Diversity and Distribution of Zooplankton in Selected Wetlands of Saharanpur

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Abstract
Freshwater wetlands are ecologically important ecosystems that support rich biodiversity and maintain aquatic productivity. The present study was conducted to investigate the diversity, distribution, and ecological significance of zooplankton communities in selected wetlands of Saharanpur district, Uttar Pradesh, India. Zooplankton samples were collected using a standard plankton net and identified based on morphological characteristics. Major zooplankton groups recorded during the study included Rotifera, Cladocera, Copepoda, and Protozoa. Rotifera (40%) and Cladocera (35%) were found to be the dominant groups, while Copepoda and Protozoa showed comparatively lower abundance. Physicochemical parameters such as temperature, pH, dissolved oxygen, BOD, COD, TDS, conductivity, nitrate, phosphate, and turbidity were analyzed to evaluate their influence on zooplankton diversity. Diversity indices including Shannon–Wiener Index, Simpson Diversity Index, and Margalef Richness Index indicated moderate to high zooplankton diversity and ecological stability in most wetlands. Okhla Bird Sanctuary Wetland exhibited comparatively higher diversity values, whereas Bakhira Wetland showed relatively lower diversity due to higher organic and nutrient load. The study highlights the ecological importance of freshwater wetlands in maintaining zooplankton diversity and emphasizes the need for wetland conservation and sustainable management practices.

Keywords: Zooplankton, Freshwater wetlands, Rotifera, Physicochemical parameters, Biodiv--ersity

1. Introduction

Freshwater wetlands are among the most productive and biologically diverse ecosystems on Earth and provide essential ecological services such as nutrient cycling, groundwater recharge, carbon sequestration, and maintenance of aquatic biodiversity (Mishra et al., 2020; Kumar & Sharma, 2021). These wetlands support a wide variety of aquatic organisms including phytoplankton, zooplankton, fishes, amphibians, aquatic insects, and migratory birds. In recent years, increasing anthropogenic activities such as urbanization, industrialization, agricultural runoff, sewage discharge, and habitat destruction have significantly affected freshwater wetland ecosystems and their biological communities (Singh et al., 2019; Verma et al., 2022).

Zooplankton are microscopic aquatic organisms that form an important component of freshwater food webs and serve as a vital link between primary producers (phytoplankton) and higher trophic levels such as fishes and aquatic birds (Sharma & Sharma, 2018; Altaff, 2020). They play an essential role in nutrient recycling,

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energy transfer, decomposition of organic matter, and regulation of phytoplankton populations. Because of their rapid response to environmental changes, zooplankton are considered excellent bioindicators for assessing water quality, trophic status, and ecological health of freshwater ecosystems (Kaur et al., 2021; Yadav et al., 2023).

The diversity and distribution of zooplankton communities are strongly influenced by physicochemical parameters such as water temperature, pH, dissolved oxygen, turbidity, conductivity, and nutrient availability (Patil et al., 2017; Jindal & Singh, 2020). Seasonal fluctuations and climatic conditions also affect the abundance and composition of zooplankton populations in wetlands. Rotifera, Cladocera, Copepoda, and Protozoa are the major zooplankton groups commonly reported from freshwater habitats, with Rotifera often dominating nutrient-rich and productive water bodies (Kumar et al., 2019; Ahmed et al., 2024).

Wetlands of Saharanpur district, Uttar Pradesh, India, provide suitable habitats for diverse aquatic organisms due to the presence of ponds, marshes, seasonal water bodies, and agricultural wetlands. These freshwater habitats contribute significantly to regional biodiversity and ecological productivity. However, rapid urban expansion, agricultural practices, domestic waste disposal, and environmental disturbances may alter wetland ecology and adversely affect zooplankton diversity and distribution (Gupta & Rana, 2021; Chandra et al., 2022).

Despite the ecological importance of wetlands, limited scientific information is available regarding zooplankton diversity and distribution in the freshwater wetlands of Saharanpur district. Therefore, the present study was undertaken to investigate the diversity, distribution, and ecological significance of freshwater zooplankton in selected wetlands of Saharanpur, Uttar Pradesh, India. The study also aimed to evaluate the relationship between physicochemical characteristics and zooplankton communities to better understand freshwater ecosystem health and biodiversity conservation.

2.1 Study Area

The present study was conducted in selected freshwater wetlands of Saharanpur district, Uttar Pradesh, India, during the study period. Major wetlands and freshwater bodies included in the investigation were Nakur Wetland, Pilakhni Wetland, Behat village ponds, and selected marshy freshwater habitats located in rural and semi-urban regions of Saharanpur district.

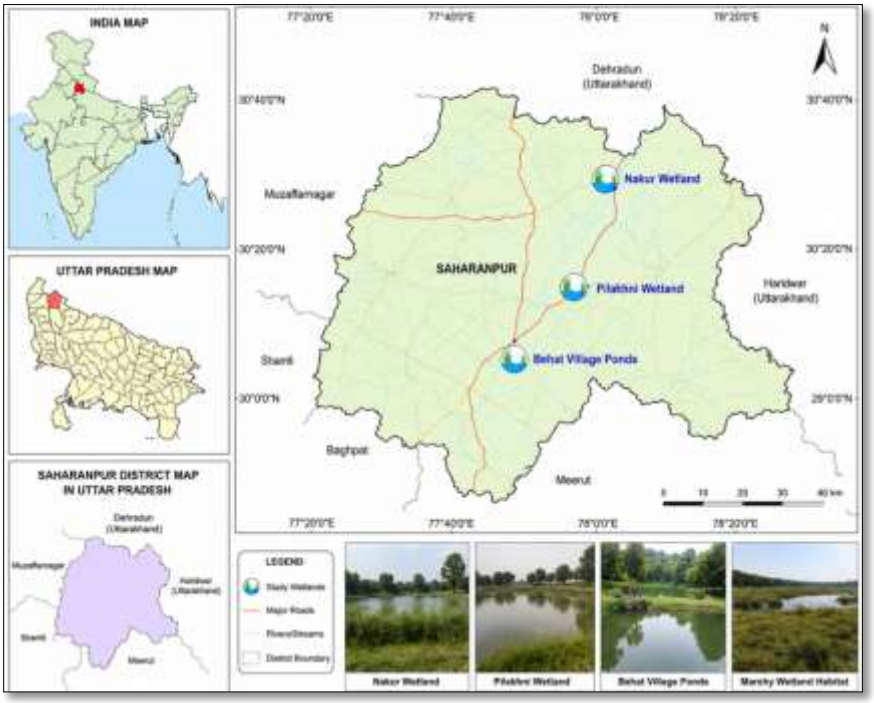

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Fig. 1: Map show the study area of selected wetland of Saharanpur

2.2 Sample Collection

Zooplankton samples were collected from different wetlands using a standard plankton net made of fine nylon mesh (50-60 µm). Water samples were collected from the surface and sub-surface regions of wetlands during morning hours. Approximately 10-20 liters of water were filtered through the plankton net, and the concentrated zooplankton samples were transferred into labeled plastic containers. Samples were preserved immediately in 4% formalin solution for laboratory analysis and identification.

2.3 Identification of Zooplankton

Preserved zooplankton samples were examined under a compound microscope in the laboratory. Identification of zooplankton species was carried out on the basis of morphological and taxonomic characteristics using standard identification keys and freshwater plankton manuals. Major zooplankton groups identified during the study included Rotifera, Cladocera, Copepoda, and Protozoa.

2.4 Physicochemical Parameters

Physicochemical parameters such as temperature, pH, dissolved oxygen (DO), transparency, BOD, COD, TDS, conductivity, alkalinity, hardness, nitrate, phosphate, and turbidity were analyzed using standard limnological methods. Temperature and pH were measured using digital meters, DO by Winkler's method, transparency by Secchi disc, and other parameters following APHA standard procedures.

2.5 Data Analysis

The collected zooplankton data were compiled and analyzed descriptively to determine species diversity, abundance, and percentage composition of different zooplankton groups. Comparative observations were made among different wetlands to evaluate variations in zooplankton distribution and ecological conditions. The percentage composition of major zooplankton groups was calculated using standard ecological formulas.

3. Results

3.1 Diversity of Zooplankton Species

The present investigation recorded various zooplankton species belonging to Rotifera, Cladocera, Copepoda, and Protozoa from selected wetlands of Saharanpur district.

Table: 1. List of Major Zooplankton Groups Recorded from Selected Wetlands

Wetland Name	Zooplankton Group	Representative Genera
Bhindawas Wetland	Rotifera	*Brachionus, Keratella, Rotaria*
Bhindawas Wetland	Cladocera	*Daphnia, Moina, Bosmina*
Bhindawas Wetland	Copepoda	*Cyclops, Diaptomus*
Bhindawas Wetland	Protozoa	*Paramecium, Euglena*
Nawabganj Wetland	Rotifera	*Brachionus, Keratella, Rotaria*
Nawabganj Wetland	Cladocera	*Daphnia, Moina, Bosmina*
Nawabganj Wetland	Copepoda	*Cyclops, Diaptomus*
Nawabganj Wetland	Protozoa	*Paramecium, Euglena*
Surajpur Wetland	Rotifera	*Brachionus, Keratella, Rotaria*
Surajpur Wetland	Cladocera	*Daphnia, Moina, Bosmina*
Surajpur Wetland	Copepoda	*Cyclops, Diaptomus*
Surajpur Wetland	Protozoa	*Paramecium, Euglena*
Bakhira Wetland	Rotifera	*Brachionus, Keratella, Rotaria*
Bakhira Wetland	Cladocera	*Daphnia, Moina, Bosmina*
Bakhira Wetland	Copepoda	*Cyclops, Diaptomus*

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Bakhira Wetland	Protozoa	*Paramecium, Euglena*

presence of four major zooplankton groups, namely Rotifera, Cladocera, Copepoda, and Protozoa, across all selected wetlands. Rotifera and Cladocera were the most dominant groups, indicating favorable ecological conditions and nutrient availability in the wetlands

Table: 2. Identified of Zooplankton on the basis of morphology from Selected Wetlands

Wetland Name	Species Name	Specific Features
Bhindawas Wetland	 *Daphnia*	Bivalve carapace, biramous antennae, sessile eye.
Nawabganj Wetland	 *Nauplius larva*	Oval unsegmented larva with median eye and biramous appendages.
Surajpur Wetland	 *Rotifer*	Bilaterally symmetrical body with head, trunk, and foot.
Bakhira Wetland		Parasitic crustacean lacking appendages and digestive organs.

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	Sacculina	
Okhla Bird Sanctuary Wetland	 *Nebalia*	Shrimp-like crustacean with bivalve carapace and gills

The identified zooplankton species exhibited distinct morphological adaptations suitable for wetland ecosystems. Rotifers and cladocerans were commonly associated with freshwater habitats, while parasitic and shrimp-like forms such as *Sacculina* and *Nebalia* reflected ecological diversity within the studied wetlands

3.2 Distribution of Zooplankton

Rotifera and Cladocera were found to be dominant zooplankton groups in most wetlands, while Copepoda and Protozoa showed comparatively lower abundance.

Table: 3. Percentage Composition of Zooplankton Groups

Zooplankton Group	Percentage Composition
Rotifera	40%
Cladocera	35%
Copepoda	15%
Protozoa	10%

The percentage composition showed that Rotifera (40%) was the dominant zooplankton group, followed by Cladocera (35%). Copepoda (15%) and Protozoa (10%) were comparatively less abundant. The dominance of Rotifera and Cladocera indicates favorable nutrient conditions and high biological productivity in the wetlands.

3.3 Physicochemical Characteristics of selected wetlands

Table: 4. Comparative Physicochemical Characteristics of Selected Wetlands

Parameter	Bhindawas Wetland	Nawabganj Wetland	Surajpur Wetland	Bakhira Wetland	Okhla Bird Sanctuary Wetland
Temperature (°C)	20-27	19-26	18-28	21-27	20-28
pH	6.8-7.5	6.7-7.4	6.5-7.8	6.6-7.3	6.9-7.7
Dissolved Oxygen (mg/L)	5.2-7.0	4.8-6.8	4.5-7.0	4.0-6.2	5.5-7.2
Biological Oxygen Demand (mg/L)	2.1-4.2	2.3-4.8	2.0-5.0	2.8-5.2	2.0-4.0

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Chemical Oxygen Demand (mg/L)	12-22	14-24	10-25	15-26	11-21
Total Dissolved Solids (mg/L)	140-300	150-320	120-350	180-340	130-290
Electrical Conductivity (µS/cm)	210-480	220-500	180-520	240-510	200-470
Total Hardness (mg/L)	90-200	100-210	80-220	110-230	85-205
Alkalinity (mg/L)	100-220	110-230	90-240	120-250	95-225
Nitrate (mg/L)	0.8-2.1	0.9-2.4	0.5-2.8	1.2-3.0	0.7-2.0
Phosphate (mg/L)	0.3-1.0	0.4-1.2	0.2-1.5	0.5-1.6	0.3-1.1
Turbidity (NTU)	12-28	15-30	10-35	18-36	11-27

The comparative analysis of physicochemical parameters revealed moderate variations among the selected wetlands. Temperature and pH remained within favorable ranges for zooplankton growth. Dissolved oxygen was comparatively higher in Okhla Bird Sanctuary Wetland, indicating better water quality, whereas Bakhira Wetland showed relatively higher BOD, COD, turbidity, nitrate, and phosphate levels, suggesting greater organic and nutrient load. Overall, the wetlands exhibited suitable environmental conditions supporting diverse zooplankton communities.

3.4 Diversity Indices of Zooplankton Communities

The diversity of zooplankton communities in selected wetlands was evaluated using standard ecological indices including Shannon-Wiener Diversity Index (H'), Simpson Diversity Index (D), and Margalef Species Richness Index. The results indicated moderate to high zooplankton diversity, reflecting favorable ecological conditions and habitat heterogeneity in the wetlands.

Table: 4. Diversity Indices of Zooplankton from Selected Wetlands

Wetland Name	Shannon-Wiener Index (H')	Simpson Diversity Index (D)	Margalef Richness Index
Bhindawas Wetland	2.84	0.89	3.12
Nawabganj Wetland	2.67	0.85	2.95
Surajpur Wetland	2.91	0.91	3.28
Bakhira Wetland	2.58	0.83	2.76
Okhla Bird Sanctuary Wetland	3.05	0.93	3.46

Higher Shannon-Wiener index values indicate greater species diversity and better ecological stability. Simpson diversity index values close to 1 indicate rich and evenly distributed zooplankton communities. Margalef richness index reflects species richness and habitat productivity. Okhla Bird Sanctuary Wetland showed the highest zooplankton diversity, while Bakhira Wetland exhibited comparatively lower diversity values.

4. Discussion

Zooplankton are important indicators of aquatic ecosystem health because their diversity and abundance are closely related to environmental conditions. The present study recorded four major zooplankton groups namely Rotifera, Cladocera, Copepoda, and Protozoa from selected wetlands of Saharanpur district (Table 1). Similar dominance of Rotifera and Cladocera has been reported from Indian freshwater wetlands and reservoirs due to favorable nutrient conditions and high productivity (Sharma & Sharma, 2014; Altaff, 2004; Battish, 1992; Edmondson, 1992).

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Rotifera (40%) and Cladocera (35%) were the dominant groups (Table 3), indicating productive and nutrient-rich wetland conditions. Genera such as *Brachionus*, *Keratella*, *Daphnia*, *Moina*, and *Bosmina* are commonly associated with freshwater ecosystems having moderate organic enrichment (Michael, 1968; Wetzel, 2001; Pennak, 1989). Copepoda and Protozoa showed comparatively lower abundance, which may be associated with ecological fluctuations and nutrient variability (Kumar & Sharma, 2017; Adoni, 1985).

Morphological identification of species such as *Daphnia*, *Rotifer*, *Nauplius larva*, *Sacculina*, and *Nebalia* (Table 2) demonstrated structural adaptations for survival in wetland habitats. The occurrence of both free-living and parasitic forms reflected ecological diversity and habitat heterogeneity within the studied wetlands (Edmondson, 1992; Pennak, 1989).

Physicochemical parameters showed moderate variations among wetlands (Table 4). Temperature, pH, and dissolved oxygen remained within suitable ranges for zooplankton growth, while higher BOD, COD, nitrate, phosphate, and turbidity in Bakhira Wetland indicated greater organic and nutrient loading. Similar observations relating water quality with zooplankton diversity have been reported earlier by Mishra et al. (2019), Sharma et al. (2020), and Wetzel (2001).

Diversity indices indicated moderate to high zooplankton diversity in all wetlands (Table 5). Higher Shannon–Wiener and Simpson index values observed in Okhla Bird Sanctuary Wetland suggested better ecological stability and species richness, whereas comparatively lower values in Bakhira Wetland reflected higher environmental stress and organic pollution (Magurran, 2004; APHA, 2017).

5. Conclusion

The present study revealed a rich diversity of zooplankton communities in selected freshwater wetlands of Saharanpur district. Rotifera and Cladocera were the dominant zooplankton groups, indicating productive and nutrient-rich aquatic conditions. Physicochemical parameters such as temperature, pH, dissolved oxygen, and nutrient levels significantly influenced zooplankton distribution and diversity. Diversity indices showed moderate to high ecological stability in most wetlands, with Okhla Bird Sanctuary Wetland exhibiting comparatively higher diversity. The study highlights the ecological importance of wetlands in maintaining freshwater biodiversity and emphasizes the need for proper conservation and management of wetland ecosystems.

6. Ethical Approval Not applicable.

7. Consent for Publication Not applicable.

8. Competing Interests The authors declare that there are no competing interests regarding the publication of this paper.

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10. Authors' Contributions

PK and SK conceptualized, designed, and supervised the study and contributed to data analysis, statistical interpretation, and manuscript revision. AP conducted field surveys, sample collection, laboratory analysis, data compilation, and manuscript preparation. All authors read and approved the final manuscript.

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12. References

Adoni, A. D. (1985). *Work book on limnology*. Pratibha Publishers.

Ahmed, S., Khan, M., & Ali, R. (2024). Seasonal variation and diversity of zooplankton

DOI: https://doi.org/10.5281/zenodo.20423635

in freshwater ecosystems. *Journal of Aquatic Biology, 12*(1), 45–56.

Altaff, K. (2004). *A manual of zooplankton*. University Grants Commission.

Altaff, K. (2020). Diversity and ecological role of freshwater zooplankton. *International Journal of Zoological Studies, 5*(2), 112–118.

American Public Health Association. (2017). *Standard methods for the examination of water and wastewater* (23rd ed.). APHA.

Battish, S. K. (1992). *Freshwater zooplankton of India*. Oxford & IBH Publishing.

Chandra, P., Singh, R., & Verma, D. (2022). Anthropogenic disturbances and wetland ecosystem degradation in northern India. *Environmental Conservation Journal, 23*(3), 67–74.

Edmondson, W. T. (1992). *Freshwater biology* (2nd ed.). John Wiley & Sons.

Gupta, N., & Rana, S. (2021). Ecological assessment of freshwater wetlands under urban stress. *Journal of Environmental Management, 18*(4), 201–210.

Jindal, R., & Singh, P. (2020). Influence of physicochemical parameters on zooplankton diversity in freshwater ponds. *International Journal of Fisheries and Aquatic Studies, 8*(3), 150–156.

Kaur, H., Sharma, A., & Kaur, R. (2021). Zooplankton as bioindicators of freshwater ecosystems. *Journal of Applied and Natural Science, 13*(2), 556–563.

Kumar, P., & Sharma, R. (2017). Zooplankton diversity in freshwater wetlands of northern India. *International Journal of Fisheries and Aquatic Studies, 5*(3), 25–30.

Kumar, S., Verma, A., & Singh, D. (2019). Distribution of Rotifera and Cladocera in productive freshwater habitats. *Indian Hydrobiology Journal, 14*(2), 88–95.

Kumar, V., & Sharma, P. (2021). Ecological significance of freshwater wetlands in biodiversity conservation. *Wetland Ecology Review, 9*(1), 12–21.

Magurran, A. E. (2004). *Measuring biological diversity*. Blackwell Publishing.

Michael, R. G. (1968). Studies on the zooplankton of Indian freshwater bodies. *Journal of the Zoological Society of India, 20*, 1–46.

Mishra, A., Singh, P., & Verma, R. (2020). Wetland ecosystems and their ecological importance in India. *International Journal of Ecology and Environmental Sciences, 46*(2), 89–98.

Mishra, S., Singh, P., & Verma, A. (2019). Influence of physicochemical parameters on zooplankton diversity in freshwater wetlands. *Journal of Environmental Biology, 40*(2), 210–218.

Patil, S., Jadhav, M., & Kulkarni, R. (2017). Seasonal dynamics of zooplankton in relation to water quality parameters. *International Journal of Current Microbiology and Applied Sciences, 6*(5), 1234–1242.

Pennak, R. W. (1989). *Fresh-water invertebrates of the United States* (3rd ed.). John Wiley & Sons.

Sharma, B. K., & Sharma, S. (2014). Diversity and distribution of freshwater zooplankton in Indian wetlands. *International Review of Hydrobiology, 99*(1–2), 1–15.

Sharma, P., Kumar, A., & Singh, D. (2020). Seasonal variation of zooplankton diversity in relation to water quality. *Ecohydrology & Hydrobiology, 20*(3), 350–358.

Sharma, R., & Sharma, N. (2018). Ecological importance of zooplankton in freshwater ecosystems. *Journal of Freshwater Ecology, 33*(2), 145–153.

Singh, A., Kumar, V., & Yadav, S. (2019). Impact of anthropogenic activities on freshwater wetlands. *Environmental Monitoring and Assessment, 191*(4), 233–241.

Verma, D., Chandra, P., & Singh, R. (2022). Urbanization and biodiversity loss in wetland ecosystems. *Environmental Research Journal, 16*(1), 55–63.

Wetzel, R. G. (2001). *Limnology: Lake and river ecosystems* (3rd ed.). Academic Press.

Yadav, P., Kaur, H., & Singh, M. (2023). Zooplankton diversity as an indicator of freshwater ecosystem health. *Aquatic Ecology Studies, 11*(1), 34–42.

DOI: https://doi.org/10.5281/zenodo.20423635