0	0	9	0.68
<i>Glyptothorax telchitta</i>	0	0	0	1	0	0	2	0	0	0	0	0	3	0.23
<i>Gogangra viridescens</i>	0	1	2	3	1	2	0	0	0	0	0	0	9	0.68
<i>Anguilla bengalensis</i>	0	0	0	3	2	2	2	0	0	0	0	0	9	0.68
<i>Mastacembelus armatus</i>	0	0	0	0	1	1	0	0	0	0	0	0	2	0.15
<i>Parambassis ranga</i>	0	4	6	4	0	3	1	4	0	0	0	2	24	1.83
Total	65	68	94	105	127	195	174	163	113	85	66	58	1313	

The relative abundance was the highest for *Barilius bendelisis* (RA, 15.31%) followed by *Garra gotyla* (RA, 14.09%) and *B. barna* (RA, 13.78%) whereas it was the lowest for *Danio rerio* (RA, 0.99%; Table 2). Abundance of several fish species has been reducing day by day due to the lack of their proper environmental conditions and other factors. Therefore, the abundance study through systematic sampling is very important for knowing the species number and also the seasonal effects on the relative abundance of fish species. The species richness varies due to various factors like available nutrients, seasonal change, habitats, fish behaviour, fishing effort, size and life stages of fishes, water level and turbidity of water (Tessema and Mohamed 2016). However, aquatic species is declining rapidly due to habitat degradation, anthropogenic activities, exotic species introduction, pollution, water diversions and global climate change (Vijaylaxmi *et al.* 2010).

4 | CONCLUSIONS

The study reveals that Hel River is rich in fish species, dominated by family Cyprinidae. It also reports the seasonal variation of fish species, their abundance and redlist status which can be used as a reference for future research work.

ACKNOWLEDGEMENTS

The authors are thankful to the Zoological Survey of India (ZSI), Shillong, Meghalaya for identification of the selected fish species.

CONFLICT OF INTEREST

The author declares no conflict of interest.

AUTHORS' CONTRIBUTION

APS involved in sample collection, data analysis and manuscript preparation; SD supervised the study, participated in manuscript review and editing; SB supervised the study, participated in manuscript review and editing.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

REFERENCES

- Ahmed EO, Ali ME, Aziz AA, Musa AM (2018) Species diversity and abundance of fish in Rosei Reservoir, Blue Nile State of Sudan. *International Journal of Advanced Science Engineering and Technology* 6(3): 5–9.
- Badoni AK (2017) Study of seasonal distribution and relative abundance of fish fauna of a small Himalayan hill stream Dhundeshwar gad along with river Alaknanda. *International Journal of Fauna and Biological Studies* 4(2): 23–26.
- Basavaraja D, Narayana J, Kiran BN, Puttaiah ET (2014) Fish diversity and abundance in relation to water quality of Anjanapura reservoir, Karnataka, India. *International Journal of Current Microbiology and Applied Sciences* 3(3): 747–757.
- Bhat A (2003) [Diversity and composition of freshwater fishes in river systems of Central Western Ghats, India](#). *Environmental Biology Fishes* 68: 25–38.
- Bisht B, Badoni AK, Bahuguna SN (2009) Seasonal distribution and relative abundance of fish fauna of a small hill-stream Dangchaura (Takoli) Gad, along with river Alaknanda. *Our Natute* 7: 182–186.
- Chaki N, Jahan S, Fahad MFH, Galib SM, Mohsin ABM (2014) [Environment and fish fauna of the Atrai River: global and local conservation perspective](#). *Journal of Fisheries* 2(3): 163–172.
- Chowdhury MSN, Hossain MS, Das NG, Barua P (2011) [Environmental variables and fisheries diversity of Naaf River Estuary, Bangladesh](#). *Journal of Coastal Conservation* 15: 163–180.
- Diaz S, Fargione J, Chapin FS, Tilman D (2006) [Biodiversity loss threatens human well-being](#). *PLoS Biology* 4(8): e277.
- Footo KJ, Biron PM, Grant JWA (2020) [Impact of in-stream restoration structures on salmonid abundance and biomass: an updated meta-analysis](#). *Canadian Journal of Fisheries and Aquatic Sciences* 77(9): 1574–1591.
- Galacatosa K, Salazarb RB, Stewarta DJ (2004) [Seasonal and habitat influences on fish communities within the lower Yasuni River basin of the Ecuadorian Amazon](#). *Environmental Biology Fishes* 71: 33–51.
- Galib SM (2015) [Fish fauna of the Brahmaputra River, Bangladesh: richness, threats and conservation needs](#). *Journal of Fisheries* 3(3): 285–292.
- Galib SM, Lucas MC, Chaki N, Fahad FH, Mohsin ABM (2018) [Is current floodplain management a cause for concern for fish and bird conservation in Bangladesh's largest wetland?](#) *Aquatic Conservation: Marine and Freshwater Ecosystems* 28(1): 98–114.
- Galib SM, Rashid MA, Chaki N, Mohsin ABM, Joadder MAR (2016) [Seasonal variation and community structure of fishes in the Mahananda River with special reference to conservation issues](#). *Journal of Fisheries* 4(1): 325–334.
- Gowda G, Naik GM, Rai SV, Nayak H, Sruthisree C (2015) Fish biodiversity of Tunga, Bhadra and Tungabhadra rivers of Karnataka, India. *Research Journal of Animal, Veterinary and Fishery Sciences* 3(10): 1–16.
- Gupta A, Michael RG (1992) [Diversity, distribution, and seasonal abundance of Ephemeroptera in streams of Meghalaya State, India](#). *Hydrobiologia* 228: 131–139.
- Hashemi SA, Ghorbani R, Kymaram F, Hossini SA, Eskandari G, Hedayati A (2015) Fish species compo-

- sition, distribution and abundance in Shadegan wetland. *Fisheries and Aquaculture Journal* 6(2): 1–8.
- Hooper DU, Chapin FS, Ewel JJ, Hector A, Inchausti P, ... Wardle DA (2005) [Effects of biodiversity on ecosystem functioning: a consensus of current knowledge](#). *Ecological Monographs* 75(1): 3–35.
- Hu M, Wang C, Liu Y, Zhang X, Jian S (2019) [Fish species composition, distribution and community structure in the lower reaches of Ganjiang River, Jiangxi, China](#). *Scientific Reports* 9: 10100.
- IUCN (2021) The IUCN Red List of Threatened Species. Version 2021-3. <https://www.iucnredlist.org>.
- Jafari NG, Gunale VR (2006) Hydrobiological study of algae of an urban freshwater river. *Journal of Applied Sciences & Environmental Management* 10(2): 153–158.
- Jayaram KC (1994) The freshwater fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka- a handbook. Zoological Society of India, Calcutta. 475 pp.
- Jenkins M (2003) Prospects of biodiversity. *Science* 302: 1175–1177.
- Kumar P, Wanganeo R, Wanganeo A, Sonaulah F (2011) Preliminary study on ichthyofaunal diversity of Shershah Suri pond, Sasaram, Bihar. *International Journal of Engineering, Science and Technology* 3(2): 1582–1588.
- Mogalekar HS, Canciyal J (2018) [Freshwater fishes of Orissa, India](#). *Journal of Fisheries* 6(1): 587–598.
- Mohanty SS, Dash BP, Pramanik DS (2015) Fish species abundance and diversity in Chandipur, Bay of Bengal, India. *International Journal of Science and Research* 4(2): 1801–1805.
- Omoike A (2021) The trend in fish species diversity and abundance at Asejire Reservoir, south western Nigeria. *Journal Aquaculture and Fisheries* 5(1): 1–9.
- Parvathy CA (2018) Fish diversity, abundance and traditional fish harvesting methods at Kole wetlands of Thrissur, Kerala. *International Journal for Research in Applied Science and Engineering Technology* 6(1): 1852–1857.
- Royal R, Bhatt A, Bahuguna P (2021) Fish fauna of river Yamuna from Doon Valley, Uttarakhand, India. *Journal of Experimental Zoology* 24(2): 973–977.
- Rumana HS, Jeeva V, Kuma S (2015) [Impact of the low head dam/barrage on fisheries – a case study of Giri River of Yamuna Basin \(India\)](#). *Transylvanian Review of Systematical and Ecological Research* 17.2: 119–138.
- Sarkar UK, Pathak AK, Sinha RK, Sivakumar K, Pandian AK, ... Lakra WS (2012) [Freshwater fish biodiversity in the River Ganga \(India\): changing pattern, threats and conservation perspectives](#). *Reviews in Fish Biology and Fisheries* 22: 251–272.
- Singh SK, Sarma KJ, Bhatt DM, Mankodi PC (2021) [Ichthyofaunal diversity and fishery status of Sutrapada Coast, Gujarat, India](#). *Journal of Fisheries* 9(2): 92204.
- Temesgen B, Tadesse Z, Temesgen M (2021) Diversity, distribution and abundance of fish species in upper Awash River Basin, West Showa Zone, Ethiopia. *Cogent Food and Agriculture* 7: 1–13.
- Tessema A, Mohamed A (2016) Abundance and fish species composition of Gerado and Dirma rivers, South Wollo, Ethiopia. *Journal of Fisheries Science* 10(2): 76–82.
- Thirumala S, Kiran BR (2017) Fish diversity in Gowdanakere tank of Bhadravathi Taluk, Karnataka. *International Journal of Multidisciplinary Research and Modern Education* 3(1): 355–358.
- Vijaylaxmi C, Rajshekhar M, Vijaykumar K (2010) Freshwater fishes distribution and diversity status of Mullameri River, a minor tributary of Bheema River of Gulbarga District, Karnataka. *International Journal of Systems Biology* 2(2): 1–9.
- Vijaylaxmi C, Vijaykumar K (2011) Biodiversity of fish fauna of the Bheema River in Gulbarga District of Karnataka. *The Ecoscan* 5(1–2): 21–25.
- Vivekanandan E (2013) The trawl fisheries of the western Bay of Bengal. Food and Agriculture Organization of the United Nations, Rome. pp. 1–39.
- Win ML, Myint TT (2020) Species composition, seasonal occurrence and abundance of freshwater fishes in Ayeyarwady River segment, Sagaing region, Upper Myanmar. *IOP Conference Series Earth and Environmental Science* 416: 1–19.
- Yadav SK, Mishra G (2013) Biodiversity measurement determines stability of ecosystems. *International Journal of Environmental Science: Development and Monitoring* 4(3): 68–72.



S Basumatary  <https://orcid.org/0000-0001-5135-3197>