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Ichthyofaunal Diversity of Small Indigenous Fish Species in the Freshwater Ecosystems of Malda District, West Bengal, India

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Abstract:

The present study had been conducted to document the ichthyofaunal diversity of small indigenous fish species (SIFs) inhabiting the freshwater ecosystems of Malda district, West Bengal, India. Small indigenous fish species are ecologically significant components of freshwater ecosystems and had been recognized as vital sources of nutrition and livelihood for rural populations. Extensive field surveys had been carried out across rivers, ponds, beels, canals, and seasonal water bodies of Malda district during the study period. Standard sampling techniques were employed, and fish specimens were identified using established taxonomic keys. The study had recorded a rich diversity of SIFs belonging to multiple orders, families, and genera, with Cypriniformes dominating the assemblage. Diversity indices, including Shannon–Wiener and Simpson indices, had indicated moderate to high species diversity across study sites. The findings had highlighted the ecological importance, nutritional value, and conservation concerns of SIFs in the region. Anthropogenic pressures such as habitat degradation, pollution, overfishing, and the introduction of exotic species were identified as major threats. The study had emphasized the need for region-specific conservation strategies and sustainable fisheries management to protect these valuable bioresources.

Keywords: *Small indigenous fish species, ichthyofaunal diversity, freshwater ecosystem, Malda district, conservation, West Bengal.*

1. Introduction

Freshwater ecosystems constitute less than one percent of the Earth's surface, yet they support nearly half of all known fish species worldwide. These ecosystems provide indispensable ecological services, including nutrient cycling, water purification, flood regulation, and the sustenance of biodiversity that supports both aquatic and terrestrial food webs. Globally, freshwater fishes have been recognized as one of the most threatened vertebrate groups due to rapid environmental changes driven by anthropogenic activities. Habitat degradation, hydrological alterations, pollution, overexploitation, climate change, and biological invasions have collectively contributed to unprecedented declines in freshwater fish diversity across continents.

Within this global framework, small indigenous fish species (SIFs) have gained increasing scientific and policy attention over the last two decades. SIFs generally refer to native freshwater fish species that attain a relatively small adult size, usually below 25 cm in length, and often complete their life cycles within localized aquatic habitats. Despite their modest size and limited commercial visibility, SIFs have been recognized as ecologically irreplaceable components of freshwater ecosystems. They play critical roles as

primary and secondary consumers, linking lower trophic levels such as plankton and benthic invertebrates to higher trophic predators including larger fishes, birds, and reptiles. Their functional diversity contributes substantially to ecosystem resilience and stability.

At the global level, studies from Asia, Africa, and Latin America have emphasized the importance of SIFs in sustaining inland fisheries and rural livelihoods. In many developing countries, small-scale inland fisheries dominated by SIFs provide a major source of animal protein and micronutrients for nutritionally vulnerable populations. Research conducted in Bangladesh, Cambodia, Laos, and parts of sub-Saharan Africa has demonstrated that SIFs contribute disproportionately to dietary intake of vitamin A, calcium, iron, zinc, and essential fatty acids compared to larger cultured fishes (Roos et al., 2003; Mohanty et al., 2013). Because these fishes are commonly consumed whole, their nutritional bioavailability is significantly higher, making them crucial in addressing hidden hunger and micronutrient malnutrition.

From a conservation perspective, SIFs have increasingly been recognized as sensitive indicators of freshwater ecosystem health. Their short life cycles, habitat specificity, and dependence on natural hydrological regimes make them particularly vulnerable to environmental disturbances. Consequently, changes in SIF community composition often reflect early ecological degradation, long before impacts become evident in larger, more resilient fish species. International conservation frameworks have therefore highlighted the need to integrate SIFs into biodiversity assessments, fisheries management plans, and ecosystem-based conservation strategies.

India represents one of the global centers of freshwater fish diversity, harboring more than 800 native freshwater fish species. Of these, nearly half have been categorized as small indigenous fish species. The diversity of India's freshwater ichthyofauna has been shaped by its complex biogeography, monsoonal hydrology, and extensive riverine and floodplain networks. Small indigenous fishes form the backbone of traditional inland fisheries across the country, particularly in floodplain wetlands, seasonal ponds, rice fields, and small streams. Despite their widespread occurrence and socioeconomic importance, SIFs in India have historically received limited scientific attention compared to commercially important major carps and exotic aquaculture species.

National-level studies have increasingly highlighted the declining status of SIF populations across Indian freshwater ecosystems. Wetland reclamation, river regulation through dams and embankments, pollution from agricultural and urban sources, indiscriminate fishing practices, and the introduction of exotic species such as Oreochromis niloticus and Cyprinus carpio have been identified as major drivers of decline. Several authors have emphasized that the erosion of SIF diversity not only threatens biodiversity but also undermines food security, livelihood resilience, and cultural traditions associated with small-scale fisheries (Barman, 2007; Islam et al., 2023).

Eastern India, particularly the state of West Bengal, occupies a prominent position in the national freshwater fisheries landscape. The state is endowed with an extensive network of rivers, floodplain wetlands, oxbow lakes, ponds, and irrigation canals. West Bengal has consistently ranked among the leading inland fish-producing states of India, with small indigenous fishes forming an integral part of capture fisheries and subsistence fishing practices. Previous ichthyofaunal studies conducted in various districts of the state have documented high levels of freshwater fish diversity; however, these investigations have largely focused on overall species inventories or ornamental fishes, often overlooking the ecological and nutritional significance of SIFs.

Malda district, located in the northern part of West Bengal, represents a unique freshwater landscape influenced by the Ganga–Mahananda river system. Seasonal flooding, sediment deposition, and dynamic hydrological conditions have historically supported diverse fish assemblages, including numerous small indigenous species. The livelihoods of a substantial proportion of rural households in Malda remain closely

linked to inland fisheries, particularly the harvesting of small fishes from rivers, beels, and ponds. Despite this dependence, systematic and quantitative assessments of SIF diversity, distribution, and habitat associations in the district have remained limited.

In this context, the present study had been designed to provide a comprehensive assessment of the ichthyofaunal diversity of small indigenous fish species in the freshwater ecosystems of Malda district, West Bengal. By documenting species composition, diversity patterns, and relative abundance across habitat types, the study aimed to generate baseline data essential for biodiversity conservation, sustainable fisheries management, and future ecological monitoring. The findings were expected to contribute to the growing body of national and global literature emphasizing the need to recognize, conserve, and sustainably utilize small indigenous fish species as vital components of freshwater socio-ecological systems.

2. Materials and Methods:

2.1 Study Area: The study had been conducted in Malda district, West Bengal, India, which lies between 24°40′N to 25°32′N latitude and 87°45′E to 88°28′E longitude. The district is characterized by a tropical monsoon climate with distinct summer, monsoon, and winter seasons. Major freshwater habitats include the Ganga and Mahananda rivers, their tributaries, floodplain wetlands (beels), ponds, tanks, canals, and seasonal water bodies.

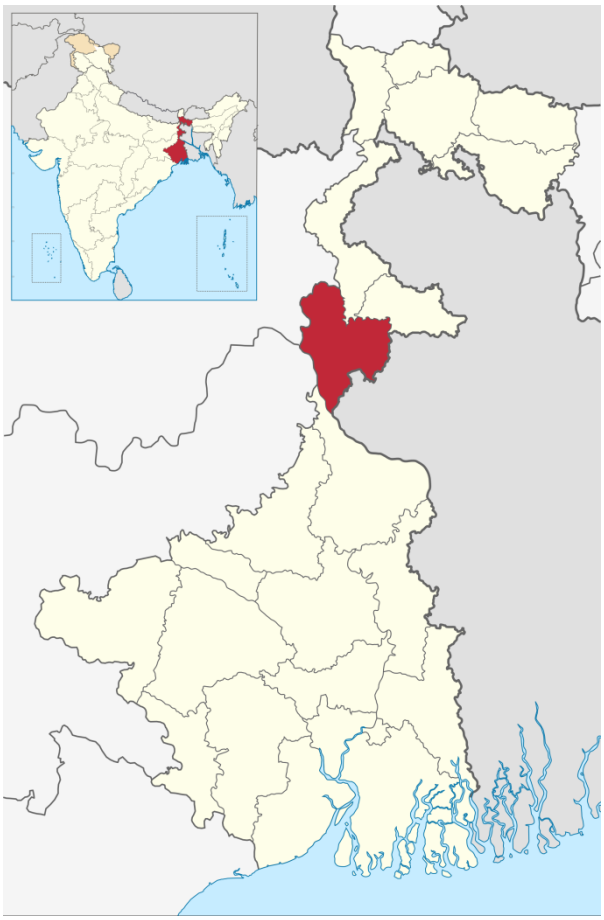

Fig. 1. Study area

2.2 Sampling Design and Data Collection : Field surveys had been carried out across selected freshwater habitats using a stratified random sampling approach. Sampling sites were categorized based on habitat type, and representative locations were selected from each category. Fish samples had been collected using cast nets, gill nets, drag nets, and hand nets, following ethical and standardized sampling protocols.

Captured specimens had been temporarily preserved in ice and later fixed in 10% formalin for laboratory identification. Information on habitat type, water depth, and associated vegetation had been recorded during sampling. Local fishermen were interviewed to obtain supplementary information on species occurrence, seasonal availability, and perceived population trends.

2.3 Species Identification: Fish specimens had been identified to species level using standard taxonomic keys and published literature (Sen, 1992; Barman, 2007). Scientific names were verified using updated taxonomic databases to ensure accuracy.

2.4 Data Analysis: Species composition and abundance data had been analyzed to calculate diversity indices. The Shannon–Wiener diversity index (H′), Simpson's dominance index (D), and species richness (S) had been computed for each habitat type. Relative abundance of species was calculated as a percentage of total catch. Data were tabulated and interpreted to assess patterns of diversity and dominance.

3. RESULTS

3.1 Species Composition and Taxonomic Diversity: The ichthyofaunal survey had documented a total of 32 small indigenous fish species from the freshwater ecosystems of Malda district. These species were distributed across 7 orders, 14 families, and 24 genera, reflecting considerable taxonomic diversity within a relatively confined geographical region. The order Cypriniformes had emerged as the most dominant group, accounting for the highest number of species, followed by Perciformes, Siluriformes, Synbranchiformes, Beloniformes, and Anabantiformes.

Cyprinidae represented the most speciose family, contributing a substantial proportion of the recorded species. Commonly encountered cyprinids included *Amblypharyngodonmola, Puntiussophore, Puntiusticto, Esomusdanricus*, and *Osteobramacotio*. The dominance of Cyprinidae was indicative of the adaptive success of this family in floodplain-driven freshwater systems. Other families such as Ambassidae, Bagridae, Mastacembelidae, Channidae, and Anabantidae were represented by fewer but ecologically significant species.

Table 1. Taxonomic composition of small indigenous fish species recorded from Malda district

Order	Family	Species Recorded
Cypriniformes	Cyprinidae	*Amblypharyngodonmola, Puntiussophore, Puntiusticto, Esomusdanricus, Osteobramacotio*
Perciformes	Ambassidae	*Parambassisranga*
Siluriformes	Bagridae	*Mystusvittatus, Mystustengara*
Synbranchiformes	Mastacembelidae	*Macrognathuspancalus*
Beloniformes	Belonidae	*Xenentodoncancila*
Anabantiformes	Anabantidae	*Anabas testudineus*

3.2 Habitat-wise Distribution of Species; Habitat-wise analysis had revealed notable variation in species composition across rivers, beels, ponds, and canals. Floodplain wetlands (beels) supported the highest species richness, followed by ponds and riverine habitats. Seasonal water bodies and canals exhibited comparatively lower species richness but served as important refugia during specific phases of the hydrological cycle.

Beels were characterized by slow-moving or stagnant water, abundant macrophyte cover, and high organic productivity, conditions that favoured the proliferation of small-bodied fishes. Species such as *Amblypharyngodonmola, Puntiussophore, Parambassisranga*, and *Macrognathuspancalus* were consistently recorded from these habitats. Riverine habitats, particularly stretches of the Ganga and Mahananda, supported species adapted to flowing water conditions, including *Esomusdanricus* and *Xenentodoncancila*.

3.3 Species Richness and Diversity Indices : Quantitative analysis of species diversity had been conducted using standard ecological indices. Species richness values ranged from 18 in riverine habitats to 25 in beels, indicating the importance of wetland ecosystems for maintaining SIF diversity. The Shannon–Wiener diversity index (H′) values varied between 2.11 and 2.78, suggesting moderate to high diversity across habitats.

Higher Shannon index values recorded in beels and ponds reflected greater habitat heterogeneity and resource availability. Simpson's dominance index (D) values remained relatively low across all habitat types, indicating the absence of strong dominance by a single species and a relatively even distribution of individuals among species.

Table 2. Diversity indices of small indigenous fish species across habitat types

Habitat Type	Species Richness (S)	Shannon–Wiener Index (H′)	Simpson's Index (D)
Rivers	18	2.11	0.18
Beels	25	2.78	0.12
Ponds	22	2.54	0.15
Canals	14	1.96	0.21

3.4 Relative Abundance Patterns: Relative abundance analysis had indicated that a small number of species contributed a disproportionately large share of the total catch. *Amblypharyngodonmola* emerged as the most abundant species across all habitat types, followed by Puntiussophore and *Esomusdanricus*. These species exhibited broad ecological tolerance, rapid reproductive cycles, and the ability to exploit diverse food resources.

Moderately abundant species included *Parambassisranga, Mystusvittatus*, and *Macrognathuspancalus*, while species such as *Xenentodoncancila* and *Anabas testudineus* were recorded less frequently. The presence of both common and relatively rare species highlighted the ecological complexity of Malda's freshwater systems.

3.5 Seasonal Variation in Species Occurrence: Seasonal analysis had revealed distinct fluctuations in species abundance and distribution. Monsoon months were associated with increased species richness and abundance, particularly in beels and floodplain-connected habitats. Seasonal flooding facilitated lateral connectivity between rivers and wetlands, enabling fish migration, breeding, and dispersal.

During the post-monsoon and winter seasons, species richness declined in temporary water bodies due to habitat contraction. However, permanent ponds and deeper beels functioned as dry-season refuges, supporting residual populations of several SIFs. Seasonal drying and water abstraction were observed to disproportionately affect smaller habitats, potentially increasing mortality and reducing recruitment.

3.6 Conservation Status and Observed Threats: Field observations and local fisher interviews had indicated declining population trends for several species, particularly those dependent on floodplain

connectivity. Habitat degradation due to wetland encroachment, indiscriminate fishing of juveniles, and pollution from agricultural runoff were identified as major threats. The introduction of exotic fishes was perceived by local communities as an emerging pressure on native SIF populations.

The overall results underscored the ecological importance of small indigenous fish species in Malda district and highlighted the need for habitat-specific conservation and management interventions.

4. Discussion:

The present study had revealed considerable ichthyofaunal diversity of small indigenous fish species in the freshwater ecosystems of Malda district. The dominance of Cypriniformes was consistent with earlier studies conducted in different parts of West Bengal (Paul & Chanda, 2015; Basu et al., 2012). The relatively high diversity recorded in beels and ponds underscored the importance of floodplain wetlands as biodiversity hotspots.

The nutritional importance of frequently occurring species such as Amblypharyngodonmola and Parambassisranga had been well documented in previous studies (Roos et al., 2003; Mohanty et al., 2013). Their widespread availability in Malda district highlighted their potential contribution to local food security.

Despite their importance, SIF populations were found to be under increasing pressure. Habitat loss due to wetland encroachment, agricultural runoff, pollution, and the introduction of exotic fishes had adversely affected species abundance. Similar threats had been reported from other regions of India (Islam et al., 2023).

5. Conservation Implications: The findings had emphasized the urgent need for conservation-oriented management of small indigenous fish species in Malda district. Protection of wetlands, regulation of fishing practices, and awareness programs for local communities were identified as essential measures. Promotion of small-scale aquaculture of selected SIFs could reduce pressure on wild stocks while enhancing livelihood opportunities.

6. **Conclusion:** The study had provided a comprehensive account of the ichthyofaunal diversity of small indigenous fish species in Malda district, West Bengal. The presence of diverse and nutritionally important species underscored the ecological and socioeconomic value of SIFs. Effective conservation strategies and sustainable management practices were deemed necessary to ensure the long-term survival of these valuable freshwater resources.

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