

Morphological Identification and Variation of Fish Species in the Tapti River at Betul District of Madhya Pradesh Using Geometric Morphometrics

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ABSTRACT: This study examines the morphological identification and variation of fish species in the Tapti River, located in Betul District, Madhya Pradesh, through geometric morphometric techniques. As a crucial freshwater ecosystem in India, the Tapti River is home to diverse fish populations that are increasingly threatened by pollution, habitat degradation, and overfishing. This research addresses the urgent need to document fish diversity within such impacted ecosystems. By selecting ten strategic sampling sites, approximately 100 specimens will be collected across summer, winter, and rainy seasons. Geometric morphometric analysis will quantify variations in key morphological traits, including total length, head length, and body depth, facilitating accurate species identification. Preliminary findings suggest the presence of various species, such as *Channa punctata* and *Cyprinus sophore*, reflecting the ecological richness of the river. The assessments with morphological analyses, this research will elucidate the relationships between fish shape, size, and their adaptive strategies in response to varying environmental pressures. Ultimately, these insights will inform vital conservation strategies aimed at preserving freshwater fish biodiversity and promoting sustainable management of aquatic resources in India, ensuring the ecological balance and resilience of this important river ecosystem.

Keywords: Fish Biodiversity, Tapti River, Geometric Morphometrics, Morphological Variation, Freshwater Ecosystems.

INTRODUCTION

India is recognized as one of the world's mega diverse nations, boasting an array of biological species and two major biodiversity hotspots: the Western Ghats and the Eastern Himalayas, which are among the top eight essential hotspots globally (Raghunathan *et al.*, 2012). Among the myriad of life forms, fish diversity constitutes a significant component of aquatic ecosystems. Freshwater fish represent one of the most diverse groups of vertebrates; however, they are also among the most threatened. As reported, freshwater fish species face considerable risks, with numerous factors contributing to their decline, including reduced inter-basin movement due to limited habitats, overfishing, pollution, deforestation, land erosion, and other human interventions (Schofield *et al.*, 2018). These threats to biodiversity underscore the critical need for understanding and conserving freshwater ecosystems. The Tapti River, a vital freshwater resource in Madhya Pradesh, flows approximately 724 km from its origin near the Multai Reserve Forest to the Arabian Sea. This river is essential for local communities and diverse flora and fauna. Nevertheless, the river faces various environmental pressures that may affect its fish populations. Understanding the limnological status is fundamental to assessing fish diversity in such

ecosystems, as it directly affects the quality of habitats and available resources (Schofield *et al.*, 2018). The significance of biodiversity extends beyond aesthetic value; it encompasses crucial ecological, genetic, and cultural dimensions that sustain ecosystem services (Ferguson & Zhang 2002). However, a noted reduction in fish biodiversity has been documented due to factors such as destructive fishing practices, water pollution, and habitat degradation (Naylor *et al.*, 2000). Historical accounts, such as those by Francis Day (1875–1878), laid the groundwork for cataloging India's freshwater fish, but updates are needed to reflect current biodiversity status.

Studies show that there are currently 227 Indian freshwater fish species classified as threatened according to the National Bureau of Fish Genetic Resources (NBFGR) (CAMP workshop Molur, 1998). Research indicates that the diversity of life on Earth is undergoing significant changes, with many species facing extinction. An example of this includes research on the Sone River, where a study found that out of 89 fish species recorded, several previously known species were no longer present while new species were identified (Joshi *et al.*, 2014).

The present study aims to evaluate the morphological variation and identification of fish species in the Tapti

River basin of Betul District, Madhya Pradesh. By employing geometric morphometric techniques, this research seeks to contribute to the understanding of fish biodiversity in this vital ecosystem, elucidating the relationship between morphological traits and environmental conditions, ultimately supporting ongoing conservation efforts and resource management in the region.

MATERIAL AND METHODS

Study Area: The study was conducted in the Tapti River at various locations in Betul District, Madhya Pradesh, India. This river serves as a vital ecosystem and is characterized by diverse habitats supporting a wide range of fish species. Ten strategic sampling sites were selected based on previous studies and ecological significance, ensuring a comprehensive representation of the river's fish diversity.

Sample Collection: Fish specimens were collected using standard fishing techniques, such as seine nets and gill nets, during the three main seasons of India: summer (March to June), monsoon (July to September), and winter (October to February). The sampling was carried out during morning hours, between 8:00 AM and 10:00 AM, to optimize the collection process. A total of approximately 100 individuals of various fish species were collected, with the aim of adequately representing the diversity of the fish community in the Tapti River basin.

Collected specimens were preserved in 10% formalin solution for transportation to the laboratory. Later, they

were transferred to ethanol (70%) for long-term preservation. Appropriate permissions were obtained from the local authorities and ethical considerations were adhered to throughout the study.

Geometric Morphometrics Analysis: For the geometric morphometric analysis, the collected fish specimens were subjected to a series of morphological measurements.

The following parameters were recorded: Total Length (TL), Standard Length (SL), Head Length (HL), Body Depth (BD), Length of Caudal Peduncle (LCP), Depth of Caudal Peduncle (DCP), Dorsal Fin Base Length (DFBL), Dorsal Fin Length (DFL).

Morphometric data were captured using digital calipers to ensure precision, and the measurements were recorded in millimeters.

RESULTS AND DISCUSSION

The results of this study are focused on the morphological variation and identification of fish species in the Tapti River, using geometric morphometric techniques (Mojekwu & Anumudu 2015). A total of 87 fish specimens were collected from 7 sampling sites along the river, and several species were identified based on their morphological characteristics (Fig. 1). The geometric morphometric analysis provided insights into the differences among species, demonstrating significant variation in shape and size (Santos *et al.*, 2019).

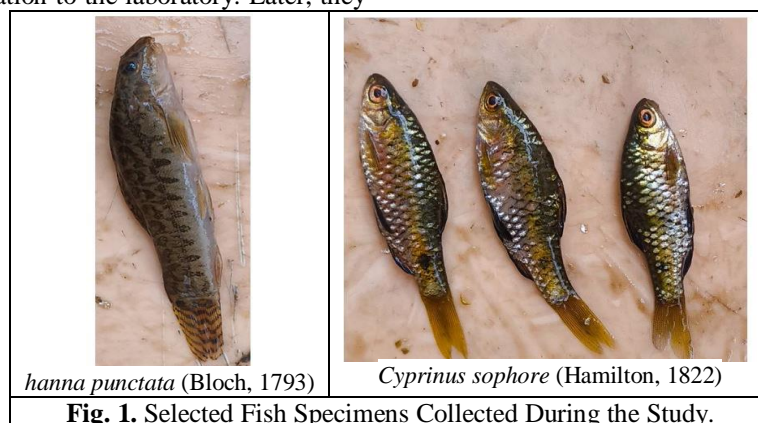


Fig. 1. Selected Fish Specimens Collected During the Study.

Table 1: Morphometric Measurements of Fish Species Identified in the Tapti River Using Geometric Morphometrics Analysis.

Fish Species	Total Length (mm)	Standard Length (mm)	Head Length (mm)	Body Depth (mm)	Caudal Peduncle Length (mm)	Caudal Peduncle Depth (mm)	Dorsal Fin Base Length (mm)	Dorsal Fin Length (mm)
<i>Channa punctata</i>	250	200	45	55	20	10	30	40
<i>Cyprinus sophore</i>	290	240	48	60	24	11	34	44
<i>Channa striata</i>	280	230	48	60	22	11	32	42
<i>Garra amandalei</i>	150	120	35	40	15	8	20	25
<i>Mystus tengara</i>	200	160	40	50	18	9	25	30
<i>Cyprinus carpio</i>	290	240	50	58	23	11	33	43

The following table summarizes the fish species identified during the study with high prevalence, along with their respective morphometric measurements as determined through geometric morphometric analysis. The geometric morphometric analysis revealed distinct shape variations among the identified species. For instance, *Channa punctata* displayed a broader body depth (Islam *et al.*, 2020) when compared to *Garra annandalei*, which exhibited a more streamlined shape. The PCA results indicated that the first two principal components explained a significant portion of the morphological variance, with groups of species clustering based on their shape characteristics. The findings from this study highlight the importance of geometric morphometrics in understanding the biodiversity of fish species in the Tapti River (Radhakrishnan and Madhusoodana 2006). The significant morphological differences observed among species may reflect adaptations to specific ecological conditions within the riverine habitat. The results align with previous research that highlights the critical role of environmental factors in shaping fish morphology and diversity (Kavya *et al.*, 2023). Moreover, the data underline the pressing need for conservation and management efforts aimed at preserving the rich biodiversity of freshwater ecosystems in India, particularly as these environments face increasing anthropogenic pressures. Future research should continue to explore the genetic diversity of these fish species in conjunction with morphological studies to facilitate comprehensive conservation strategies tailored to the unique ecological contexts of the Tapti River and similar habitats.

CONCLUSIONS

This study successfully identifies key fish species in the Tapti River and demonstrates the utility of geometric morphometrics as a tool for assessing morphological variation. The results contribute to the broader understanding of freshwater fish biodiversity, informing efforts to preserve and manage these vital resources amidst ongoing environmental challenges. Further investigations are warranted to explore the interplay between genetic and morphological diversity in these species.

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Conflict of Interest. None.

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