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Mollusc community in Lotic and Lentic Habitats in the Bhima River Basin, India

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ABSTRACT: A comparative investigation was undertaken to evaluate the diversity and community composition of freshwater molluscs inhabiting lotic and lentic environments within the Bhima River basin, India. Across both habitat types, a total of 18 molluscan species were recorded, encompassing 4 taxonomic orders and 7 families. The most frequently encountered species included *Filopaludina bengalensis* (Viviparidae), *Tarebia lineata* (Thiaridae), and *Idiopoma dissimilis* (Viviparidae). Species richness exhibited a marginally higher value in lotic systems relative to lentic counterparts. Noteworthy was the consistent presence of *Lamellidens corrianus* and *Lamellidens marginalis* (Unionidae) in both habitat types, reflecting their ecological plasticity. Gastropod taxa predominated over bivalves across all surveyed locations. The results further indicate that spatial variation in physico-chemical parameters exerts a significant influence on molluscan community structure. This study enhances the understanding of habitat-specific biodiversity dynamics and the environmental determinants governing mollusc distribution in freshwater ecosystems.

Keywords: Physico-chemical parameters, Jawalgaon Lake, Bhima River, Freshwater molluscs, Lentic, Lotic, Solapur.

INTRODUCTION

Freshwater molluscs are vital constituents of aquatic ecosystems, performing several critical ecological functions that sustain the health and productivity of riverine and lake environments. These invertebrates play an essential role in nutrient cycling by processing organic matter and facilitating the transfer of nutrients through sediment bioturbation, which enriches water quality and supports primary productivity (Ade and Makode 2023, Jadhav *et al*., 2019). Molluscs are widely recognized as bioindicators of water quality due to their sensitivity to fluctuations in environmental conditions such as dissolved oxygen, pH, and pollutant levels. Their presence, abundance, and diversity often reflect the underlying health of aquatic habitats, making them valuable for ecological assessments and conservation monitoring (Chaudhary, 2017 and Saha *et al*., 2017). Furthermore, freshwater molluscs serve as a crucial food source for higher trophic levels, including fish, birds, and other wildlife, thereby supporting complex food webs and maintaining ecosystem balance. Given their susceptibility to environmental changes, molluscan communities respond rapidly to alterations in physico-chemical parameters, which underlines their usefulness for tracking ecological impacts of pollution and habitat modification. This sensitivity not only reinforces their role in ecosystem assessment but also highlights their need for conservation within the broader framework of freshwater biodiversity management (Waghmare *et al*., 2012).

Lotic habitats are aquatic systems characterized by flowing water, such as rivers and streams, while lentic habitats are defined by standing or stagnant water, including lakes, ponds, and wetlands. The primary distinction between these two lies in their hydrological regimes lotic ecosystems feature continuous water movement, whereas lentic systems are relatively still, resulting in profound ecological differences. Hydrological regimes greatly shape the biological communities in each habitat. In lotic systems, constant water flow enhances oxygenation and typically leads to higher turnover of organic matter, supporting species well-adapted to turbulent conditions, such as streamlined or substrate-clinging molluscs. This dynamic environment dictates dispersal and survival strategies, with species needing to anchor themselves or employ specific life cycle adaptations to avoid being washed downstream. Conversely, lentic habitats create more stable conditions with distinct stratification based on light and temperature, leading to unique ecological niches and supporting species suited to less variable environments. Biodiversity patterns commonly differ between these systems. Lotic habitats often exhibit greater species richness due to occupational gradients and dynamic nutrient cycling, while lentic systems support specialized communities with depth and light-driven zonation. The contrasting flows and stability thus result in differentiated community composition, dispersal strategies, and survival mechanisms among freshwater taxa (Lehner, 2024).

Numerous studies have documented the diversity of freshwater molluscs across varied Indian aquatic systems, revealing over 200 species distributed among rivers, lakes, and wetlands. Major taxonomic works by Subba Rao (1989) and subsequent regional inventories have enriched knowledge of molluscan distributions, especially within biodiversity hotspots like the Western Ghats, North-East India, and selected wetland systems. Detailed assessments in Maharashtra, including the Ujani wetland and reservoirs in Solapur district, have highlighted the ecological dominance of families such as Viviparidae and Unionidae, with frequent reports of widely distributed species like *Filopaludina bengalensis* and *Lamellidens corrianus* (D'Souza 2025, Shaikh *et al.*, 2011).

Despite this progress, significant knowledge gaps remain. Comparative studies systematically investigating molluscan diversity and community structure in both lotic and lentic habitats—especially within the Bhima River basin are limited or lacking, Sonowal and Kardong (2020), Markad and Pillai (2021). Most available literature tends to focus on single habitat types or is restricted to species lists without deep analysis of ecological adaptability and species-specific distribution patterns in relation to environmental gradients. This shortfall underlines the need for comprehensive, habitat-explicit surveys to enhance the understanding of molluscan biodiversity and the environmental drivers shaping community organization in Indian freshwater ecosystems (Sulthana *et al.*, 2023).

The Bhima River basin is a prominent freshwater system in western India, primarily located in Maharashtra and extending into Karnataka and Telangana. Originating from the Bhimashankar hills in the Western Ghats, the river travels southeast for roughly 861 kilometers before joining the Krishna River, with its basin encompassing a vast area of over 48,000 square kilometers. The region is characterized by monsoonal climatic patterns, producing significant seasonal fluctuations in river flow. The upper reaches exhibit rugged forested terrain of the Western Ghats, transitioning into fertile plains and agricultural lands in the Deccan Plateau. Numerous dams and reservoirs, notably the Ujjani Dam, regulate hydrological dynamics to support agriculture, water supply, and energy production, while also modulating natural processes and aquatic habitat availability. Anthropogenic pressures in the basin are substantial. Intensive agriculture, urbanization—especially surrounding Pune metropolitan region—and infrastructural development have contributed to habitat modification and water quality alterations. This makes the Bhima River basin highly representative for biodiversity assessments, as it integrates diverse natural and human-impacted environments, providing an ideal model for studying ecological processes and conservation challenges in Indian freshwater ecosystems.

This study holds significant value for several reasons. Firstly, it contributes to expanding regional biodiversity inventories by providing detailed, habitat-specific data on molluscan species in the Bhima River basin, an understudied and ecologically important freshwater system. Secondly, the findings support conservation planning and habitat management by identifying species distribution patterns and environmental influences, which can guide targeted efforts to preserve vulnerable molluscan communities and maintain aquatic ecosystem health amid increasing anthropogenic pressures. Additionally, this research deepens understanding of ecological responses to habitat heterogeneity, particularly differences between lotic and lentic environments. Such knowledge is crucial for predicting how molluscan biodiversity and community structure might shift in response to environmental changes. Ultimately, the study fosters a more comprehensive, ecosystem-based approach to freshwater biodiversity conservation in India.

Molluscs are among the most imperilled aquatic taxa, with many species facing extinction due to habitat degradation, pollution, and climate change. Understanding their diversity is essential for identifying vulnerable ecosystems and formulating effective strategies to preserve aquatic biodiversity. In light of these concerns, the present study aims to address the following research questions: (a) How does molluscan species diversity differ between lotic and lentic habitats within the Bhima River basin? (b) What is the composition and structure of mollusc communities in these two habitat types, and which taxa are most dominant? (c) To what extent do variations in physico-chemical parameters influence the assemblage patterns of freshwater molluscs across lotic and lentic environments?

MATERIAL AND METHODS

The study was conducted between 2017 and 2019 to assess the diversity of freshwater molluscan species across two wetland ecosystems in Solapur district, Maharashtra: Jawalgaon Lake, and Bhima river at Machnur. Field surveys were performed using line transact. Field visits were conducted monthly, typically between 0600 and 0900 hours. Molluscs were manually collected using hand-picking techniques, with gloves employed to mitigate parasitic risks. Specimens were preserved in 5% formalin, photographed, and identified using morphological keys from Tonapi (1980) and Subba Rao (1989). Sampling was standardized to a 1kilometer transect per site, and water samples were also collected and analysed as per APHA Manual (Lipps *et al.,* 2023).

Identification of molluscs, particularly those from the Lymnaeidae family, required examination beyond shell morphology. Detailed anatomical features such as radula structure and prostate gland shape were considered essential for accurate species determination. Soft tissues were preserved alongside shells. For relaxation and observation, specimens were placed in enamel trays containing source water and treated with powdered menthol, magnesium sulphate, or chloral hydrate, then covered and left undisturbed for 24 hours.

Study Sites. To ensure comprehensive coverage of habitat heterogeneity, representative sampling sites were selected to include key microhabitats such as riffles, pools, and riverbanks within the riverine system. Preliminary reconnaissance surveys were conducted to identify avian rich zones, facilitating the stratified random surveys in distinct habitat types. Two sites were chosen for detailed investigation: Machnur, representing the lotic environment of the Bhima River, and Jawalgaon Lake, representing the lentic ecosystem within the Bhima River basin in Solapur district (Fig. 1).

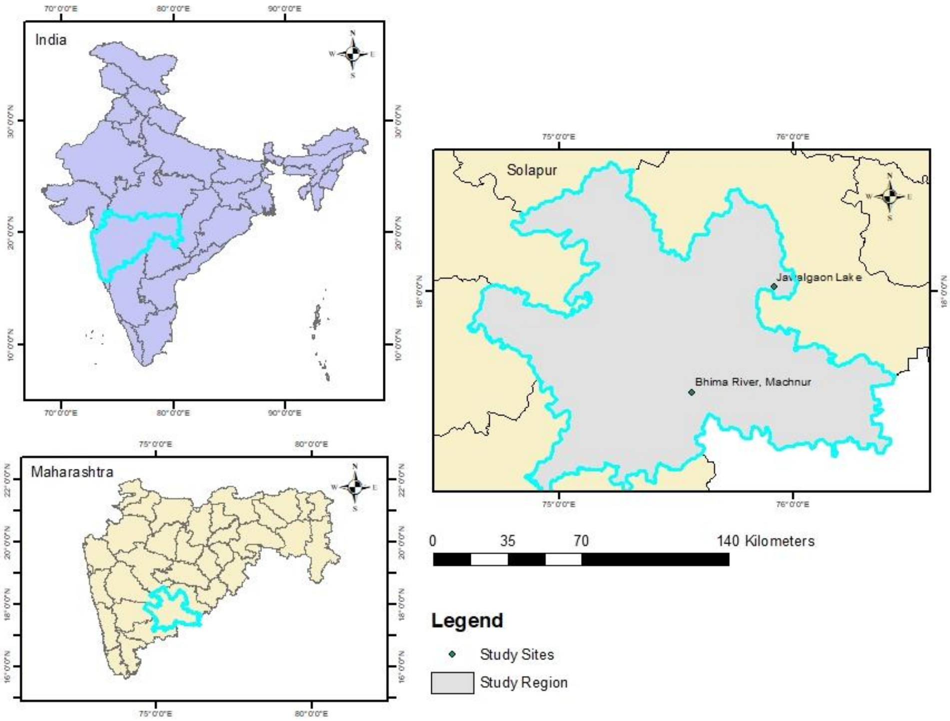

Fig. 1. Map indicates the locations of study sites.

Bhima River at Machnur

The Bhima River, a prominent eastward-flowing watercourse in western and southern India, is the largest tributary of the Krishna River. Originating from the Bhimashankar hills in the Western Ghats of Pune district, Maharashtra, it traverses approximately 861 kilometers through Maharashtra, Karnataka, and Telangana before confluencing with the Krishna River. The Bhima River is integral to the region's hydrological dynamics, agricultural productivity, cultural heritage, and ecological integrity. At Machnur (17°33'54"N to 75°55'94"E), the river supports a diverse assemblage of ichthyofauna and algal communities, as evidenced by recent ecological assessments. A 2024 survey documented 12 fish species spanning five taxonomic orders, with Cichliformes being the most dominant group (Sutrave *et al.,* 2024). The site functions as a vital freshwater reservoir, sustaining local biodiversity. However, seasonal anthropogenic pressures particularly during the monsoon and pilgrimage periods have been shown to influence water quality and aquatic biota (Jadhav and Mali 2022; Dede and Deshmukh 2016). Given its ecological significance and multifaceted value, Machnur was selected as the lotic sampling site for the present study.

Jawalgaon Lake

Jawalgaon Lake is a historically and ecologically important lentic water body situated towards north of Solapur city in Maharashtra. Jawalgaon dam was established in year 1997 for irrigation and located at 18°00′47″ N to 75°55′24″ E in Jawalgaon village in Solapur district. The height of dam above foundation is 21.71 m and length 1229 m with 223 sq.km backwater area. Jawalgaon dam is an earthen type dam constructed on Nagzira River and from all sites covered with agricultural land. The lake plays a crucial role in maintaining freshwater biodiversity, ecological equilibrium, and providing socio-economic benefits through agriculture, fisheries, and avian habitats. A study by Sakhare (2001) reported 23 different fish species belonging to seven orders in the Jawalgaon reservoir. The Cyprinidae family was noted as dominant, with 11 species. The lake also harbours a variety of algal taxa that contribute significantly to its primary productivity, thereby supporting molluscan survival and proliferation. In light of its ecological functionality and biodiversity value, Jawalgaon Lake was selected as the lentic site for this investigation.

Fig. 2. Geography of Study sites (A) Bhima River, Machnur (B) Jawalgaon Lake.

RESULTS AND DISCUSSION

A total of 18 freshwater molluscan species, encompassing two major taxonomic classes Gastropoda and Bivalvia were recorded across both study sites, Machnur (lotic) and Jawalgaon (lentic), within the Bhima River basin. These species represent four orders and seven families, indicating a diverse and well-structured mollusc community (Table 1). Gastropods were represented by families Thiaridae, Viviparidae, Lymnaeidae, Planorbidae, and Bullinidae, with species *Tarebia lineata*, *Melanoides tuberculata*, *Mieniplotia scabra*, and *Tarebia granifera* consistently present in both habitats. Similarly, *Filopaludina bengalensis*, *Idiopoma dissimilis*, and *Bellamya eburnea* (Viviparidae) were observed across both sites, suggesting broad ecological tolerance. Other gastropod taxa including *Racesina luteola*, *Planorbella scalaris*, and *Indoplanorbis exustus* were also uniformly distributed. Bivalves were represented by Corbiculidae and Unionidae families, with *Corbicula striatella* and *Corbicula peninsularis* (Corbiculidae) occurring in both environments. The Unionidae family exhibited notable diversity, with species such as *Inodonaia caerulea*, *Parreysia corrugata*, *Lamellidens marginalis*, *Lamellidens corrianus*, and two unidentified Lamellidens morphotypes recorded at both sites. The consistent presence of all listed species across lotic and lentic habitats underscores their ecological adaptability and reflects the relatively stable environmental conditions supporting molluscan diversity in the Bhima River basin.

Table 1: List of freshwater molluscs recorded at study sites.

Order	FAMILY	SPECIES	Lotic Machnur	Lentic Jawalgaon
Gastropoda	Thiaridae	*Tarebia lineata* (Gray, 1828)	+	+
		Melanoides tuberculata (O. F. Müller, 1774)	+	+
		Mieniplotia scabra (O. F. Müller, 1774)	+	+
		Tarebia granifera (Lamarck, 1816)	+	+
	Viviparidae	*Filopaludina bengalensis* (Lamarck, 1822)	+	+
		Idiopoma dissimilis (O. F. Müller, 1774)	+	+
		Bellamya eburnea	+	+
	Lymnaeidae	*Racesina luteola* (Lamarck, 1822)	+	+
	Planorbidae	*Planorbella scalaris* (J. C. Jay, 1839)	+	+
	Bullinidae	*Indoplanorbis exustus* (Deshayes, 1833)	+	+
Bivalvia	Corbiculidae	*Corbicula striatella* (Deshayes, 1855)	+	+
		Corbicula peninsularis (Prashad, 1928)	+	+
	Unionidae	*Inodonaia caerulea* (Prashad, 1922)	+	+
		Parreysia corrugata (O. F. Müller, 1774)	+	+
		Lamellidens sp. 1	+	+
		Lamellidens sp. 2	+	+
		Lamellidens marginalis (Lamarck, 1819)	+	+
		Lamellidens corrianus (I. Lea, 1834)	+	+

+ indicates occurred, - indicates not occurred

Quantitative analysis of molluscan diversity across the lentic (Jawalgaon) and lotic (Machnur) habitats revealed comparable species richness, with both sites hosting 18 distinct taxa (Table 2). However, the total number of individuals recorded was higher in the lotic site (Machnur: 5,435) than in the lentic site (Jawalgaon: 4,652), suggesting greater population density in the flowing water system. The Shannon diversity index (H) values indicated slightly higher species diversity in the lentic habitat (H = 2.560) compared to the lotic habitat (H = 2.478), reflecting a more even distribution of individuals among species in the lake environment (Fig. 1). Statistical comparison using the t-test yielded a t-value of 5.6052, which exceeds the critical value (Crit = 1.9601) at 1 degrees of freedom, with significant p-value (p = 2.13).

The abundance of the study organism in the Jawalgaon Lentic environment is most strongly influenced by Temperature, exhibiting a moderate negative correlation (r = -0.5804). This inverse relationship suggests that increasing water temperatures are a limiting factor for the organism's population size.

Table 2: Diversity indices for lentic (Jawalgaon) and lotic (Machnur) habitats.

Site	Jawalgaon	Machnur
Total	4652	5435
Richness	18	18
H	2.560847	2.478527
S^2_H	0.000102	0.000114
t	5.605223	
df	10083	
Crit	1.960199	
p	2.13E-08	
CI	0.020153	0.021369

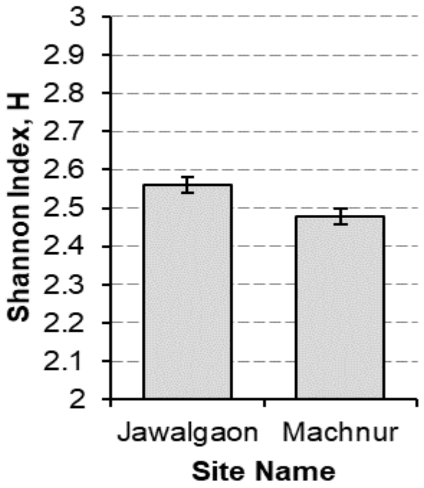

Fig. 3. Diversity of freshwater molluscs at the study sites.

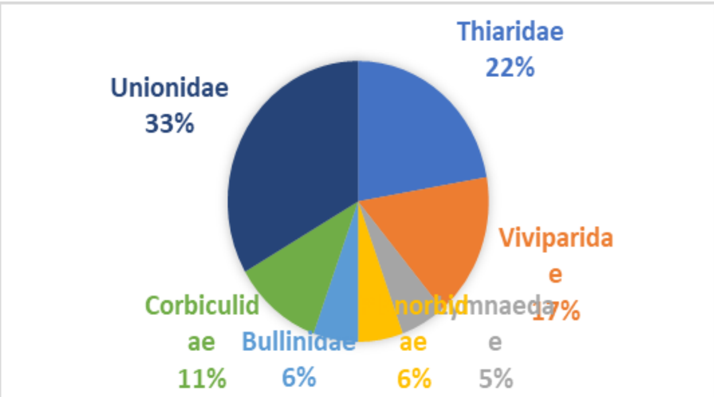

Fig. 4. Familywise Diversity of freshwater molluscs at the study sites.

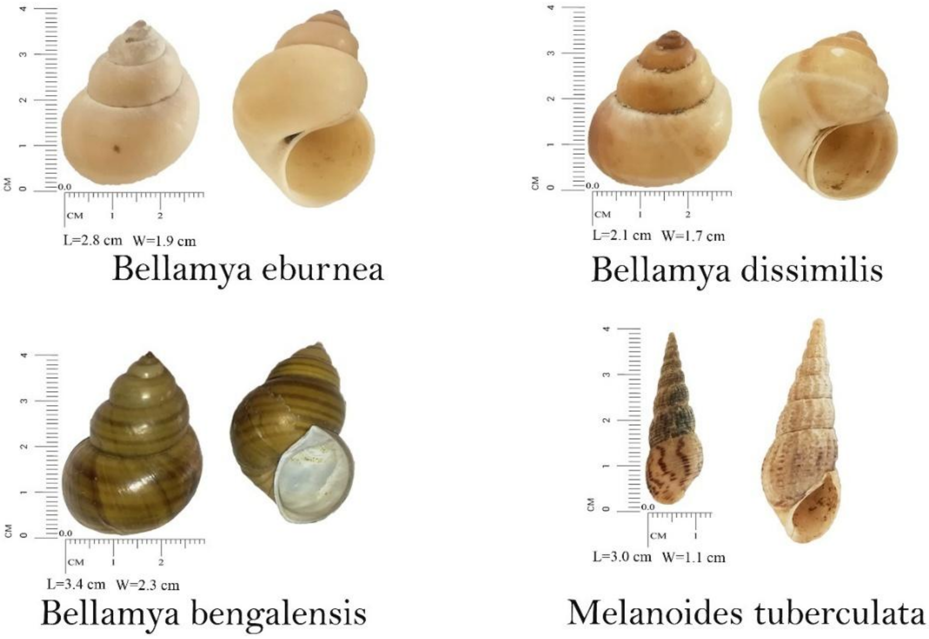

Fig. 5. Representative species reported during the study.

Nutrient concentrations also play a role, with Nitrates showing a weak-to-moderate positive correlation (r = 0.3980), indicating a potential growth benefit from higher nitrate levels. Conversely, Orthrophosphate showed a weak-to-moderate negative correlation (r = -0.3610), suggesting that high orthrophosphate concentrations may be unfavorable. Other factors, such as Dissolved oxygen (r = 0.2149) and (r = -0.2190), showed only weak correlations with abundance, while factors like Turbidity, Sulphate, and Total hardness had negligible observed effects (r <0.1). Analysis of the inter-parameter relationships showed that Orthrophosphate and Turbidity possess the strongest internal association, displaying a moderate positive correlation (r = 0.5926). This indicates a tendency for high concentrations of phosphate to coincide with increased water turbidity, likely due to common sources such as runoff or suspended particulate matter. Several other weak-to-moderate correlations were observed: Temperature showed a positive correlation with (r = 0.4157), while demonstrated a negative correlation with Turbidity (r = -0.4681). Furthermore, Nitrates and Dissolved oxygen were positively related (r = 0.3566) (Table 3). Overall, these correlations highlight the interconnected nature of water quality, with temperature and nutrient status emerging as the primary environmental drivers affecting the abundance of the study organism in this lentic system.

Table 3: Correlation matrix of Physico-chemical parameters at Jawalgaon.

Jawalgaon (Lentic)	**Lentic Abundance**	**Temperature**	**pH**	**Turbidity**	**Dissolved oxygen**	**Sulphate**	**Total hardness**	**Orthrophosphate**	**Nitrates**
Abundance	1								
Temperature	-0.5804	1							
pH	-0.2190	0.4157	1						
Turbidity	-0.0656	0.2633	-0.4681	1					
Dissolved oxygen	0.2149	-0.0480	-0.2470	0.1830	1				
Sulphate	0.0508	-0.1844	-0.2050	-0.1992	0.0181	1			
Total hardness	-0.0121	-0.1783	-0.2992	0.0742	0.0557	0.1319	1		
Orthrophosphate	-0.3610	0.2344	-0.2844	0.5926	0.0926	-0.0814	0.0043	1	
Nitrates	0.3980	-0.0328	-0.1617	0.2158	0.3566	0.0064	-0.1000	-0.0101	1

The abundance of the study organism in the Machnur Lotic system is overwhelmingly dominated by a very strong negative correlation with Turbidity ($r=-0.8933$), indicating that turbidity is the most significant limiting factor for the biota in this lotic stretch. Conversely, Abundance showed moderate positive correlations with both Temperature ($r=0.6828$) and Total hardness ($r=0.6195$), suggesting that these factors may be conducive to the organism's presence. Abundance also exhibited moderate negative correlations with two key parameters: Orthophosphate ($r=-0.5951$) and Dissolved oxygen ($r=-0.5339$). The positive correlation with Temperature and negative correlation with Dissolved oxygen present a complex ecological profile, as high temperature often leads to lower dissolved oxygen, yet the organism appears to thrive when both are high and low, respectively. Furthermore, a weak-to-moderate positive correlation was observed with Nitrates ($r=0.4836$). Relationships with pH and Sulphate were found to be negligible ($r<0.05$).

Analysis of the inter-parameter correlations reveals several strong and moderate relationships that define the water quality profile. Turbidity is central to these relationships, showing a strong negative correlation with Temperature ($r=-0.7266$) and moderate negative correlations with Total hardness ($r=-0.5877$) and Nitrates ($r=-0.6018$). Counter-intuitively, Turbidity showed a moderate positive correlation with Dissolved oxygen ($r=0.6281$) and Orthophosphate ($r=0.6422$). Other significant inter-relationships include a moderate negative correlation between Temperature and Dissolved oxygen ($r=-0.6274$), and between the two major nutrients, Orthophosphate and Nitrates ($r=-0.5656$) (Table 4). These strong internal associations highlight the interconnectedness of flow-related variables (Turbidity) and basic water chemistry (Nutrients and Dissolved oxygen) in controlling the environmental conditions of the Machnur lotic environment.

Table 4: Correlation matrix of Physico-chemical parameters at Machnur.

Machnur (Lotic)	Abundance	Temperature	pH	Turbidity	Dissolved oxygen	Sulphate	Total hardness	Orthophosphate	Nitrates
Abundance	1								
Temperature	0.682842	1							
pH	0.040328	0.289437	1						
Turbidity	-0.89331	-0.72662	0.005767	1					
Dissolved oxygen	-0.53391	-0.62737	0.031793	0.628138	1				
Sulphate	0.020638	0.142249	0.132411	-0.12307	-0.18454	1			
Total hardness	0.619454	0.480795	0.074962	-0.58773	-0.47766	-0.05894	1		
Orthophosphate	-0.59513	-0.34638	0.080156	0.642235	0.368554	-0.06432	-0.32008	1	
Nitrates	0.483563	0.367536	-0.1523	-0.60182	-0.37574	0.132801	0.257628	-0.56557	1

DISCUSSION

The study offers a comprehensive, comparative analysis of freshwater molluscan communities across contrasting lotic (Machnur) and lentic (Jawalgaon) habitats within the ecologically significant, yet anthropogenically pressured, Bhima River basin. The results reveal a community structure characterized by exceptional species overlap, yet controlled by fundamentally different, habitat-specific environmental stressors, highlighting the complex ecological consequences of hydrological modification in tropical systems.

The most striking finding is the remarkable uniformity of species presence: a total of 18 molluscan species, spanning Gastropoda (Thiaridae, Viviparidae, Lymnaeidae, Planorbidae, Bullinidae) and Bivalvia (Corbiculidae, Unionidae), were found to be consistently present at both the flowing (Machnur) and standing (Jawalgaon) sites. This complete overlap in species richness (S = 18) suggests that the regional molluscan fauna of the Bhima River basin is dominated by eurytopic taxa that possess wide ecological tolerances, enabling them to persist across dynamic lotic environments and stable lentic reservoirs. This pattern often emerges in river systems experiencing significant human impact, such as regulated flow regimes imposed by dams, which effectively homogenize selective pressures and favor robust, generalist species over specialized stenotopic ones.

Despite identical richness, quantitative analysis indicates a functional differentiation between the habitats. The lentic site (Jawalgaon) exhibited a slightly, but statistically significantly higher Shannon diversity index (H = 2.5608) compared to the lotic site (Machnur H = 2.4785). This disparity, validated by a highly significant -test result (t = 5.6052, p = 2.13), reflects higher species evenness in the reservoir environment. The physical stability inherent to lentic systems, characterized by lower shear stress and stable stratification, tends to facilitate more equitable resource distribution and reduced competition for attachment sites, preventing the ecological hyper-dominance often seen in turbulent flows (Yue *et al*., 2025). Conversely, the lotic habitat recorded a higher total abundance (N = 5,435 versus N = 4,652 in Jawalgaon) (Table 5). This higher density, combined with lower evenness, suggests that a few highly successful, flow-adapted, or opportunistic species are able to exploit the enhanced oxygenation and productivity of the river, leading to a concentration of abundance in dominant taxa.

Table 5: Comparative Molluscan Diversity Metrics in the Bhima River Basin.

Site Type	Habitat Location	Total Abundance (N)	Species Richness (S)	Shannon Diversity (')	Implication for Evenness
Lotic	Machnur	5,435	18	2.478	Lower Evenness; Concentration of abundance in dominant taxa.
Lentic	Jawalgaon	4,652	18	2.560	Higher Evenness; More balanced distribution of populations.

The assemblage structure in the flowing river habitat is governed primarily by acute physical stressors related to hydrological energy and sediment flux, indicative of significant upstream land-use impacts.

Mollusc abundance in the Machnur lotic system is overwhelmingly controlled by a very strong negative correlation with Turbidity ($r=-0.8933$). This coefficient is the strongest environmental predictor observed in the study and demonstrates that suspended particulate matter acts as the primary ecological bottleneck in this river stretch. The physiological mechanism linking high turbidity to mollusc decline involves the physical impairment of filter-feeding mechanisms (Hope *et al*., 2020). High suspended sediment concentrations reduce the capacity of bivalves and suspension-feeding gastropods to filter water efficiently. Studies show that bivalves inhibit respiration and reduce ventilation rates to limit sediment ingestion, which simultaneously starves the organism of both food and oxygen (Grant and Thorpe 1991). Furthermore, when suspended sediment loads exceed a concentration threshold (e.g., 100–119 mg/L^{-1} for pseudo feces production in some species), the mollusc must expend significant energy rejecting excess inorganic material, leading to chronic energetic depletion and growth inhibition during prolonged exposure (Grant and Thorpe 1991). Given that the community includes filter-feeding Bivalvia (Unionidae and Corbiculidae) which provide essential ecosystem services such as water clarification (Verma *et al*., 2025), this intense physical stress threatens the functional integrity of the lotic ecosystem (Goldsmith *et al*., 2021).

The Machnur community profile presents a classic ecological complexity involving temperature and oxygen dynamics. Abundance showed a strong positive correlation with Temperature ($r=0.6828$) but a counter-intuitive moderate negative correlation with Dissolved Oxygen (DO) ($r=-0.5339$). This inverse relationship between abundance and DO in a flowing system challenges the expectation that most aquatic invertebrates, especially vulnerable bivalves, require high oxygen levels. Instead, it strongly suggests that the high total abundance recorded in the lotic environment is disproportionately driven by species highly tolerant of low DO conditions, effectively signaling organic pollution. Taxa such as certain Thiaridae gastropods (*Melanoides tuberculata, Tarebia granifera*) and the pulmonate snail *Indoplanorbis exustus*, which can utilize atmospheric oxygen, thrive in environments where organic pollution (likely from upstream urban and agricultural runoff in the Bhima basin) increases microbial decomposition, driving down DO levels. Thus, the negative DO correlation is interpreted not as oxygen being harmful, but rather as the mollusc community shifting to a dominance structure indicative of pollution stress. The positive temperature correlation likely reflects enhanced metabolic and reproductive activity during warmer periods (Liyanagedara *et al*., 2023), but only for the cohort of organisms resilient enough to withstand the concurrent physical (turbidity) and chemical (hypoxic) stresses. Total Hardness, which reflects the concentration of essential calcification ions (calcium and magnesium), exhibited a strong positive correlation with abundance ($r = 0.6195$). This confirms that the availability of these fundamental elements is crucial for shell development and survival of both gastropods and bivalves (Garg *et al.*, 2009).

Nutrient parameters also provided distinct signals: Nitrates showed a moderate positive correlation ($r = 0.4856$), indicating that nitrogen acts primarily as a trophic stimulant, supporting the primary producers that form the base of the molluscan diet. Conversely, Orthrophosphate displayed a moderate negative correlation ($r = -0.5951$). While phosphorus is an essential nutrient, high concentrations often correlate with undesirable processes such as land runoff and the subsequent risk of eutrophication-induced ecosystem instability, which negatively impacts molluscan communities (Ngatia *et al*., 2019). In the Machnur system, the negative influence of phosphate appears to be intricately linked to the overall degradation resulting from sediment input. The Jawalgaon reservoir, representing a more physically stable lentic habitat, is primarily constrained by chronic, climate-related factors and diffuse nutrient pollution from the surrounding watershed.

The strongest limiting factor identified for mollusc abundance in Jawalgaon is a moderate negative correlation with Temperature ($r = -0.5804$). Lentic water bodies in tropical regions, such as the Jawalgaon reservoir, are susceptible to prolonged heat retention and thermal stratification during warm seasons. Elevated water temperatures exceed the thermal optima of many sedentary species, particularly bivalves, inducing severe physiological stress. High temperatures accelerate metabolic rates, requiring greater oxygen consumption, yet simultaneously reduce the amount of oxygen soluble in water (Bonacina *et al*., 2023). This synergistic effect of increased demand and reduced supply significantly depletes energy reserves, leading to suppressed growth, reduced fecundity, and overall population decline during periods of thermal maxima (Cushway *et al*., 2025).

The lentic nutrient profile reinforces the link between surrounding agricultural practices and water quality. Nitrates showed a weak-to-moderate positive correlation (r = 0.3980), suggesting a beneficial trophic role. In contrast, Orthrophosphate showed a weak-to-moderate negative correlation (r = -0.3610). The analysis of inter-parameter relationships in Jawalgaon provides a crucial interpretation: Orthrophosphate exhibits a strong positive association with Turbidity (r = 0.5926). This strong co-occurrence indicates that high phosphorus levels originate predominantly from diffuse runoff carrying suspended sediment from agricultural land, a common issue in the Bhima River basin. Although turbidity settles more quickly in the reservoir than in the river, the resulting nutrient loading contributes to eutrophication, algal blooms, and sediment oxygen demand, creating undesirable conditions that limit overall mollusc abundance (Lewin *et al*., 2023).

The persistence of eurytopic families such as Thiaridae (*T. lineata*, *M. tuberculata*) and Viviparidae (*F. bengalensis*, *I. dissimilis*) across both flow regimes is evidence of their adaptability to hydrological variability and pollution. The Thiaridae, known for their asexual reproduction and resistance to environmental fluctuations, are highly successful colonists (Kumar and Vyas 2012). *Pulmonate snails* (*I. exustus*) utilize atmospheric oxygen, giving them a distinct competitive advantage in the organically stressed, low-DO Machnur environment (Liyanagedara *et al*., 2023).

The presence of filter-feeding Unionidae (*Lamellidens* spp., *Parreysia corrugata*) in the highly turbid lotic environment is particularly significant. While highly sensitive to suspended sediments, their persistence suggests that these bivalves rely on seeking out hydraulic refugia—such as deep pools or areas with lower bed shear stress—where flow velocity is mitigated, allowing them to continue feeding and respiration during high-flow, high-turbidity events (Cushway *et al.,* 2024). The reliance of these vital organisms on limited refugia underscores their vulnerability within the highly dynamic and disturbed river channel.

The findings dictate a bifurcated management approach based on the specific limiting factor identified at each site. Conservation efforts in the lotic system (Machnur) must prioritize mitigating acute physical stress, primarily sediment loading (turbidity) and associated organic pollution causing hypoxia (Pandey, 2025). In the lentic system (Jawalgaon), conservation should focus on managing chronic climate and nutrient stressors, particularly thermal maxima and diffuse phosphate runoff, to stabilize the productive reservoir environment (Ngatia *et al*., 2019). The mollusc community, while showing high regional tolerance, provides clear sentinel indicators for localized environmental quality decline (Choubisa and Sheikh 2013).

CONCLUSIONS

This comparative analysis of the freshwater mollusc community in the Bhima River basin successfully identified the structural differences and environmental mechanisms driving population dynamics in lotic and lentic habitats. The molluscan fauna exhibits strong regional eurytopy, confirmed by the identical species richness (S = 18) shared between the lotic (Machnur) and lentic (Jawalgaon) habitats. This suggests a community adapted to the broad, regulated, and anthropogenically modified hydrological conditions characteristic of the Deccan Plateau. Significant differences in community structure were quantified: the lentic environment demonstrated higher species evenness (H = 2.560), reflecting physical stability, while the lotic environment exhibited higher total abundance (N = 5435) but lower evenness, indicating dominance by highly successful, likely pollution-tolerant, taxa. The lotic system is overwhelmingly limited by acute physical stress, evidenced by the exceptionally strong negative correlation between abundance and Turbidity (r = -0.8933). The concurrent negative correlation with Dissolved Oxygen (r = -0.5339) further suggests that the community structure has been functionally skewed toward hypoxia-tolerant species that thrive in organically polluted waters. The lentic system is predominantly limited by chronic climatic stress, indicated by the moderate negative correlation with Temperature (r = -0.5804), suggesting physiological constraints associated with thermal stratification. Nutrient dynamics reinforce this: Orthrophosphate acts as an indicator of undesirable agricultural runoff, linking community decline to watershed disturbance.

The study concludes that local anthropogenic stressors, rather than fundamental flow differences, are the primary drivers shaping mollusc abundance and distribution, necessitating targeted, site-specific water quality management interventions.

FUTURE SCOPE

To advance the understanding of molluscan ecology in the Bhima River basin and translate these correlative findings into effective management practice, future investigations must prioritize establishing causal relationships and utilizing predictive modeling.

Recommendations for Advanced Ecological and Hydrological Studies

1. Causal Determination of Hypoxia Tolerance and Organic Load

The unexpected negative correlation between mollusc abundance and Dissolved Oxygen in the lotic reach requires confirmation of the underlying drivers of low DO. It is crucial to determine if this pattern is caused by high organic load depressing oxygen levels while favoring tolerant species. Future studies should quantify the Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) in Machnur to confirm the degree of organic pollution. Furthermore, conducting laboratory respirometry studies on locally dominant pollution-tolerant species, such as *Indoplanorbis* *exustus* and prevalent Thiaridae species, is essential to establish their precise physiological tolerance thresholds to low DO and elevated organic matter, thus validating their status as robust bioindicators.

2. Physiological Cost Assessment of Turbidity on Native Bivalves

The devastating impact of turbidity (r=−0.8933) on the lotic community requires quantitative assessment of the functional decline in native bivalves. Future research should focus on the sublethal effects of suspended sediments on Unionidae species (*Lamellidens corrianus, Parreysia corrugata*), which are crucial biofilters. Controlled, long-term (chronic) exposure experiments utilizing sediment concentrations representative of Machnur's peak levels should measure key endpoints such as growth rate inhibition (dry tissue weight change), energetic reserves (glycogen and ATP levels), and the specific Clearance Rate Reduction caused by suspended solids. Determining the critical concentration of suspended sediment (mg/L) that triggers pseudofeces rejection for native species is essential for setting ecologically meaningful water quality standards.

The findings justify the following targeted management priorities: Prioritize Lotic Sediment and Erosion Control: Given that turbidity is the single strongest limiting factor, management must focus upstream of Machnur on reducing non-point source pollution and watershed erosion. Implementation of agricultural Best Management Practices (BMPs), riparian buffer restoration, and stringent controls on construction activities are critical to limit the input of suspended sediments and particulate phosphorus. Mitigate Lentic Thermal and Eutrophication Stress: Management in Jawalgaon must address the chronic threats of temperature and nutrient loading. Strategies should include dual nutrient control (Nitrogen and Phosphorus) to curb eutrophication risk. Furthermore, maintaining minimum ecological flows or increasing riparian zone shading may help buffer the reservoir against extreme thermal fluctuations, thereby protecting sensitive species from metabolic depletion. Establish Molluscan Bioindicator Programs: The identified species spectrum can form the basis of a standardized monitoring protocol for the Bhima basin. The sensitive Unionidae bivalves should be utilized as primary sentinel species to track recovery from turbidity and hypoxia, while the abundance of pollution-tolerant gastropods (Thiaridae, Planorbidae) can serve as robust indices of overall organic pollution load.

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REFERENCES

Ade, G. V. and Makode, P. M. (2023). Study of Water Quality Status and Gastropod Diversity of Bodalkasa Dam and Pujaritola Dam of Gondia District, Maharashtra, India. *International Journal of Zoological Investigations, 9*(1), 768–773.

Bonacina, L., Fasano, F., Mezzanotte, V. and Fornaroli, R. (2023). Effects of water temperature on freshwater macroinvertebrates: a systematic review. *Biological Reviews, 98*(1), 191–221.

Chaudhary, P. (2017). Species diversity, consumption trends and conservation status of freshwater molluscs in Ghodaghodi Lake area, Kailali District, Nepal. TU Central Library [Master’s thesis, Tribhuvan University].

Choubisa, S. L. and Sheikh, Z. (2013). Freshwater snails (Mollusca: Gastropoda) as bio-indicators for diverse ecological aquatic habitats. *Cibtech Journal of Zoology, 2*(3), 22–26.

Cushway, K. C., Geist, J. and Schwalb, A. N. (2025). Surviving global change: a review of the impacts of drought and dewatering on freshwater mussels. *Biological Reviews, 100*(1), 275–307.

Cushway, K. C., Harris, A. E., Piercy, C. D., Mitchell, Z. A. and Schwalb, A. N. (2024). Go with the flow: Impacts of high and low flow conditions on freshwater mussel assemblages and distribution. *PLoS One, 19*(2).

D’Souza, S. L. (2025). Freshwater molluscan diversity of India—Threats and conservation. *International Journal of Zoology Studies, 10*(2), 114–120.

Dede, A. N. and Deshmukh, A. L. (2016). Study on Rotifer Diversity Indices in Bhima River Near Machnur Village, Dist. Solapur (MS) India. *International Journal for Scientific Research & Development, 4*(6), 562–564.

Garg, R. K., Rao, R. J. and Saksena, D. N. (2009). Correlation of molluscan diversity with physicochemical characteristics of water of Ramsagar reservoir, India. *International Journal of Biodiversity and Conservation, 1*(6), 202–207.

Goldsmith, A. M., Jaber, F. H., Ahmari, H. and Randklev, C. R. (2021). Clearing up cloudy waters: a review of sediment impacts to unionid freshwater mussels. *Environmental Reviews, 29*(1), 100–108.

Grant, J. and Thorpe, B. (1991). Effects of Suspended Sediment on Growth, Respiration, and Excretion of the Soft-Shell Clam (*Mya arenaria*). *Canadian Journal of Fisheries and Aquatic Sciences, 48*(7), 1285–1292.

Hope, J. A., Hewitt, J., Pilditch, C. A., Savage, C. and Thrush, S. F. (2020). Effect of Nutrient Enrichment and Turbidity on Interactions Between Microphytobenthos and a Key Bivalve: Implications for Higher Trophic Levels. *Frontiers in Marine Science, 7,* 695.

Jadhav, P., Shejwal, P., Wagh, D. and Patil, M. (2019). Gonadal Index of the Freshwater Snail, *Bellamya dissimilis*. *International Journal of Recent Scientific Research, 10*(7), 33868–33870.

Jadhav, S. R. and Mali, N. S. (2022). Study of algal diversity of Bhima river at Machnur bandhara in Mangalwedha tehsil, dist. Solapur, Maharashtra. *International Journal of Science & Engineering Development Research, 7*(12), 65–69.

Kumar, A. and Vyas, V. (2012). Diversity of molluscan communities in River Narmada, India. *Journal of Chemical, Biological and Physical Sciences, 2*(3), 1407–1412.

Lehner, B. (2024). Rivers and Lakes—their distribution, origins, and forms. In Wetzel's Limnology (pp. 25-56). Academic Press.

Lewin, I., Stępień, E., Szlauer-Łukaszewska, A., Pakulnicka, J., Stryjecki, R., Pešić, V., Bańkowska, A., Szućko-Kociuba, I., Michoński, G., Krzynówek, Z., Krakowiak, M., Chatterjee, T. and Zawal, A. (2023). Drivers of the Structure of Mollusc Communities in the Natural Aquatic Habitats along the Valley of a Lowland River: Implications for their Conservation through the Buffer Zones. *Water*, *15*(11), 2059.

Lehner, B. (2024). Rivers and Lakes—their distribution, origins, and forms. In Wetzel's Limnology (pp. 25-56). Academic Press.

Lipps, W. C., Braun-Howland, E. B. and Baxter, T. E. (2023). Standard methods for the examination of water and wastewater (24th edition). American Public Health Association.

Liyanagedara, P., Wijesundara, W., Yatigammana, M. and Kumburegama (2023). Freshwater gastropod composition and the key environmental determinants in Hulu Ganga and Ma Oya river basins of Sri Lanka. *TAPROBANICA – The Journal of Asian Biodiversity, 12*(1), 14-22.

Markad, S. R. and Pillai, A. S. (2021). Study of diversity of fresh water Molluscs from Ujani wetland, Maharashtra, India. *International Journal of Fisheries and Aquatic Studies, 9*(1), 296–298.

Ngatia, L., Grace III, J. M. and Moriasi, D. (2019). Nitrogen and phosphorus eutrophication in marine. *Monitoring of Marine Pollution,* 77–93.

Pandey, C., Thiske, S., Guru, G. S. and Mansoori, N. A. (2025). A review on molluscan diversity in freshwater habitats: Implications for conservation and aquatic health. *International Journal of Engineering Sciences & Research Technology, 14*(2), 1–6.

Saha, B. K., Jahan, M. S. and Hossain, M. A. (2017). Ecology and abundance of *Bellamya bengalensis* (Lamarck, 1822) (Gastropoda: Viviparidae) in pond habitats of Rajshahi. *Bangladesh Journal of Scientific and Industrial Research, 52*(2), 107–114.

Sakhare, V. B. (2001). Ichthyofauna of Jawalgaon Reservoir in Solapur District (M.S.). *Journal of Aquatic Biology, 16*, 31–33.

Shaikh, T. A., Mulani, A. C., Rao, K. R. and Reddy, K. R. (2011). Fresh water molluscan diversity from a perennial tank near Hotagi, Solapur (District), Maharashtra, India. *Journal of Experimental Zoology, India, 14(*2), 435–438.

Sonowal, J. and Kardong, D. (2020). Assessment on diversity, distribution and conservation status of Indian freshwater pond mussel *Lamellidens* spp. from upper Brahmaputra basin of Assam. *Asian Journal of Conservation Biology, 9*(1), 123–129.

Sulthana, R., Padmavathi, P. and Deepa, J. (2023). Freshwater Molluscs of Konaseema District, Andhra Pradesh, India. *Uttar Pradesh Journal of Zoology, 44*(11), 25–32.

Sutrave, A. S., Shagalolu, V. V., Dama, L. B. and Mushan, L. C. (2024). Fish Diversity of Bhima River at Machnur, Solapur (M.S.) India. *Ela Journal of Forestry and Wildlife, 13*(1), 1536–1540.

Subba Rao, N. V. (1989). Handbook: Freshwater molluscs of India. Zoological Survey of India, i–xxiii + 1–289.

Tonapi, G. T. (1980). Freshwater animals of India (An ecological approach). Oxford & IBH Publishing Co., New Delhi.

Verma, A. K., Rahman, A., Hussain, S. and Singh, N. S. (2025). Freshwater Mussels as Multifaceted Ecosystem Engineers: Insights into Their Ecological Importance, Bioindication, and Economic Contributions. *Water, 17*(11), 1629.

Waghmare, P. K., Rao, K. R. and Shaikh, T. A. (2012). A correlation between freshwater molluscan diversity with Bhima River pollution near Pandharpur, Maharashtra, India. *Trends in Life Sciences, 1*(3), 38–42.

Yue, Z., Fang, Q., Zhang, S., Wu, C. and Wang, L. (2025). A novel approach to integrating the stability of river ecosystem and its driving factors. *Frontiers in Environmental Science, 13*, 1524086.

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