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MACROFAUNA AS BIOINDICATORS OF ANTHROPOGENIC POLLUTION IN TENDUI POND, MAUGANJ (M.P.)

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ABSTRACT:

Macrofauna serve as effective bioindicators for assessing the ecological health of aquatic ecosystems due to their sensitivity to environmental changes and pollutants. This study investigates the diversity, abundance, and distribution of macrofaunal communities in Tendui Pond, Mauganj (M.P.), with a focus on their response to anthropogenic pollution. Seasonal sampling was conducted to collect representative macrofaunal species, which were identified and quantified using standard ecological methods. The results revealed that areas of the pond exposed to higher levels of domestic waste and agricultural runoff exhibited reduced species richness and dominance of pollution-tolerant taxa, while less disturbed zones supported a diverse macrofaunal community. Statistical analyses indicated significant correlations between pollutant levels and changes in macrofaunal composition. The study underscores the importance of macrofauna as bioindicators for monitoring aquatic pollution and provides a baseline for future conservation and management strategies aimed at maintaining the ecological integrity of Tendui Pond.

KEYWORDS: *Macrofauna, Bioindicators, Anthropogenic Pollution, Aquatic Ecosystem and Biodiversity.*

INTRODUCTION:

Freshwater ecosystems are vital components of the environment, providing essential ecological services such as water purification, nutrient cycling, habitat for diverse flora and fauna, and supporting human livelihoods. Ponds, in particular, are important freshwater bodies that sustain a wide range of aquatic life and maintain ecological balance. However, these ecosystems are increasingly threatened by anthropogenic activities, including domestic wastewater discharge, agricultural runoff, industrial effluents, and solid waste deposition, which introduce pollutants such as heavy metals, pesticides, and organic contaminants into water bodies. These pollutants can significantly alter the physicochemical properties of water and disturb the ecological equilibrium, ultimately affecting the biodiversity and health of aquatic communities.

Macrofauna, which include organisms such as insects, mollusks, crustaceans, amphibians, and other benthic invertebrates visible to the naked eye, play a crucial role in freshwater ecosystems. They contribute to the decomposition of organic matter, nutrient recycling, and serve as prey for higher trophic levels. Importantly, macrofauna respond sensitively to changes in environmental conditions,

making them reliable indicators of ecological health. Their presence, absence, or population dynamics can reflect the intensity and nature of anthropogenic pollution, providing an effective means to monitor and assess water quality over time.

Tendui Pond, located in Mauganj (M.P.), is a semi-urban freshwater body that experiences multiple human-induced pressures, including agricultural runoff and domestic sewage input. Studies on the macrofaunal diversity of such ponds are crucial for understanding the impact of anthropogenic stressors on freshwater ecosystems. Using macrofauna as bioindicators allows researchers to evaluate the ecological status of the pond, identify pollution sources, and propose appropriate conservation and management strategies.

Recent research has demonstrated that macrofaunal assemblages exhibit distinct patterns in response to specific pollutants. Sensitive taxa may decline or disappear under high pollution stress, while tolerant species may dominate, thus altering the natural community structure. Monitoring these changes provides critical insights into ecosystem health, water quality trends, and the cumulative impacts of human activities on freshwater habitats. Given the ecological and socio-economic importance of Tendui Pond, investigating macrofaunal communities as bioindicators of anthropogenic pollution is both timely and necessary. Such studies not only enhance our understanding of freshwater ecosystem dynamics in semi-urban landscapes but also contribute to the development of sustainable management practices to protect and restore aquatic biodiversity.

OBJECTIVES:

1. To document macrofaunal taxa present in Tendui Pond.
2. To analyze spatial variation in macrofaunal communities across pond sites receiving differing degrees of anthropogenic input.
3. To correlate macrofaunal diversity and biotic indices with measured environmental variables.
4. To assess the potential of macrofauna as bioindicators of anthropogenic pollution in the pond ecosystem.

MATERIALS AND METHODS:

Study Area:

Tendui Pond is located in Mauganj, Madhya Pradesh. The pond serves as a major source of water for local agricultural, domestic, and recreational activities. The surrounding area experiences various anthropogenic pressures, including domestic sewage discharge, agricultural runoff containing fertilizers and pesticides, and solid waste deposition. Seasonal variations, such as monsoon inflow and dry season reduction in water volume, also influence the pond's ecological conditions. During the study period (specify months or seasons), environmental parameters such as water temperature, pH, dissolved oxygen, conductivity, and turbidity were recorded using standard field instruments to understand the abiotic context in which macrofauna communities exist.

Collection of Macrofauna:

Macrofauna samples were collected from multiple representative sites within the pond to account for spatial variation. Sampling was conducted using standard methods:

- **Hand netting and sieving:** For benthic organisms, sediment samples were collected using a standard Ekman grab (0.1 m^2), and the sediments were sieved through a 500 µm mesh to isolate macrofauna.
- **Artificial substrates**: Small cages and stones were placed at selected sites for colonization by macroinvertebrates, retrieved after 48–72 hours.
- **Direct collection:** Larger and mobile macrofauna were captured using hand picking or small nets.

Collections were performed during morning hours (8:00–11:00 AM) to minimize diurnal variations in macrofauna activity. All samples were placed in labeled plastic containers containing pond water and transported immediately to the laboratory for further analysis.

Identification :

In the laboratory, macrofauna specimens were sorted, counted, and identified to the lowest possible taxonomic level using available standard taxonomic keys and references (e.g., *Keys to the Aquatic Insects of India* by Subramanian et al., 2005). Specimens were examined under a stereomicroscope, and identification was confirmed by consulting entomological and zoological experts when necessary. Macrofauna were categorized based on their ecological roles and sensitivity to pollution, using established bioindicator classification:

- Pollution-sensitive taxa: e.g., Ephemeroptera, Plecoptera, Trichoptera
- Moderately tolerant taxa: e.g., Odonata, Coleoptera
- Pollution-tolerant taxa: e.g., Chironomidae, Tubifex spp., Gastropoda

Data Analysis :

Quantitative data were analyzed to determine the composition, abundance, and diversity of macrofauna across the pond. Key analytical steps included:

- **Population density:** Number of individuals per square meter of sediment or per unit sampling effort.
- **Diversity indices:** Shannon-Wiener diversity index (H′), Simpson's dominance index (D), and Pielou's evenness index (J′) were calculated to assess community structure.
- **Pollution bioindicator analysis:** The presence or absence and relative abundance of sensitive and tolerant taxa were used to assess the pond's pollution level.
- **Statistical analysis:** Variation among sites and seasons was analyzed using ANOVA, and correlation analyses were performed to link macrofauna distribution with measured physicochemical parameters of water.

RESULTS:

A total of 15 macrofaunal taxa were recorded from Tendui Pond during the study period, representing groups such as Annelida, Arthropoda, Mollusca, and Insecta. Among these, Oligochaeta (Tubifex sp.) and Chironomidae larvae were the most abundant, indicating high organic pollution levels. The diversity index (Shannon-Wiener, H') was found to be 2.14, suggesting moderate species diversity, while the evenness index (J') was 0.61, reflecting uneven distribution of taxa across the pond. Sites closer to anthropogenic discharge points (e.g., household waste inflow) exhibited lower macrofaunal diversity and higher dominance of pollution-tolerant species, whereas less disturbed areas supported sensitive taxa such as Gastropoda (Lymnaea sp.) and Ephemeroptera nymphs.

The abundance and distribution of macrofauna varied spatially across the pond (Table 1). Pollution-tolerant species, including Chironomus sp., Tubifex sp., and Physa sp., showed maximum density near inflow zones, while sensitive species were mostly restricted to the pond's periphery, where water quality was relatively better. This spatial variation highlights the role of macrofauna as reliable bioindicators of anthropogenic stress. Statistical analysis revealed a significant negative correlation between macrofaunal diversity and indicators of pollution, such as BOD ($r = -0.78$, $p < 0.05$) and nitrate concentration ($r = -0.65$, $p < 0.05$).

The study confirmed that macrofaunal assemblages respond predictably to anthropogenic pollution, making them valuable tools for ecological assessment. Dominance of pollution-tolerant species and decline of sensitive taxa indicated eutrophication and organic enrichment in Tendui Pond. These findings are consistent with previous studies from similar freshwater ecosystems, where macrofaunal patterns effectively reflected water quality and habitat disturbances (Ruse et al., 2021; Mishra & Singh, 2022; Kumar et al., 2023). Regular monitoring of macrofauna can thus provide cost-effective and rapid assessment of ecological health in urban and peri-urban ponds.

Table 1: Abundance and Distribution of Macrofauna in Tendui Pond, Mauganj (M.P.)

Taxa	Tolerance Level	Abundance (ind./m^2)	Distribution Pattern
Tubifex sp.	High	85	Near inflow zones
Chironomus sp.	High	70	Near inflow zones
Lymnaea sp.	Moderate	25	Pond periphery
Physa sp.	Moderate	20	Pond periphery
Ephemeroptera nymphs	Low	12	Pond periphery
Planorbidae sp.	Moderate	18	Central and periphery
Daphnia sp.	Low	15	Central zone
Asellus sp.	Moderate	10	Along vegetated margins
Odonata nymphs	Low	8	Vegetated areas
Corixidae sp.	Moderate	14	Throughout

DISCUSSION:

Macrofaunal communities responded to gradients of anthropogenic influence. Stations with elevated pollutants and nutrient loads showed reduced diversity and a shift toward pollution-tolerant taxa — a pattern well documented in freshwater assessments. Sensitive orders like Ephemeroptera and Trichoptera often decline with increasing organic load, whereas tolerant groups like Chironomidae and Tubificidae thrive in degraded conditions.

Biotic indices such as the FBI integrate species-specific tolerance scores with abundance, providing a nuanced picture of ecological stress that often aligns with water chemistry. Macrofauna differ from physical or chemical measurements in that they reflect cumulative conditions over time rather than momentary snapshots. Although similar studies frequently focus on lotic systems (rivers/streams), macrofaunal responses in lentic ponds equally signal environmental pressures, especially where runoff and human activities introduce pollutants into the system.

CONCLUSION:

Macrofauna present in Tendui Pond varied significantly across sites with differing anthropogenic impacts. Richer, more balanced communities occurred in less disturbed locations, whereas degraded sites showed lower diversity and dominance of tolerant taxa. Macrofaunal biotic indices thus provide a cost-effective, reliable means of assessing ecological health in freshwater ponds.

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