

Systematic Diversity, Population Abundance and Ecological Significance of Shellfish Fauna in Bihar India

Abstract

Freshwater shellfishes, despite their ecological and economic importance, remain poorly studied in many parts of India, particularly in the northeastern region of Bihar. This study was undertaken to document the taxonomic diversity, abundance, and economic value of shellfishes in the Mahananda-Koshi basin. Shellfishes were collected from both lentic and lotic water bodies using hand-picking and dredging techniques. Systematic identification was carried out using standard taxonomic keys and reference literature. Species were categorized into three groups—abundant, common, and rare—based on their frequency of occurrence. In addition, market surveys were conducted to assess the economic significance of different taxa. A total of 24 taxa, including gastropods, bivalves, and crustaceans, were recorded. Out of the 24 taxa recorded, the most abundant species group accounted for 16.7%, whereas the least abundant (rare) group represented 20.8% of the total diversity. Market analysis revealed that *M. gangeticum* and other small-sized *Macrobrachium* species had the highest economic value, followed by *Paratelphusa* and edible gastropods (*Pila* and *Bellamya*). Overall, the study highlights the rich ecological diversity and considerable economic potential of freshwater shellfishes in the region, underscoring the urgent need for their sustainable exploitation, management, and conservation to maintain ecological balance and support rural livelihoods.

Keywords: Shellfish diversity, abundance, economic value, molluscan, crustacean

Introduction

Shellfishes represent an ancient and highly heterogeneous group, exhibiting remarkable diversity across freshwater ecosystems (Strong *et al.*, 2008). Biodiversity is the number of different species represented in a particular community. Freshwater shellfishes perform diverse functional roles, providing ecosystem services that are vital to rural human settlements (Sajan *et al.*, 2021; Khatoon & Kumari, 2025). They contribute significantly in maintaining ecological equilibrium by facilitating nutrient cycling, sediment turnover, and serving as reliable bioindicators of water quality (Vaughn & Hakenkamp, 2001; Lydeard *et al.*, 2004). In rural Bihar, shellfishes hold notable socio-economic importance. They serve as valuable sources of protein, traditional medicine, and livelihoods for local communities Patel & Kurhe, (2023); Prasad & Sinha, (2024). Additionally, they form a crucial component of the ethnomedicinal, food chain, transferring energy and nutrients from phytoplankton, macrophytes, and zooplankton to fishes, amphibians, reptiles, birds, mammals, and other wildlife species (Subba Rao, 1989; Jamir *et al.*, 2005; Prabhakar & Roy, 2009; Ghosh, *et al.*, 2016; Prasad *et al.*, 2023; Chutia & Pegae, 2017; Jadav *et al.*, 2023; Ghosh, 2022; Hasan *et al.*, 2024).

However, the diversity of freshwater shellfishes is increasingly threatened by anthropogenic pressures such as overharvesting, habitat degradation, and pollution (Dudgeon *et al.*, 2006; Singh *et al.*, 2012; Prasad & Sinha, 2024; Dey, 2017; Prasad *et al.*, 2025; Gupta, *et al.*, 2025). Considerable research has been conducted on the taxonomy, biology, ecology, and behavior of molluscs and crustaceans in the Indian subcontinent (Prasad, 2005; Bhattacharya *et al.*, 2014; Dey, 2017; Chandrawansi *et al.*, 2023; Jha *et al.*, 2014; Navan & Kathv, 2019; Sharma *et al.*, 2012; Athyaman & Rajendran, 2014; Susilo *et al.*, 2020; Jayachandran, 2005; Salathia and Langer 2022). Additional stressors, such as climate change, water scarcity, and the unregulated use of pesticides particularly during the cultivation of fox nuts (*Euryale ferox*) and water chestnuts (*Trapa natans*) have also contributed to a marked decline in snail populations and production (Prasad, 2023; Prasad & Sinha, 2024). Despite shellfish harvesting being a traditional practice in northeastern Bihar, and certain species enjoying high market demand, systematic documentation of their diversity, relative abundance, and economic significance remains scarce.

Therefore, present study aims to identify as well as categorize freshwater shellfish species in the region based on their relative abundance as a consequence to assess their economic value in rural and urban markets. This documentation is expected to strengthen the knowledge base required for the sustainable management and conservation of shellfish resources.

Materials and Methods

Study Area

The study was conducted in the region between the Mahananda and Koshi river basins of Bihar, covering five districts: Purnea, Madhepura, Supaul, Katihar, and Khagaria. These northeastern districts are characterized as flood-prone areas with extensive wetlands, including ponds, *makhana* (*Euryale ferox*) and *singhara* (*Trapa natans*) fields, paddy fields, and riverine habitats, all of which support diverse shellfish populations (Prabhakar & Roy, 2008; Jha, 2009). Fieldwork was carried out over two consecutive years (January 2020-December 2022) to document the systematic variation and taxonomic diversity of freshwater shellfishes. Sampling was performed across lentic and lotic habitats, and species were categorized into abundance groups (abundant, common, and rare) based on frequency of occurrence. In parallel, market surveys were conducted in both rural and urban fish markets through interviews and on-spot enquiries. Market prices were recorded in Indian Rupees per kilogram. These data were used to assess the economic value of different taxa. Finally, the combined ecological and economic information was visualized to highlight the dual importance of shellfishes in the study region (Figure 1).



Figure:1. (a), Marketing of shellfish, (b). Shellfish museum at BPSAC, Purnea, (c), the Saura river, Purnea, (d) Catching of shellfish by fishermen & women in Purnia wetland

Sampling and Identification

Shellfishes were collected from lentic and lotic habitats using hand-picking, dredging, and netting methods, depending on habitat type. After that instantly representative specimens

were preserved in 5% formalin and transported to the Shellfish Biodiversity Laboratory at Bholu Paswan Shastri Agricultural College (BPSAC), Purnea, Bihar (Atsawe *et al.*, 2009). Systematic identification (external morphology, shell arrangement etc) was carried out using standard pictorial keys and reference literature (Subba Rao & Dey, 1989; Prasad, 2005; Jayachandran, 2005; Sharma *et al.*, 2012; Prasad *et al.*, 2012; Ramakrishna *et al.*, 2010; Athiyaman and Rajendran, 2014). Relative abundance of species was categorized as Abundant (+++): frequently encountered, forming large populations. Common (++): moderately encountered. Rare (+): infrequently encountered, were recorded sporadically during surveys (Jha, 2009). The collected and identified specimens were deposited in the museum of the Department of Entomology, BPS Agricultural College, Purnea, Bihar (Figure 1b).

Data Analysis

All the respective data were analysed as well as generated for ease of understanding in Microsoft Excel 2010 edition. Relative abundance categories were expressed as simple tabular and market data on price were summarized using descriptive statistics, and mean values were reported in Rs./ Kg. Comparisons of market value across taxa were presented using bar diagrams.

Results

In the present study, a total of 24 shellfish taxa were recorded and identified from the wetlands and riverine habitats of northeastern Bihar detail presented in the Tables (1 & 2). Among these, 7 species were categorized as abundant, 9 as common, and 8 as rare. The equitable distribution taxa included *Bellamya bengalensis* (race & typica), *Pila globosa*, *Pila virens*, *Lymnaea acuminata*, *Lymnaea luteola*, *Melanoides lineatus*, *Indoplanorbis exustus*, *Novaculina gangetica*, *Lamellidens marginalis*, *Macrobrachium* spp., and the crab *Paratelphusa spinigera*. The genus *Bellamya* emerged as the most evenness in terms of abundance, followed by *Lymnaea* and *Pila*. Crustaceans were represented by medium and small-sized *Macrobrachium* species (abundant) and the freshwater crab *Paratelphusa spinigera* (common). A single large-sized freshwater prawn, *Macrobrachium gangeticum* (200 mm), was rarely encountered in the lower stretch of the Koshi river system during the rainy season. In contrast, medium-sized prawns such as *M. gandaki* (75 mm) and *M. tiwari* (85 mm) were classified as common, while smaller-sized *M. lamerri* (80 mm) was abundant in the wetland ecosystems.

Market surveys revealed a marked variation in shellfish prices between rural and urban areas (Table 3 and Figure 2). Edible gastropods such as *Pila* and *Bellamya* were priced at ₹50-100/kg in rural markets, compared to ₹100-200/kg in urban markets. Crustaceans such as crabs (*Paratelphusa*) were sold for ₹75-100/kg in rural markets and ₹120-200/kg in urban markets.

Medium and small-sized prawns (*Macrobrachium spp.*) were priced at ₹200-300/kg in rural areas and ₹300-400/kg in urban areas. The large freshwater prawn *M. gangeticum*, available only occasionally during the rainy season, fetched the highest price, ranging from ₹500-600/kg in rural markets to ₹500-800/kg in urban markets.

Table 1. Systematic variances and abundance of shellfish fauna in Bihar

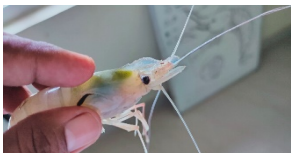



S. N.	Species / Genera	Taxonomical Features	Relative abundance		
1	<i>Bellamya bengalensis</i> (Race)	The shell is thick, globosely turbinate with reddish-brown transverse stripes, bearing 4–5 regularly increasing convex whorls and spaced spiral striae.	+++		
2	<i>Bellamya bengalensis typica</i> (Lamarck)	These smaller shell is smooth, thin, and banded showing 2 dark green or rusty brown bands on the 4th whorl, 5-7 on the body whorl with 5 convex whorls and an operculum elongated towards the body whorl.	+++		
3	<i>Pila globosa</i> (Swainson, 1822)	These shell is large, thick, and globose, spirally coiled around the columella, with 3–4 well-developed, less-inflated whorls and a slightly depressed spire.		++	
4	<i>Pila Virens</i> (Lamarck)	It is smaller than <i>P. globosa</i> , with the spire more strongly depressed to about one-fourth of the shell's total length.		++	
5	<i>Achatina fulica</i> (Bowdich)	These shell is elongated, thick, and light horny in colour, with six spire whorls and an oval, elongate body whorl; the operculum is absent, and in adults, the columella and whorls are whitish with brown bands.	+++		
6	<i>Lymnaea</i> (Pseudosuccinia) <i>acuminata</i>	The shell is light amber in color with four spire whorls; the first four are large, lightly convex, and pointed towards the apex, while the body whorl is the largest, oval, elongated, and without an operculum.	+++		
7	<i>Lymnaea</i> (Pseudosuccinia) <i>luteola</i> (Gray)	These shell is small to medium-sized, oval, thin, and imperforate, usually light amber in color, with four spire whorls, the first three being small and convex.	+++		
8	<i>Melanoides lineatus</i> (Gray)	These shell is less elongated with numerous transverse ridges, having 7–8 slightly convex spire whorls, while the		++	


		body whorl is large, oval, and with a <i>slightly depressed</i> spire.			
9	<i>Melanoides tuberculatus</i> (Muller)	The shell is highly elongated with numerous transverse ridges, having 8–9 convex spire whorls, while the body whorl is small and oval with a <i>strongly depressed</i> spire.		++	
10	<i>Digoniostroma ceraneopoma</i> (Benson)	These shell is small, oval, and conic to elongate, with 4–6 convex spire whorls, and an umbilicus ranging from narrow to wide.			+
11	<i>Indoplanorbis exustus</i> (Deshayes)	The shell is brown, stout, and spirally coiled, sinistral and discoidal with a depressed spire, bearing three spire whorls marked with transverse striations.			+
12	<i>Gyraulus convexiusculus</i> (Hulton)	These shell is small, thin, and transparent, with very fine transverse striations; it is discoidal with whorls rounded to carinate and marked by a spiral ridge.			+
13	<i>Segmentina calathus</i> (Benson)	These shell is small and thin-walled, convex on one side and flat on the other, with the last whorl being wide.			+
14	<i>Corbiculla bensoni</i> (Deshayes)	The shell is dark brown, strongly striated, and triangular, with an outer surface sculptured by concentric ridges and covered with a greenish, shining periostracum; each valve bears two cardinal teeth and serrated lateral teeth.		++	
15	<i>Novaculina gangetica</i> (Benson)	These shell is kidney-shaped, light yellowish-brown, and elongated, with valve margins slightly concave below and a narrower whitish umbo.			+
16	<i>Lamellidens corriamus</i> (Lea)	These shell is strongly inequilateral, large, transverse, and thin, with the left valve bearing one thin cardinal tooth and the right valve two elongated lateral teeth; the umbones are slightly elevated with coarse ridges.		++	
17	<i>Lamallidens marginalis</i> (Lamarck)	These shell is transversely oblong, ovate to oval, with swollen, knoblike umbones positioned near the anterior end of each valve and bearing coarse ridges. It is bottom dweller of freshwater lentic and lotic system and omnivorous in nature.		++	
18	<i>Parreysia favidens</i> (Benson)	These shell is rounded, oval to elliptical, broad, and thick, shorter than <i>Lamellidens</i> ,			+

		with narrowed cardinal teeth and elevated umbones bearing a strong ridge.			
19	<i>Parreysia corrugata</i>	The shell is small, elliptical to round-oval, slightly inequilateral, and smooth, with strong non-lamellar cardinal teeth and prominent, sometimes eroded umbones. It is bottom dweller of freshwater lentic and lotic system and omnivorous in nature.			+

Abundant = +++ Common = ++ Rare = +

Table 2. Taxonomic diversity of Crustacean shellfish fauna and their relative abundance in Bihar

S.N.	Species / Genera	Taxonomical Features	Relative abundance		
1	<i>Macrobrachium gangeticum</i> (Bate) 	Body larger elongated, bilaterally symmetrical, pale yellow with brown in older specimens. Body divided into cephalothorax, abdomen & telson and 19 segments. A pairs of appendages, present in each segment. Maximum sized 200 mm. Rostral formula 9-11/4-6.			+
2	<i>Macrobrachium gandaki</i> (Prasad <i>et al</i> , 2020) Rostral formula 8-10/2-3, maximum sized 75 mm. 	Medium size freshwater prawn, <i>Macrobrachium gandaki</i> Rostrum short and not reaching as far as antennal peduncle, basal crest moderately elevated and distal end directed forwards. The second pair of chelate leg largest, unequal; in which one was very large in size and another small. It is unequal among the all species.		++	
3	<i>Macrobrachium tiwari</i> Rostral Formula- 9-10/2-0. 	Medium size Rostrum elongated reaching up to or beyond antennal scale. The basal crest moderately elevated, distal end directed forwards. The second pereopods was larger and shorter than body length. Sized 85 mm.	+++		
4	<i>Macrobrachium lammerii</i> 	Smaller size, Eco-biology, Food and feeding habit same as <i>M. gangeticum</i> . Rostrum long sword shaped reaching past antennal scale. Basal crest moderately elevated and distal end directed forwards. Rostral formula 8-9/10-12. Maximum sized 80 mm. Second pereopods' was small, larger than others pereopods.	+++		

5	<p><i>Paratelphusa Spinigera</i></p> 	<p>Its body dorso-ventrally compressed and consist of a large, broad cephalothorax and stumpy abdomen. Rostrum absent. antennules and eye stalks are contained in the sockets of carapace. Five pairs of thoracic legs are well developed. Abdomen is reduced and fixed under cephalothorax. Five pairs of thoracic legs are well developed.</p>	+++		
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Abundant = +++ Common = ++ Rare = +

Table 3. Economic importance of edible shellfish species in Bihar

Genera / Species	Local rural market price (Rs/Kg)	Urban market price (Rs/kg)
<i>Pila and Bellamya</i>	50 to 100	100 to 200
<i>Paratelphusa Spinigera</i>	75 to 100	120 to 200
<i>Macrobrachium small size</i>	200 to 300	300 to 400
<i>Macrobrachium gangeticum</i>	500 to 600	500 to 800

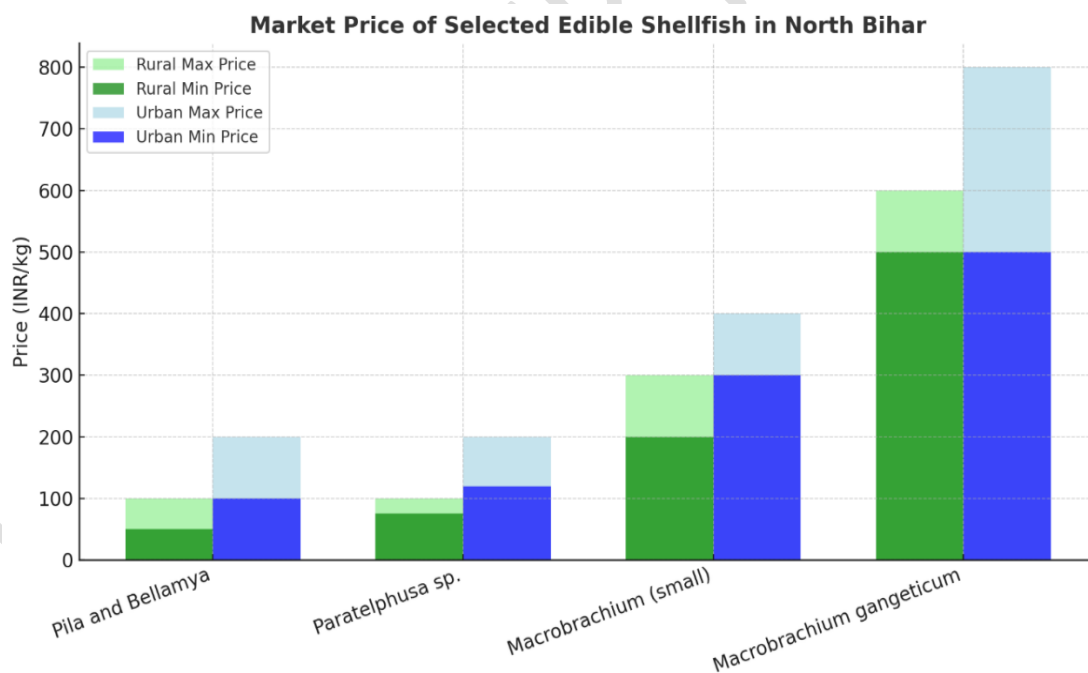


Figure 2. Showing rural & urban market price ranges for edible shellfish species in Bihar

Overall, the findings indicate that shellfishes are closely linked to the socio-economic conditions of local communities, with strong human – shellfish interactions shaping both ecological and economic dynamics. Price differentials between rural and urban sectors highlight the commercial value of certain taxa, particularly *Paratelphusa* and *Macrobrachium*,

which enjoy high market demand across the region. The higher and middle class people are ready to pay higher price of this species.

Discussion

The northeastern region of Bihar, situated between the Mahananda and Koshi river basins, supports a rich assemblage of freshwater shellfishes. The present survey recorded high diversity, with gastropods forming the dominant group, followed by bivalves and crustaceans. Among them, *Bellamya bengalensis*, *Lymnaea acuminata*, *Achatina fulica*, and several *Macrobrachium* species exhibited wide distribution and high abundance, reflecting their adaptability to varied freshwater habitats and resilience to moderate pollution. In contrast, the detection of rare taxa such as *Parreysia favidens* and *Novaculina gangetica* indicates the persistence of specialized microhabitats, which require targeted conservation attention. The hydrobiological characteristics of this region appear favorable for sustaining high taxonomic diversity of shellfishes (Begum and Khan, 2002; Prasad, 2005). Similarly, Prasad *et al.*, 2012; Athiyaman and Rajendra, 2014, reported fresh water prawn diversity in the Ganga and Cauvery ecosystem, while Sajan *et al.* (2021) recorded 276 malacofaunal specimens from Chintamani Kar Bird Sanctuary, West Bengal. Sharma *et al.* (2012) reported 21 taxa of gastropods and bivalves from stagnant water bodies in Patna, Bihar. Dey, 2017; Gupta *et al.*, 2025 have been reported 9 & 7 species of freshwater crabs in the aquatic habitat of Kanwar Lake, Begusarai and Burhi Gandak river Monika oxbow Lake in Bihar respectively. The freshwater crab species diversity observed in the present study appears to be lower than the earlier studies from north Bihar (Yadav *et al.*, 2016; Dey, 2017; Priyadarshini *et al.* 2018; Gupta *et al.*, 2025).

From an ecological perspective, bivalves like *Lamellidens* and *Parreysia* contribute to nutrient cycling and water biofiltration, though their relatively lower abundance may be linked to overharvesting and sedimentation. The presence of the invasive snail *Achatina fulica* is of particular concern, as it poses potential threats of competition to native molluscs. Overall, these findings demonstrate that the hydrobiological conditions of the Mahananda-Koshi basin remain favorable for sustaining molluscan diversity, consistent with earlier reports from the region (Prabhakar & Roy, 2008; Sharma *et al.*, 2017).

In terms of socio-economic dimensions, shellfishes remain integral to the livelihoods of middle- and lower-income communities across both rural and urban areas. Gastropods (*Pila*, *Bellamya*) provide a low-cost protein source and are valued in traditional medicine, (Jha *et al.*, 2014; Panda *et al.*, 2021; Prasad & Sinha, 2024; Ghosh, 2022), whereas *Macrobrachium* prawns command significantly higher market prices, highlighting their disproportionate

economic role despite fewer species being recorded. These preferences also reflect cultural diversity, with consumption patterns varying across Hindu, Muslim, and tribal groups (Jha, 2009).

However, unsustainable practices, particularly the use of pesticides in makhana cultivation, threaten the long-term viability of these populations. Declines in shellfish abundance not only reduce food availability but also impact associated biodiversity, including fish and waterbirds. Thus, while the region demonstrates appreciable molluscan diversity, urgent management strategies are needed to protect rare species, regulate overharvesting, and mitigate agrochemical pollution.

Conclusion

The study reveals high freshwater shellfish diversity in the Mahananda-Koshi basin, with gastropods dominant and rare taxa indicating specialized habitats. Shellfishes play dual roles—supporting ecosystem processes and providing food and income for local communities, with *Macrobrachium* prawns holding the highest economic value. However, unsustainable harvesting, agrochemical use, habitat degradation, and invasive species threaten their persistence. Conservation of rare taxa, eco-friendly farming, community involvement, and stronger policy integration are essential for sustainable management. Overall, the findings provide a baseline for balancing biodiversity conservation with rural livelihood

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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