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Ichthyofaunal Diversity and its Conservation Status of Nambol River, Manipur

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Abstract

Documentation of fish biodiversity of the river will be one essential step towards making strategic planning for conservation and management of the river ecosystem as well as its fisheries resources. With this view, the present investigation was carried out in order to assess the ichthyofaunal diversity of Nambol River, one of the feeder river of Loktak Lake, a Ramsar Site in Manipur, North-East India. Live fishes were collected for three seasons viz. pre-monsoon, monsoon and post-monsoon during 2023 by selecting four sites from the whole stretch of the Nambol River, Manipur. The collected fishes were preserved in the laboratory and were identified by following the methods of Jayaram (1999) and Vishwanath (2002). A total of 36 different fish species belonging to 8 orders, and14 families were found and identified during the study period. The percent composition of family Cyprinidae was found to be highest followed by Nemacheilidae and Channidae.

***Key words*:** Fish composition, Cyprinidae, IUCN, Nambol river, Manipur

Species diversity is widely recognized as an important trait of functioning and resilient ecosystem [1]. Across different biotic components of the aquatic ecosystem, fish flora recognizes an important place. Fishes have been known as the guards of the aquatic food chain. Fishes are regarded as the most diverse vertebrate species in the world. The fishes play a pivotal role in the structure and functioning of aquatic ecosystems on one side and on other side these species are regarded as the bioindicators of the health of aquatic ecosystems [2]. Fish biodiversity plays a crucial role in maintaining the health and functioning of aquatic ecosystems. As pointed out by Meinam *et al*. [3], following are the key reasons why fish biodiversity is important among others: (a) Ecosystem Stability - A diverse fish community ensures a balance within the ecosystem and promotes its stability. (b) Food Security - Maintaining fish biodiversity ensures sustainable fisheries and helps meet the nutritional needs of communities that rely on fish as a primary food source. (c) Indicator Species - Monitoring fish diversity helps in detecting and addressing environmental issues early on. (d) Research and Education - Diverse fish communities offer rich opportunities for educational purposes, enabling students and researchers to study and appreciate aquatic ecosystems. (e) Invasive Species Control - This may involve monitoring and early detection of invasive species, implementing measures to prevent their introduction or spread, and developing eradication or feasible programs. At present, the documentation of biodiversity has become very important aspect due to different environmental influences. The fish diversity of any regime has great significance in assessment of that zone reference to environment and pollution, as well as it contributes to the necessary information for fisheries [4]. Moreover, documentation of biodiversity is very much important aspect to understand different ecosystems and their interactions. One should know what really exist and then planning for conservation can be made [5]. Diversity, abundance and distribution pattern of the fish fauna are important aspects that need to be considered in order to frame the conservation and management strategies in any water body [6].

Rivers are indispensable freshwater systems that are necessary for the continuation of life [7]. They are considered as one of the main resources of water supply for various applications such as agricultural, drinking and industrial purposes. [8]. Ichthyofaunal diversity of a river 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 [9].Fish richness and diversity serve as important indicators of a healthy stream ecosystem, which are influenced by a complex web of ecological factors, including regional climate, watershed characteristics, riparian zone quality, and water quality. Investigating how these factors interconnect and impact fish community is crucial for developing effective management strategies to safeguard freshwater ecosystems [10].

Moreover, capture fisheries are essential for food security, nutrition and cultural diets since capture fisheries provide high-quality food that is high in protein, essential amino acids, and long-chain poly-unsaturated fatty acids, with many benefits for human health. For sustainability of these resources, an adequate knowledge of species composition, diversity and

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relative abundance of the fisheries resources of the water bodies must be understood [11]. Also, the conservation and management of fishery resources is an indispensable component of the protection of community interests in international law, as well as involving the interests of the survival and development of human beings, which is not only for the present but also for future generations [12].

Manipur, one of the eight northeastern states of India is situated in the extreme northeast frontier of India. It is surrounded on the north by Nagaland, on the east and southeast by Burma (now Myanmar), on the south west by Mizoram and on the west by Assam [13]. Next to rice, fish forms an important part of the food culture of Manipur. It also forms an important part of the traditional and religious rituals of the Manipuris. The Manipuris loved eating fish and any fish of any size starting from 1cm has food value [14]. Fisheries has been playing an integral role in the Manipuri society as fish forms a part and parcel of every Manipuri dish served on the table. Fish has thus, been termed to be the most widely accepted food items in the state. It is consumed by almost all people irrespective of age, culture, religion and food habits including vegetarian sect of people [15]. The state does not have any marine coastlines and seas. Its only fishery resources available are from inland waters [16]. Community fishing is unique in terms of its cultural heritage of Manipur and it has played a significant role in the socio-economic and food security of the ethnic communities in the state [17]. Manipur is rated as one of the highest fish consumer in the country instead of its limited fishery resources.

MATERIALS AND METHODS

Manipur is blessed with numerous rivers and streams, of which many are feeding important lakes of the state. In the past Nambol River (river under study) was the prime tributary of the Nambul River but today the river empties into the Loktak Lake at the extreme north-western side. This river rises from the western hill ranges of Imphal Valley and flows through Nambol Town [18]. The river while traversing through hills, before reaching plain, maintain unpolluted water quality due to less human activities, but due to human population growth, urbanization, and associated land use changes have led to water quality deterioration in the downstream of the river [19]. The length of the river (main stream only) is about 42 km. and its elevation is 770-830 meters from the mean sea level. It lies at the latitude of 24°38' N to 24°50' and longitude of 93°46' E to 93°50'E. The river water is deteriorated by the sewage discharge, chemical fertilizers, pesticides, dumping of solid waste and other activities like washing, bathing etc. [20].

For the present study, four sites from the whole stretch of the river under study were selected for sample collection. The sites were:

1.Maklang (Site- I)
2. Khumbong (Site- II)
3. Kongkham (Site- III)
4. Toubul (Site- IV)

Collection of live fishes were done from the above mentioned four study sites for three seasons viz. pre-monsoon, monsoon and post-monsoon during 2023. Live fishes were caught using different types of nets like gill net, cast net, drag net with the help of local fishers. The fishes caught were identified by following the methods as given in Jayaram [21], Vishwanath [22]. The identified fishes were checked for its conservation status following IUCN Red List [23]. Diversity indices of various fish species found during the study period were calculated by using Shannon-Wiener Index [24] along with Shannon Equitability Index. Shannon-Wiener Diversity Index, H, is calculated using the following equation:

$$H = - \Sigma Pi (\ln Pi)$$

Here,
Pi: the relative abundance (n/N)
n: Number of individuals of each species
N: Total no of individual of all species

The Shannon Equitability Index is a way to measure the evenness of species in a community. The term “evenness” simply refers to how similar the abundances of different species are in the community.
Denoted as E_H, this index is calculated as:

$$E_H = H / \ln(S)$$

where:
H: The Shannon Diversity Index
S: The total number of unique species

RESULTS AND DISCUSSION

Ichthyofaunal diversity refers to variety of fish species; depending on context and scale, it could refer to alleles or genotypes within piscian population, to species of life forms within a fish community, and to species of life forms across aqua regimes [25]. Fish species diversity pattern in rivers is dependent on the complex interaction of the different ecological variables of the river viz, size, surface area of the drainage basin, mean annual river discharge, temperature, depth, flow velocity, channel morphology, substrate and climate [26]. Also, ichthyofaunal composition is the important and essential biotic component of an aquatic ecosystem [27]. Environmental stress and fishing pressure are reflected in the fish community composition and biodiversity of fishes [28]. In recent years, ichthyofaunal diversity of the aquatic ecosystems is at severe risk due to aquatic pollution, other anthropogenic stress, habitat destruction, overfishing, etc. [29].

Table 1 List of fish species found in Nambol river and their conservation status

S. No.	Name of the Species	Family	Order	Sites				IUCN status
				I	II	III	IV	
1	*Anabas testudineus* [34]	Anabantidae	Anabantiformes	+	+	+	+	LC
2	*Trichogaster fasciata* [35]	Osphronemidae	-	+	+	+	+	LC
3	*Colisa labiosa* [36]	-	Perciformes	+	+	+	+	LC
4	*Oreochromis mossambicus* [37]	Cichlidae	Cichliformes	+	+	+	+	VU
5	*Lepicocephalichthys berdmorei* [31]	Cobitidae	Cypriniformes	+	-	-	-	LC
6	*Lepidocephalichthys irrorate* [32]	-	-	-	+	-	-	LC
7	*Hypophthalmichthys molitrix* [38]	Cyprinidae	-	-	+	+	+	NT
8	*Barilius bendelisis* [39]	-	-	-	-	+	+	LC
9	*Esomus danrica* [39]	-	-	+	+	+	+	LC
10	*Catla catla* [39]	-	-	-	-	+	+	LC

11	*Amblypharyngodon mola* [39]	-	-	+	+	+	+	LC
12	*Ctenopharyngodon idella* [38]	-	-	-	+	+	+	LC
13	*Cirrhinus mrigala* [39]	-	-	-	+	+	+	LC
14	*Devario acuticephala* [32]	-	-	+	+	-	-	VU
15	*Cyprinus carpio* [40]	-	-	-	+	+	+	VU
16	*Labeo rohita* [39]	-	-	-	+	+	+	LC
17	*Labeo gonius* [39]	-	-	-	+	+	+	LC
18	*Puntius chola* [39]	-	-	+	+	+	+	LC
19	*Pethia manipurensis* [30]	-	-	-	-	-	+	EN
20	*Puntius javanicus* [41]	-	-	-	-	+	+	LC
21	*Puntius sophore* [39]	-	-	-	+	+	+	LC
22	*Puntius ater* [42]	-	-	-	+	+	+	VU
23	*Garra lissorhynchus* [43]	-	-	+	+	-	-	LC
24	*Acanthocobitis botia* [39]	Nemacheilidae	-	-	+	+	-	LC
25	*Schistura manipurensis* [44]	-	-	+	+	-	-	NT
26	*Schistura kangjupkhulensis* [32]	-	-	+	+	-	-	EN
27	*Glossogobius giuris* [33]	Gobiidae	Gobiiformes	-	+	+	+	LC
28	*Notopterus notopterus* [39]	Notopteridae	Osteoglossiformes	-	+	+	+	LC
29	*Channa marulius* [39]	Channidae	Perciformes	-	-	+	+	LC
30	*Channa gachua* [33]	-	-	-	-	-	+	LC
31	*Chana punctata* [45]	-	-	+	+	+	+	LC
32	*Mystus bleekeri* [36]	Bagridae	Siluriformes	-	+	+	+	LC
33	*Clarias batrachus* [40]	Clariidae	-	-	+	+	+	LC
34	*Heteropneustes fossilis* [39]	Heteropneustidae	-	-	+	+	+	LC
35	*Mastacembelus armatus* [46]	Mastacembelidae	Synbranchiformes	-	+	+	+	DD
36	*Monopterus albus* [47]	Synbranchidae	-	-	+	+	+	LC

* + Present; * - Absent

The fish fauna of Nambol River includes 36 species as shown in the (Table 1). The fishes were belonging to 8 orders, and 14 families. The total number of species of each family found from different study sites and percent composition of various families are presented in (Table 2). The highest percent composition was shown by the family Cyprinidae with 43.95% which was followed by two families Nemacheilidae and Channidae with 08.62% each. The percent composition of family Osphronemidae was 07.75%. and that of Anabantidae, Cichlidae and Clariidae were 4.31% each. The percent composition of the remaining 7 fish species viz. Cobitidae, Gobiidae, Notopteridae, Bragidae, Heteropneuslidae, Mastaecembitidae, and Synbranchidae were 2.59% each. In this river *Pethia manipurensis* [30], *Lepicocephalichthys berdmorei* [31], *Lepidocephalichthys irrorata* [32] and *Channa gachua* [33] were rarely found in all the collection sites (Table 1).

Table 2 Family-wise distribution of fish species in various study sites and percent composition

S. No.	Family	Site I	Site II	Site III	Site IV	Total no. of species	Percent composition
1	Anabantidae	1	1	1	2	5	4.31
2	Osphronemidae	2	2	3	2	9	7.75
3	Cichlidae	1	1	1	2	5	4.31
4	Cobitidae	1	2	0	0	3	2.59
5	Cyprinidae	5	15	14	17	51	43.95
6	Nemacheilidae	3	5	2	0	10	8.62
7	Gobiidae	0	1	1	1	3	2.59
8	Notopteridae	0	1	1	1	3	2.59
9	Channidae	1	1	5	3	10	8.62
10	Bagridae	0	1	1	1	3	2.59
11	Clariidae	0	1	2	2	5	4.31
12	Heteropneustedae	0	1	1	1	3	2.59
13	Mastacembilidae	0	1	1	1	3	2.59
14	Synbranchidae	0	1	1	1	3	2.59
	Total					116	100

The International Union for Conservation of Nature (IUCN) red list criteria are a globally accepted method of assessing species extinction risk, and countries around the world are adapting these criteria for domestic use [48]. The IUCN global species conservation assessments are based on objective criteria which classify taxa into nine clearly defined categories. Of them, three categories concern species with higher extinction risk: Critically Endangered (CR), Endangered (EN), and Vulnerable (VU). The other categories refer to Extinct (EX) or Extinct in the Wild (EW) species; species that are close to become threatened (Near Threatened – NT); species that do not qualify for threatened nor NT categories (Least Concern – LC); species without sufficient data available for assessment (Data Deficient – DD); and Not Evaluated species (NE) [49]. Out of 36 different fish species found in the river during the present study, 2 (i.e. 5.56%) species were listed in the EN category, 4 (11.11%) species were listed in VU category, another 2 (5.56%) species were listed in NT category, 1 (2.77%) species was listed in DD category and remaining 27 (75%) species were listed in LC category. There were no species from CR and NE categories [50]. Although three fish species found in this study viz. *Lepicocephalichthys berdmorei*

[31], *Lepidocephalichthys irrorata* [32] and *Channa gachua* [33] were listed in the LC category in IUCN red list, they were found to be locally very rare. The integration of both global and local assessments is essential for effective conservation planning and management. By recognizing and addressing the nuances of species distributions and abundance, we can better prioritize conservation actions to ensure the long-term viability of fish populations in the Nambol River and similar ecosystems worldwide.

Shannon diversity index based on data found during the study was calculated as 2.065indicating moderate diversity of the fishes in the river. Shannon's equitability (E_H) index which was used to measure the evenness of species was found to be 0.78.

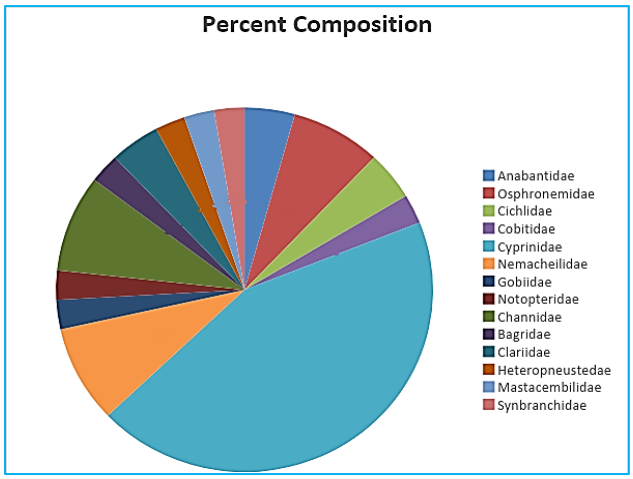

Fig 1 Diagrammatic representation of family-wise percent composition of fish

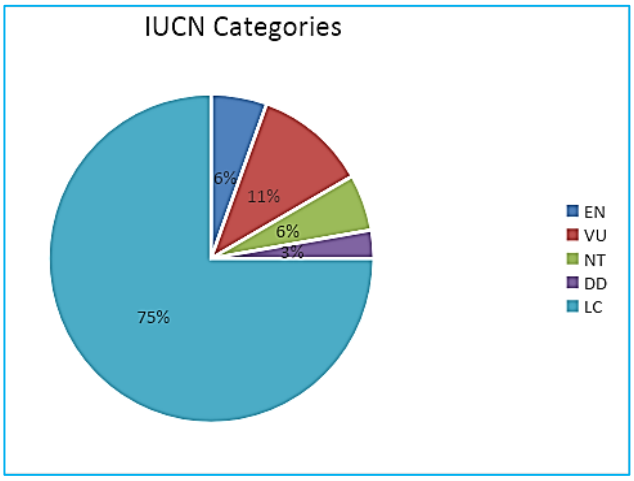

Fig 2 Diagrammatic representation of percentage contribution of species under IUCN (2023-1) categories

Fig 3 *Pethia manipurensis*

Fig 4 *Lepidocephalicthys berdmorie*

Fig 5 *Lepidocephalicthys irrorata*

Fig 6 *Channa gachua*

CONCLUSION

A total of 36 different fish species belonging to 8 orders, and 14 families were found and identified during the study period from 4 different study sites of Nambol River, Manipur. Out of these 36 identified species, 2 (i.e. 5.56%) species were listed in the EN category, 4 (11.11%) species were listed in VU category, another 2 (i.e. 5.56%) species were listed in NT category, 1 (2.77%) species was listed in DD category and remaining 27 (75%) species were listed in LC category. There were no species from CR and NE categories. Aquatic ecosystems contain three sub-systems. The first involves the physico-chemical sub-system, the second sub-system includes all the biota and the third depending upon the productivity is a social sub-system and determines what the problems are, what has caused them and what their solutions ultimately will be. So, the authors feels that the findings of this study will help in future aquatic research in general and also will help in making strategy for future conservation and management plan of this river and its ichthyofauna in particular. By comprehensively understanding these dynamics, we believe our findings will serve as a valuable resource for future aquatic research endeavors. Furthermore, the insights gleaned from this study can inform the development of robust conservation and management strategies tailored to safeguard the biodiversity of the Nambol River and its ichthyofauna. Through concerted efforts informed by scientific inquiry, we can strive towards the preservation and sustainable management of this vital natural resource for generations to come.

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