International Journal of Scientific Research and Modern Technology (IJSRMT) ijsrmt.com
Volume 5, Issue 5, 2026
DOI: https://doi.org/10.38124/ijsrmt.v5i5.1432

Seasonal Assessment of Zooplankton Communities in Ponds of Hisua Block, Nawada, Bihar

Pinku Kumar[1]; Dr. Bhrigu Nath[2]

[2]Associate Professor

[1,2]PG Department of Zoology, Magadh University, Bodhgaya, Bihar, India

Publication Date: 2026/05/23

Abstract

Zooplankton constitute a key trophic link between primary producers and higher consumers and are widely used as bioindicators of freshwater ecosystem health. Seasonal changes in monsoon-driven systems of the Indo-Gangetic plain strongly influence hydrology and water quality, with consequences for plankton community structure. The present study investigated seasonal variation in zooplankton communities and basic physicochemical characteristics of three village ponds located in Hisua Block, Nawada District, Bihar, India, during pre-monsoon and post-monsoon periods in 2024. One pond each from Gopalpur, Bagodar, and Chandipur villages was selected as a representative perennial pond subjected to domestic and agricultural use. From each pond, five replicate plankton samples were collected in pre-monsoon and post-monsoon seasons, and zooplankton were quantified to major taxonomic groups (Cladocera, Copepoda, Ostracoda, Protozoa, and Rotifera). Concurrently, water depth, transparency, temperature, pH, dissolved oxygen, total alkalinity, and total hardness were measured following standard limnological protocols. Across all ponds, total zooplankton abundance increased from pre-monsoon to post-monsoon, driven mainly by marked rises in Cladocera, Copepoda, and Ostracoda, while Rotifera densities declined and Protozoa showed pond-specific trends. Rotifera dominated numerically in pre-monsoon, whereas the community became more evenly shared between rotifers, cladocerans, and copepods in post-monsoon. The results highlight clear seasonal restructuring of zooplankton communities associated with monsoon-related changes in water column depth and basic chemistry, and demonstrate the value of small village ponds in Hisua Block as productive freshwater habitats with potential implications for fisheries and local water management.

Keywords: *Zooplankton; Seasonal Variation; Pond Ecosystems; Physicochemical Parameters; Monsoon; Hisua Block.*

I. INTRODUCTION

Zooplankton serve pivotal functions in aquatic food chains of freshwater systems, functioning as herbivores on phytoplankton and bacteria while serving as prey for fish larvae and adults (Chen, Qi, et al., 2025; Pereira, Leonel, 2025). Short life cycles and constant immersion make them highly responsive to ecological shifts, earning them status as reliable sentinels of pollution, nutrient overload, and stress (Goździejewska, Anna Maria, et al., 2024). In tropical and subtropical regions influenced by monsoonal rainfall, seasonal changes in hydrology strongly affect physicochemical parameters such as temperature, depth, transparency, dissolved oxygen, and nutrient concentrations, which together regulate plankton productivity and community composition (Rahman, Md Mofizur, et al., 2025).

Numerous investigations across India's inland aquatic ecosystems have revealed striking seasonal fluctuations in zooplankton populations and species richness, closely tied to environmental physicochemical profiles. Studies from northern and central Indian lakes, ponds, and reservoirs frequently document greater zooplankton concentrations before and after the monsoon compared to its peak, attributing this to better light penetration, increased oxygenation, and optimal nutrient regimes (Rajashekhar, M., et al., 2010; Manjunath, Honganur Raju, et al., 2025; Ujjania, N. C., 2014; Sharma, Ramesh C., and Rama Kumari, 2018; Koli, K. B., and D. V. Muley, 2012). Rotifers, Cladocera, Copepoda, and Ostracoda form the core community, frequently with rotifers and copepods outnumbering others. Statistical correlations from varied water bodies further demonstrate that zooplankton numbers positively associate with transparency, oxygen content, and mild

Kumar, P., & Nath, D. B. (2026). Seasonal Assessment of Zooplankton Communities in Ponds of Hisua Block, Nawada, Bihar. *International Journal of Scientific Research and Modern Technology*, *5*(5), 28–23. https://doi.org/10.38124/ijsrmt.v5i5.1432

alkalinity, while inversely relating to extreme heat, sediment turbidity, and pollution markers like elevated biochemical oxygen demand (Ganvir, Prachi M., and Deepak S. Bansod, 2022; Gavrilko, Dmitriy, et al., 2024; Asibor, Godwin, and Funso Adeniyi, 2021).

At the core of the Indo-Gangetic basin, Bihar depends on its extensive network of village ponds and tanks for domestic needs, crop irrigation, and small-scale fisheries. Emerging research on temple and aquaculture ponds in Bihar and adjacent Jharkhand reveals rich plankton diversity alongside strong productivity, yet signals growing pressures from excess nutrients, sewage inputs, and unregulated fish culture (Kumari, Mahima, and Prashant Kumar, 2024; Shachi, Kumari, et al., 2020; Kant, Shashi, et al., 2022). Yet, foundational data on zooplankton's seasonal shifts and water quality traits continue to elude documentation in user-intensive village ponds across multiple districts.

Hisua Block, situated in southern Bihar's Nawada District, features abundant perennial ponds central to household water needs and modest fisheries. These ponds experience strong seasonal hydrological changes driven by the southwest monsoon and receive runoff from surrounding agricultural fields and human settlements. However, rigorous assessments of how these monsoon effects on depth and water properties reshape zooplankton assemblages are largely absent for the area. Acquiring these findings is key to biodiversity profiling, bioindicator analysis, and forward-looking pond governance with bolstered small-scale aquaculture prospects.

Accordingly, the current work assessed zooplankton populations seasonally in three ponds of Hisua Block, selecting one from Gopalpur, Bagodar, and Chandipur villages during 2024's pre- and post-monsoon intervals. Aims encompassed: (i) characterizing pond water's physicochemical basics before/after rains; (ii) assessing major zooplankton abundances by pond and season; and (iii) tying faunal changes to water quality dynamics. By providing fresh baseline insights for Nawada, this research bolsters wider Indian scholarship viewing zooplankton dynamics as barometers of freshwater habitat integrity.

II. MATERIALS AND METHODS

➢ *Study Area*

This research was conducted in Hisua Block, Nawada District, Bihar, within eastern India's subtropical monsoon zone. The climate is characterized by a hot pre-monsoon summer (April–June), a rainy monsoon season (July–September), and a winter period (October–February). Three reliable village ponds, drawn one from Gopalpur, Bagodar, and Chandipur respectively, stood in for prevalent local water systems. These open, earthen ponds serve multiple uses, accepting household sewage, livestock bathing water, and farm runoff from nearby fields. Throughout this work, they are designated Pond 1 (Gopalpur), Pond 2 (Bagodar), and Pond 3 (Chandipur).

➢ *Sampling Design and Period*

Sampling was conducted in two distinct hydrological phases during 2024: pre-monsoon (May–June) and post-monsoon (September–October). Five replicate samples per pond were obtained each season. At each sampling point, measurements of physicochemical parameters were taken in situ or on freshly collected water as described below. Zooplankton was sampled simultaneously from the same points, guaranteeing synchronized biological and physicochemical data for robust spatial-temporal matching.

➢ *Physicochemical Analysis*

Water quality parameters in pond ecosystems were systematically evaluated across pre- and post-monsoon periods employing established field and lab protocols. Measurements encompassed water depth, transparency (Secchi disc), temperature, pH, DO, total alkalinity, and hardness, strictly adhering to APHA (Bridgewater, Laura L., 2017). All measurements were made carefully at each sampling site to assess seasonal variation in pond water quality and its relationship with zooplankton distribution.

➢ *Zooplankton Collection and Identification*

Zooplankton were collected by filtering 50 litres of pond water through a bolting silk plankton net (mesh no. 25) at each site. Multiple oblique and horizontal hauls per station yielded a composite sample of the euphotic zone. The filtrate was transferred to vials and preserved on-site in 4% buffered formaldehyde. Enumeration and taxonomic assessment occurred via Sedgwick-Rafter cells examined under compound microscopy at suitable magnifications. Organisms were classified into principal groups—Cladocera, Copepoda, Ostracoda, Protozoa, and Rotifera—using established keys for Indian inland water zooplankton.

➢ *Statistical Analysis*

Zooplankton densities were reported as mean ± standard error of the mean (SEM) based on five replicates per pond per season (n=5). Inter-seasonal variations (pre- vs. post-monsoon) were assessed via two-way ANOVA with subsequent Bonferroni post-hoc testing using GraphPad Prism version 5.0. Significance levels were set at $p<0.05$ ($p<0.05$, $p<0.01$, $p<0.001$ vs. pre-monsoon baselines).

III. RESULTS

➢ *Seasonal Variation in Physicochemical Parameters*

Marked seasonal differences were observed in the basic physicochemical characteristics of the three ponds (Table 1).

Table 1 Physicochemical Parameters of Pond Water During Pre- and Post-Monsoon Seasons.

Parameter	Range	
	Pre-Monsoon	Post-Monsoon
Water depth (m)	0.5 – 1.5	1.0 – 3.5
Transparency (cm)	10 – 40	20 – 70
Water temperature (°C)	28 – 35	20 – 28
pH	7.5 – 9.0	6.8 – 8.2
Dissolved Oxygen (mg/L)	3.5 – 6.5	5.5 – 9.0
Total alkalinity (mg/L)	60 – 120	40 – 100
Total hardness (mg/L)	150 – 350	80 – 250

➢ *Seasonal Dynamics of Major Zooplankton Groups Across Study Ponds*

Table 2 Zooplankton Abundance in Pond 1 (Pre- and Post-Monsoon Season)

Pond 1	**Zooplankton Abundance (Mean ± SEM)**	
Zooplankton Group	**Pre-Monsoon (No./L)**	**Pre-Monsoon (No./L)**
Cladocera	108.4 ± 6.00	152.8 ± 6.14
Copepoda	88.4 ± 7.03	127.6 ± 5.23
Ostracoda	43.2 ± 3.35	81.6 ± 4.92
Protozoa	126.0 ± 5.58	74.2 ± 5.95
Rotifera	244.4 ± 23.26	148.4 ± 12.36
Total Zooplankton	**610.4 ± 25.85**	**584.6 ± 16.65**

Zooplankton communities in the three ponds were consistently dominated by Rotifera, Cladocera, Copepoda, Ostracoda, and Protozoa (Table 2-4; Figures 1-3). All groups were recorded in both seasons, but their relative abundances exhibited consistent seasonal trends. Pre-monsoon conditions favored Rotifera dominance across all ponds, with densities substantially exceeding those of other groups. Cladocera and Copepoda ranked second, supported by lower Ostracoda and Protozoa abundances. Inter-pond consistency was evident, though one pond showed elevated rotifers and another protozoan prominence. Post-monsoon witnessed marked density increases site-wide, particularly for Cladocera, Copepoda, and Ostracoda, which rose significantly relative to pre-monsoon levels. Rotifera, conversely, receded in prominence, both numerically and proportionally, in every pond. Protozoa responded with pond-specific moderation, fostering greater equilibrium among groups overall. Such patterns evoke a responsive aquatic biota attuned to seasonal hydrological and chemical cues, underscoring the adaptability of freshwater ecosystems to monsoonal rhythms.

Table 3 Zooplankton Abundance in Pond 2 (Pre- and Post-Monsoon Season)

Pond 2	**Zooplankton Abundance (Mean ± SEM)**	
Zooplankton Group	**Pre-Monsoon (No./L)**	**Pre-Monsoon (No./L)**
Cladocera	108.6 ± 4.52	139.6 ± 5.46
Copepoda	71.6 ± 4.94	109.4 ± 3.91
Ostracoda	48 ± 4.76	62 ± 4.92
Protozoa	116 ± 9.05	67.8 ± 6.17
Rotifera	243.8 ± 22.19	136.4 ± 9.96
Total Zooplankton	**588.0 ± 25.34**	**515.2 ± 14.37**

Table 4 Zooplankton Abundance in Pond 3 (Pre- and Post-Monsoon Season)

Pond 3	**Zooplankton Abundance (Mean ± SEM)**	
Zooplankton Group	**Pre-Monsoon (No./L)**	**Pre-Monsoon (No./L)**
Cladocera	111.4 ± 2.15	151 ± 4.19
Copepoda	72.2 ± 6.18	113.4 ± 7.52
Ostracoda	41.6 ± 4.85	60.6 ± 4.57
Protozoa	63.8 ± 7.01	75 ± 4.55
Rotifera	186.4 ± 22.71	148.8 ± 12.50
Total Zooplankton	**475.4 ± 25.13**	**548.8 ± 16.49**

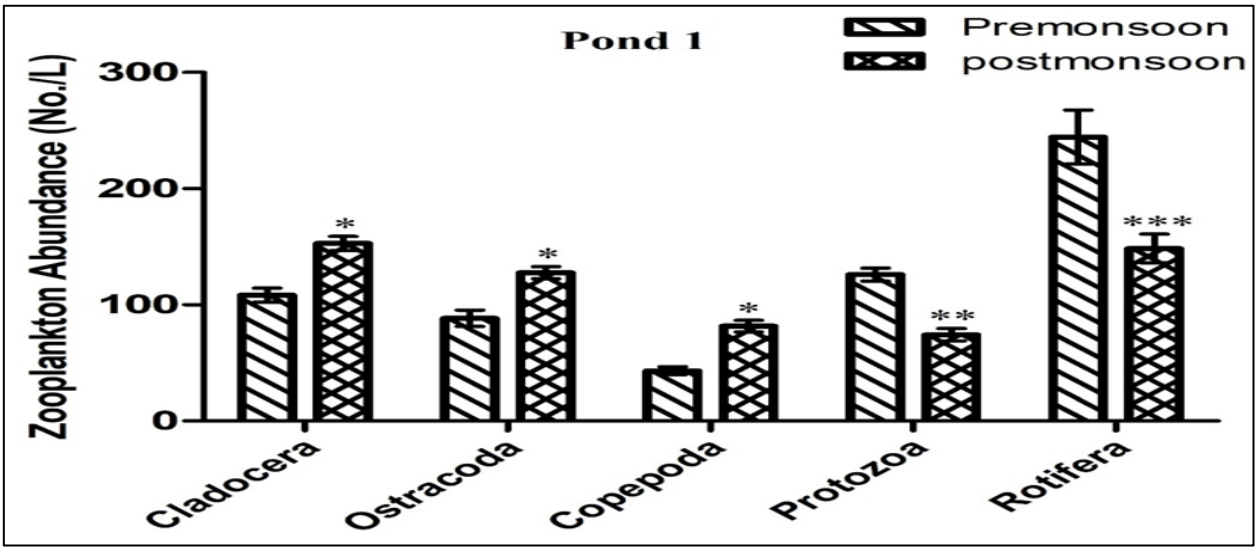

Fig 1 Mean Abundance (±SEM) of Major Zooplankton Groups in Pond 1 During Pre-Monsoon and Post-Monsoon Seasons. Significant Differences: *p<0.05,* p<0.01, *p<0.001 (Two-Way ANOVA with Bonferroni Post-Hoc Test).*

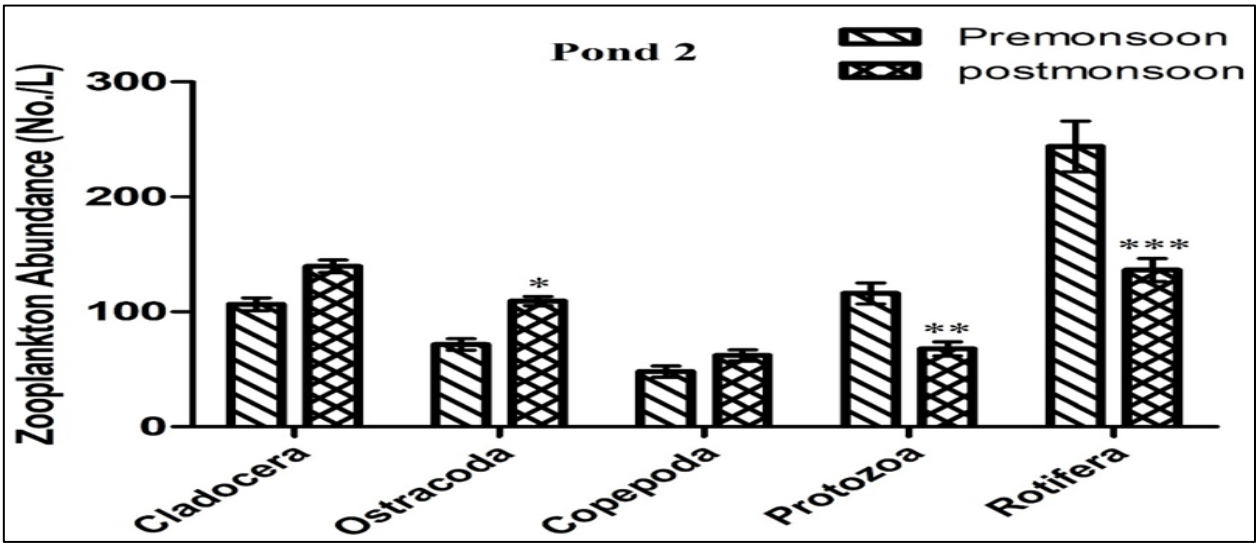

Fig 2 Mean Abundance (±SEM) of Major Zooplankton Groups in Pond 2 During Pre-Monsoon and Post-Monsoon Seasons. Significant Differences: *p<0.05,* p<0.01, *p<0.001 (Two-Way ANOVA with Bonferroni Post-Hoc Test).*

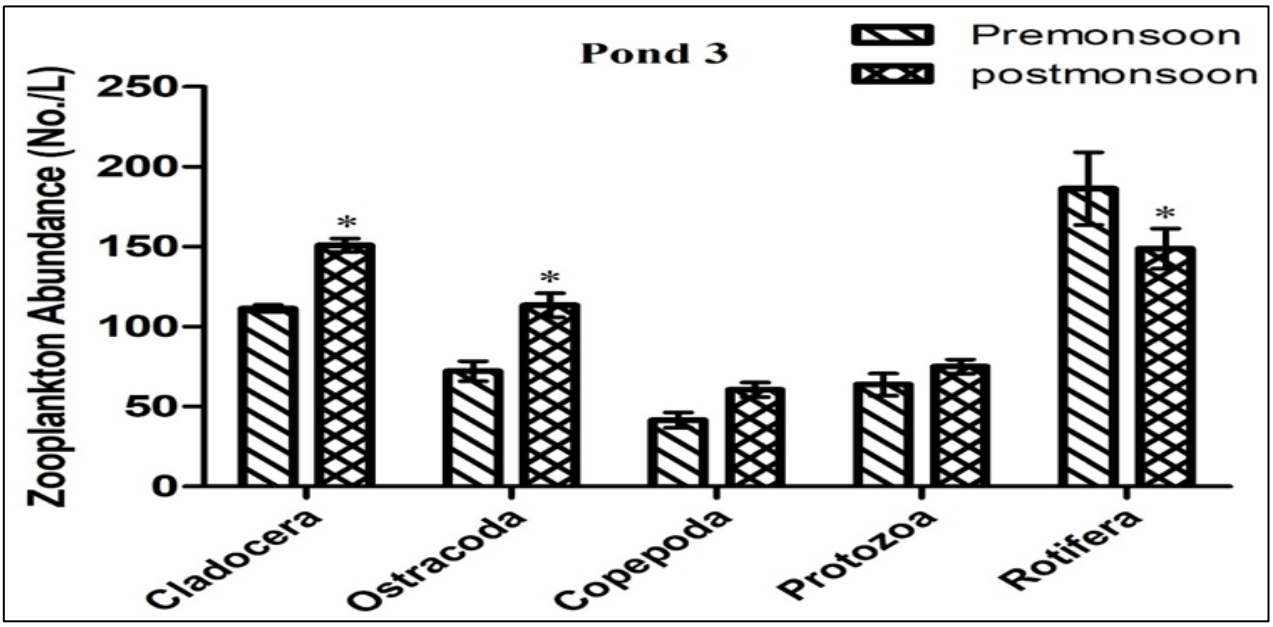

Fig 3 Mean Abundance (±SEM) of Major Zooplankton Groups in Pond 3 During Pre-Monsoon and Post-Monsoon Seasons. Significant Differences: *p<0.05,* p<0.01, *p<0.001 (Two-Way ANOVA with Bonferroni Post-Hoc Test).*

IV. DISCUSSION

The prevalence of Rotifera, Cladocera, and Copepoda as primary groups, supplemented by lesser roles of Ostracoda and Protozoa, mirrors patterns documented in fellow Indian ponds and minor aquatic systems. Accounts from Jharkhand's Raja Bandh pond and Jammu's Barnai pond describe matching taxonomic setups, featuring rotifer numerical supremacy followed by copepods and cladocerans (Singh, S., et al., 2021; Sharma, Arti, and Meenu Sharma, 2019). Investigations in ponds and reservoirs across Bihar and neighbouring states likewise highlight these groups as the primary constituents of freshwater zooplankton (Rajashekhar, M., et al., 2010; Manjunath, Honganur Raju, et al., 2025; Ujjania, N. C., 2014; Sharma, Ramesh C., and Rama Kumari, 2018; Koli, K. B., and D. V. Muley, 2012).

Documented patterns across Indian freshwater systems frequently reveal transitions from rotifer-dominated assemblages during periods of elevated warmth, nutrient surplus, or hydrological constraint to enhanced proportions of cladocerans and copepods in cooler, more transparent waters. Northern and central Indian lake and reservoir studies pinpoint maximal zooplankton richness before or after monsoon peaks, when deluge-driven nutrient washout and sediment loading suppress populations (Ujjania, N. C., 2014; Rajashekhar, M., et al., 2010; Manjunath, Honganur Raju, et al., 2025; Vijayasree, T. S., and M. V. Radhakrishnan, 2017; Sharma, Ramesh C., and Rama Kumari, 2018; Koli, K. B., and D. V. Muley, 2012). In the present study, sampling was restricted to pre-monsoon and post-monsoon, but the higher total zooplankton abundance in post-monsoon relative to pre-monsoon is consistent with studies where post-monsoon often supports rich crustacean communities after the flushing and cooling effects of the monsoon.

The pronounced seasonal shifts in zooplankton community structure observed here carry significant implications for pond utilization and ecological monitoring. Notably, the diverse mix featuring prominent cladocerans, copepods, and rotifers points to robust food web dynamics, indicative of mesotrophic conditions conducive to fisheries development. Parallel investigations attribute these traits, combined with temperate physicochemical conditions, to intermediate eutrophication levels favorable for fisheries enhancement and resource optimization (Qi, Jiangqianhui, et al., 2025; Karpowicz, Maciej, et al., 2025).

Particularly, post-monsoon elevations in total density, with emphasis on bulkier crustaceans favored by young fish, position this phase as pivotal for replenishment activities. Coupling stocking operations with amplified zooplankton resources may elevate hatchery performance in village contexts, in opposition to pre-monsoon stressors like diminished volume and amplified hardness that temper such ambitions. Finally, it furnishes an efficient blueprint for inexpensive monitoring, integrating zooplankton metrics with rudimentary water chemistry via accessible techniques. Consistent seasonal inventories could pinpoint advancing trophic overloads, contamination episodes, or chronic anoxia, betrayed by hardy dominants and taxonomic simplification, empowering evidence-based rural waterbody governance.

V. CONCLUSION

Village ponds in Hisua Block, Nawada, host diverse zooplankton communities that shift markedly from rotifer dominance in shallow, warm pre-monsoon conditions to balanced cladoceran-copepod assemblages post-monsoon, driven by changes in depth, temperature, transparency, DO, and water chemistry. These patterns highlight zooplankton as practical bioindicators for monitoring rural pond health and optimizing community fisheries management.

REFERENCE

[1]. Asibor, Godwin, and Funso Adeniyi. 2021. "Correlation between Seasonal Physicochemical Parameters and Zooplankton Diversity in Asejire Reservoir, Southwest Nigeria." *International Journal of Biology* 3 (1): 41–45.

[2]. Bridgewater, Laura L. 2017. *Standard Methods for the Examination of Water and Wastewater*. American Public Health Association.

[3]. Chen, Qi, Jinrui Zhang, Yiming Liu, Hongjingzheng Jiang, Gang Liu, and Xuwang Yin. 2025. "Nutrient-Driven Shifts in Zooplankton Structural-Functional Dynamics across Different Types of Freshwater Systems." *Water Biology and Security*: 100449.

[4]. Ganvir, Prachi M., and Deepak S. Bansod. 2022. "Zooplankton, Phytoplankton, Avifauna and Ichthyofauna Diversity in Gadchiroli Lake, Maharashtra, India."

[5]. Gavrilko, Dmitriy, Vyacheslav Zhikharev, Tatyana Zolotareva, Ivan Kudrin, Basil Yakimov, and Aleksandra Erlashova. 2024. "Biodiversity of Zooplankton (Rotifera, Cladocera and Copepoda) in the Tributaries of Cheboksary Reservoir (Middle Volga, Russia)." *Biodiversity Data Journal* 12: e116330.

[6]. Goździejewska, Anna Maria, Ireneusz Cymes, and Katarzyna Glińska-Lewczuk. 2024. "Zooplankton Functional Diversity as a Bioindicator of Freshwater Ecosystem Health across Land Use Gradient." *Scientific Reports* 14 (1): 18456.

[7]. Kant, Shashi, M. K. Dubey, and N. K. Mandal. 2022. "Plankton Diversity in a Fish Pond of Godda District (Santal Pargana), Jharkhand." *Journal of Environment & Biosciences* 36 (2).

[8]. Karpowicz, Maciej, Natalia Kuczyńska-Kippen, Łukasz Sługocki, Robert Czerniawski, Elżbieta Bogacka-Kapusta, and Jolanta Ejsmont-Karabin.

2025. “Zooplankton as Indicators of Lake Trophic Status: Novel Universal Metrics from 224 Temperate Lakes.” *Ecological Indicators* 179: 114236.

[9]. Koli, K. B., and D. V. Muley. 2012. “Study of Zooplankton Diversity and Seasonal Variation with Special Reference to Physicochemical Parameters in Tulshi Reservoir of Kolhapur District (MS), India.” *E-International Scientific Research Journal* 4 (1): 38–46.

[10]. Kumari, Mahima, and Prashant Kumar. 2024. “Study of Planktonic Diversity and Ichthyo-Diversity in the Temple Pond of Ujain, Siwan, Bihar (India).” *Research Journal of Science and Technology* 16 (1): 43–50.

[11]. Manjunath, Honganur Raju, Varun Kumar Sharma, J. Guntaj, and Swarna Swetha Kolaventi. 2025. “Investigating the Seasonal Dynamics of Zooplankton Abundance in Relation to Water Quality Parameters.” *Natural and Engineering Sciences* 10 (1): 279–289.

[12]. Pereira, Leonel, ed. 2025. *The Role of Plankton in Freshwater and Marine Ecology*. BoD–Books on Demand.

[13]. Qi, Jiangqianhui, Yang Wang, Jing Yuan, Chuansong Liao, Jiashou Liu, and Chuanbo Guo. 2025. “Variations of Zooplankton Community as Bioindicators of Eutrophication and Water Quality in Shallow Yangtze Lakes.” *Limnologica* 112: 126248.

[14]. Rahman, Md Mofizur, Md Robiul Hasan, Md Milon Sarker, Md Saeduzzaman Faraji, Mehedi Mahmudul Hasan, Asma Jaman, Takaomi Arai, Norhayati Ngah, and Mohammad Belal Hossain. 2025. “Zooplankton Diversity Patterns, Assemblage, and Environmental Determinants in a Seasonally Dynamic Tropical River.” *Science Progress* 108 (4): 00368504251403063.

[15]. Rajashekhar, M., K. Vijaykumar, and Zeba Parveen. 2010. “Seasonal Variations of Zooplankton Community in Freshwater Reservoir, Gulbarga District, Karnataka, South India.” *International Journal of Systems Biology* 2 (1): 6.

[16]. Shachi, Kumari, Sanjeev Kumar, and Nayan Kumar Prasad. 2020. “Distribution and Abundance of Macroinvertebrates within Two Ponds of LNMU Campus, Darbhanga, Bihar.” *Uttar Pradesh Journal of Zoology* 41 (15): 12–21.

[17]. Sharma, Arti, and Meenu Sharma. 2019. “Zooplankton Diversity in Relation to Physico-Chemical Parameters in Subtropical Pond of Jammu, Jammu and Kashmir, India.” *Biosciences Biotechnology Research Asia* 16 (2): 425–439.

[18]. Sharma, Ramesh C., and Rama Kumari. 2018. “Seasonal Variation in Zooplankton Community and Environmental Variables of Sacred Lake Prashar, Himachal Pradesh, India.” *International Journal of Fisheries and Aquatic Studies* 6 (2): 207–213.

[19]. Singh, S., V. Kumari, E. Usmani, R. Dutta, R. Kumari, J. Kumari, and M. Arif. 2021. “Study on Zooplankton Diversity in a Freshwater Pond (Raja Bandh) of Jamtara, Jharkhand, India.” *International Journal of Advancement in Life Sciences Research* 4 (2): 5–13.

[20]. Ujjania, N. C. 2014. “Diversity and Seasonal Variations of Zooplankton in Jaisamand Lake, Udaipur, India.” *Indian Journal of Animal Research*.

[21]. Vijayasree, T. S., and M. V. Radhakrishnan. 2017. “Seasonal Variations in Diversity and Dynamics of Zooplankton in Kuttanad River.” *Environment & Ecology* 35 (1B): 405–410.