Pen & Prosperity

Website: https://penandprosperity.vgcet.com

**Volume 2 :: Issue 3 :: September 2025 :: e-ISSN- 3048-9555 :: DOI Link : https://doi.org/10.70798/PP/020300016**

# Seasonal Variations of Zooplankton Diversity in Freshwater Aquatic Bodies in Sub-Urban West Bengal

***Sibendu Dutta & Dr. Koomkoom Khawas***

Research Scholar, Department of Zoology, RKDF University

***Sibendu Dutta & Dr. Koomkoom Khawas***

Assistant Professor, Department of Chemistry, RKDF University, Ranchi

Email ID: Koomkoom.khawas@rkdfuniversity.org

ARTICLE INFO

*Article history:*

**Received: 10** August 2025

**Received** in revised form 20 August 2025

**Accepted** 29 August 2025

**Citation: Dutta. S. & Khawas. Dr. K.,** (2025) "Seasonal Variations of Zooplankton Diversity in Freshwater Aquatic Bodies in Sub-Urban West Bengal", *Pen and Prosperity*, Vol. 2, Issue. 3, September 2025.

**Abstract:**

*Zoo plankton connect primary producers to higher trophic levels and are sensitive bio-indicators of environmental health in freshwater environments. This study studies seasonal zooplankton diversity in suburban Kolkata ponds in Birati, New Barrackpore, Madhyamgram, and Panihati to determine how climatic rhythms, ecological adaptations, and anthropogenic pressures affect community dynamics. Monthly sampling at numerous locations in each pond showed seasonal changes in Rotifera, Cladocera, Copepoda, Ostracoda, and Protozoa abundance and composition. Rotifers, especially Brachionus species, increased in winter due to their adaptability to nitrogen enrichment and lower temperatures. Cladocerans like Diaphanosoma and Moina had pond-specific seasonal peaks, showing niche partitioning and competition. Winter surges of copepods, dominated by Cyclops and Calanus, showed their cold resistance and importance as larval fish food. Ostracods had life-stage-dependent seasonal tactics, while Euglena, Vorticella, and Paramoecium demonstrated ecosystem functioning from a microbiological perspective. Cooler months enhance zooplankton multiplication, although inter-pond variances show the impact of local circumstances including nutrition loading, predation pressure, and microhabitat variety. Despite sewage intrusion, eutrophication, and cultural practices, these complementing seasonal dynamics maintain food web energy transmission and ecosystem stability. Seasonal monitoring is crucial for understanding biodiversity dynamics, fisheries management, water quality evaluation, and conservation strategies in increasingly urbanizing areas. The work shows how long-term zooplankton diversity monitoring in sub-urban West Bengal might reveal freshwater ecosystem resilience and function by merging species-level data with ecological patterns.*

**Keywords:** *Zooplankton, Rotifera, Cladocera, Copepoda, Ostracoda, Protozoa.*

## 1. Introduction:

Since zooplankton are sensitive markers of water quality and crucial to the maintenance of aquatic food webs, it is of tremendous ecological and environmental significance to monitor seasonal changes in zooplankton diversity in freshwater aquatic bodies of Kolkata and its surrounding suburban areas. Seasonal shifts impact the region's freshwater habitats, which include wetlands, canals, rivers, ponds, and lakes. These ecosystems are impacted by temperature swings, nutrient loads (both natural and man-made), and the dominance of the monsoon climate. The quantity, diversity, and composition of zooplankton reflect the health and productivity of aquatic ecosystems. As main consumers, they play a vital role in connecting phytoplankton to higher trophic levels, including fish. Because of the high population density, increasing urbanization, sewage discharge, and agricultural runoff—all of which aggravate eutrophication and disturb aquatic ecological balance—seasonal monitoring becomes particularly critical in Kolkata and its suburbs. High temperatures and increased evaporation during the summer and pre-monsoon seasons reduce water levels, which in turn concentrates nutrients and encourages algae blooms. This has a profound effect on zooplankton composition, favouring species that can withstand pollution. In contrast, zooplankton communities may undergo a change in response to the substantial rainfall and allochthonous material input that occurs during the monsoon season, which dilutes pollutants but also introduces new nutritional loads. More species richness and diversity is commonly supported during the post-monsoon and winter periods due to the stabilization of water conditions, lower temperatures, and higher oxygen availability. Researchers can evaluate the resistance of freshwater bodies to environmental pressures and learn about dominance patterns among taxa like Rotifera, Cladocera, Copepoda, and Ostracoda by tracking such seasonal variations. Untreated sewage and industrial effluents are becoming an increasing problem in these water bodies, and zooplankton diversity investigations in urban and peri-urban Kolkata assist discover bio-indicators of organic pollution and heavy metal contamination. Suburban people rely on local fisheries for their livelihood, and the decline of zooplankton variety threatens both those fish stocks and the ecological balance. Climate change is changing the hydrological cycles in the Ganga-Brahmaputra delta region, where Kolkata is located, and affecting rainfall patterns and the frequency of heat waves. To detect these changes, long-term seasonal monitoring is also important. Different levels of ecological stress and human influence can be revealed by comparing the seasonal diversity of urban water bodies like Rabindra Sarobar or Subhas Sarobar with suburban wetlands like East Kolkata Wetlands or Barrackpore. Restoration of eutrophic ponds, sustainable aquaculture methods, and improved sewage management systems are just a few examples of how comprehensive documentation of zooplankton variety between seasons can contribute in creating conservation and management plans. Environmental managers and policymakers can benefit from a thorough ecological assessment that takes seasonal variation data into account along with physicochemical factors such as conductivity, dissolved oxygen, pH, and phosphate and nitrate concentrations. To ensure ecological sustainability, improve water quality, safeguard food resources for dependent communities, and continuously monitor seasonal variations in zooplankton diversity in the freshwater ecosystems of Kolkata and its suburbs is absolutely necessary. To better understand the biological state of ponds in the Kolkata area, this study aims to find out how local ponds and the zooplankton biodiversity they support depend on constant monitoring, preservation initiatives, and education campaigns to stay healthy over time. The findings will shed light on the elements that influence zooplankton diversity, allowing for more effective conservation and management of these vital ecosystems.

## 2. Study Area and Methodology:

There are a lot of ponds all around Sub Urban Kolkata, and they keep the ecosystem in check. Many species of fish, amphibians, insects, and birds call the ponds home. The breeding and survival of several bird species depend on these ponds, including both migratory and resident bird species. Water conservation is another important factor to think about. Nearby ponds encourage groundwater recharge by slowing the rate of subsurface water loss throughout the summer. Ponds are an integral part of the local ecology and culture, and there are many of them throughout the district and throughout West Bengal. The study was carried out in West Bengal's 24 Parganas (North) region in order to identify localized and seasonal changes, this study aimed to regularly sample zooplankton populations in ponds situated in suburban regions around Kolkata. Ponds in Birati, New Barrackpore, Madhyamgram, and Panihati municipality were also included in the research. The five ponds that were considered are all surrounded by dense residential areas. The city government has leased the ponds exclusively for aquaculture. Also, very few homes really use the pond water for laundry and dishwashing. Following religious rituals, the ponds are often used to submerge the sacred objects. On rare occasions, the water is redirected to wash the adjacent streets. Rainfall and overland flow restock the ponds' water levels. The majority of the trash that ends up in the ponds comes from the nearby residential neighbourhood's residences, even though the ponds aren't linked to any specific drainage system. Water bodies are already under a lot of artificial stress from things like ponds and other aquaculture facilities using all sorts of chemicals and feeding products. Sometimes, although rarely, chemicals and detergents used to wash dishes and clothes end up in the ponds. The ponds also collect trash, as many locals either pour their soiled dishes and plastic bottles into them or let the rainwater carry them there.

Each pond had three sampling stations, and the water was pooled, to analyse zooplankton diversity. The zooplankton were collected using a Hensen's Standard Plankton net that had a 20 cm diameter, was made of bolting silk, and had a mesh size of 70 µm. Fifty litres of water were filtered through the net. Thoroughly rinsing the interior of the net with water eliminated any clinging particles from the meshes. To ensure accurate quantitative analysis, all samples were preserved in a solution of 5% formaldehyde. In preparation for laboratory examination the next day, a 1 ml subsample was quickly drawn from the mixture using a wide-mouthed pipette and moved to the Sedgewick-Rafter counting chamber. We averaged the counts of five such aliquot specimens to acquire the total number of organisms per litre of water. The main categories of zooplankton were measured. Monthly data was used to calculate seasonal averages. The zooplankton were all positively identified under the microscope. The identification of zooplanktons was based on the standard literature (Ward and Whipple, 1945). Quantitative measurement was performed using Lackey's drop approach (Trivedy and Goel, 1984) to determine the number per litre. For the purpose of zooplankton taxonomy, live specimens were utilized whenever possible. The quantities of zooplankton were expressed as individuals per litre.

## 3. Results and Discussion:

Anthropogenic pressures, ecological adaptations, and climatic rhythms all interact to form the biological communities of the freshwater ponds in Kolkata and its suburbs. This is revealed through the study of seasonal changes in water quality and zooplankton diversity. The key idea behind this work is that zooplankton do more than just float around in the water; they actively regulate ecological balance by feeding on phytoplankton and acting as prey for higher trophic levels. Thus, the community structure, diversity, and abundance of these ponds' inhabitants serve as a real-life indicator of the ponds' ecological health.

**Table 1: Zooplankton diversity and distribution in the study area**

| Pond Group | Birati | NBE 1 | NBE 2 | MMG | Panihati |
|---|---|---|---|---|---|
| **Rotifer** | *Brachionus falcatus*<br>*Brachionus quadridentatus*<br>*Polyarthra* sp.<br>*Keratella* sp. | *Brachionus falcatus*<br>*Keratella* sp. | *Brachionus diversicornis*<br>*Brachionus plicatilis*<br>*Brachionus angularis*<br>*Asplanchna* sp.<br>*Keratella* sp. | *Brachionus diversicornis*<br>*Brachionus falcatus*<br>*Brachionus plicatilis*<br>*Brachionus quadridentatus*<br>*Asplanchna* sp.<br>*Keratella* sp. | *Polyarthra* sp.<br>*Brachionus plicatilis*<br>*Brachionus quadridentatus*<br>*Brachionus angularis*<br>*Brachionus falcatus*<br>*Trichocerca* sp. |
| **Cladocera** | *Diaphanosoma* sp. | *Daphnia* sp.<br>*Moina* sp. | *Daphnia* sp.<br>*Moina* sp. | *Daphnia* sp. | *Ceriodaphnia* sp.<br>*Diaphanosoma* sp. |
| **Copepoda** | *Cyclops* sp.<br>*Pseudodiaptomus* sp. | *Calanus* sp<br>*Cyclops* sp. | *Cyclops sp.* | *Calanus* sp.<br>*Cyclops* sp. | *Cyclops* sp. |
| **Ostracoda** | Nauplius larvae | Nauplius larvae | Nauplius larvae<br>*Cypris* sp. | Nauplius larvae | Nauplius larvae |
| **Protozoa** | *Euglena oxyuris*<br>*Vorticella* sp.<br>*Paramoecium* sp. | *Euglena oxyuris*<br>*Vorticella* sp.<br>*Paramoecium* sp. | *Vorticella* sp.<br>*Paramoecium* sp. | *Paramoecium* sp.<br>*Euglena oxyuris* | *Euglena oxyuris*<br>*Vorticella* sp.<br>*Paramoecium* sp. |

Their seasonal dynamics can be studied at several sites, including Birati, New Barrackpore, and Madhyamgram, among others. This allows us to see how changes in the environment, changes in water quality, and changes in ecosystem stability impact the biology of smaller creatures. In an integrated interpretation of the results, the interplay between environmental forces, species-specific life history features, and the passage of time causes these urban and peri-urban aquatic habitats to experience periodic cycles of dominance, decline, and renewal.

A kind of zooplankton known for their ability to colonize nutrient-rich habitats and as markers of water quality, rotifers kick off the seasonal zooplankton cycle in the ponds of Birati. As the year progresses, more and more favourable conditions are accumulating, leading to a seasonal increase in rotifer abundance that peaks in February. As the cooler months approach, rotifers here show a cumulative effect of increasing nutrient availability, phytoplankton production, and reduced predation pressure, rather than responding abruptly to short-term fluctuations. Consistent upward trajectories were seen among the rotifers of the *Brachionus* species, which suggests that these fish are able to adapt to changing water conditions and take advantage of eating opportunities. Differences in niche specialization and reactions to seasonal influences may explain why *Polyarthra* is relatively stable while *Keratella* experiences more dramatic ups and downs. Even within the same functional group, species exhibit distinct patterns of ecological opportunity partitioning; for example, some species reach their reproductive optimum in the warmer summer waters while others wait for the cooler, oxygen-rich winter waters. Even if the numbers of individual rotifer species rise and fall during the year, the overall presence of the assemblage remains fairly constant due to the range of methods employed.

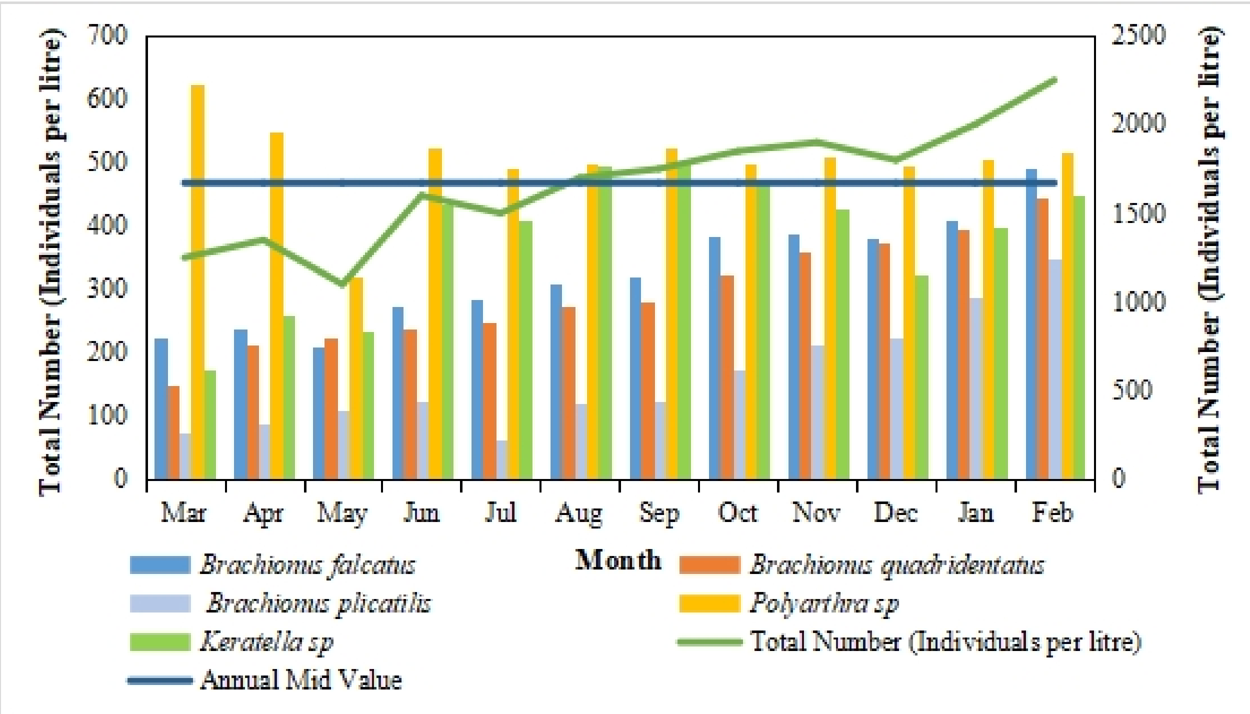


**Figure 1: Diversity of Rotifers in the study Ponds at Birati**

Similar trends are observed in the cladoceran population of the Birati pond, where *Diaphanosoma* experiences a remarkable surge from the start of summer into the colder winter months. Because of its remarkable ability to adjust to fluctuating food availability and its competitive advantage in grazing on phytoplankton during periods of high productivity, this cladoceran species demonstrated remarkable potential for consistent population growth, in contrast to the more fluctuation-prone rotifers. Since cladocerans are able to increase their populations during cooler periods due to the decreased metabolic rates of predators, the spike in winter months is also in line with less predation from fish. By exerting grazing pressure on algae and thereby affecting habitat conditions for other planktonic animals, cladocerans play an essential role as energy conduits in freshwater food webs, as is demonstrated by *Diaphanosoma's* persistent dominance.

The seasonal scene is further enhanced by the copepods of Birati. While the more volatile *Pseudodiaptomus* showed a dramatic mid-year surge followed by stabilization, the resilient and adaptable Cyclops genus showed a continuous growth throughout the year. These divergent approaches point to distinct reproductive cycles, dietary specialization, and reactions to seasonal temperature changes. Because of their bigger bodies compared to rotifers and cladocerans, copepods graze phytoplankton heavily and are vital for the survival of fish larvae and juveniles. Their late-year abundance coincides with the times when fish larvae emerge and need a lot of food, therefore it provides a timely food supply for higher trophic levels. Although there were fewer nauplius stages of ostracods overall, their abundance increased as winter approached, lending credence to the idea that cooler months offer ecological opportunities for zooplankton to proliferate in these systems.

Rotifer dynamics at New Barrackpore's first pond resembled those at Birati, with subtle temporal fluctuations and species-specific trends. The rising trends in *Brachionus* species were consistent once again, but the notable jump in *Brachionus plicatilis* during winter suggests a preference for cooler weather or maybe less interspecific competition at that time. The microecological heterogeneity found in tiny freshwater bodies is highlighted by these inter-pond variances, even if the seasonal causes are often identical. Microclimate, nutrient dynamics, and predator-prey assemblages are unique to each pond, and they play a mediating role in the biological responses to global seasonal signals like rainfall and temperature. The cladocerans in this pond, which included *Moina* and *Diaphanosoma*, showed synchronicity in their seasonal maxima, with summer being the apex and winter being the peak of severe decline. This contradicts the winter surges seen in Birati and serves as a reminder that when drawing broad conclusions regarding zooplankton ecology, it is crucial to account for site-specific heterogeneity. The presence of two cladoceran species together brings attention to the competitive dynamics at play; whereas *Diaphanosoma* is more common, *Moina* takes advantage of ecological windows of opportunity during specific months to sustain large numbers.

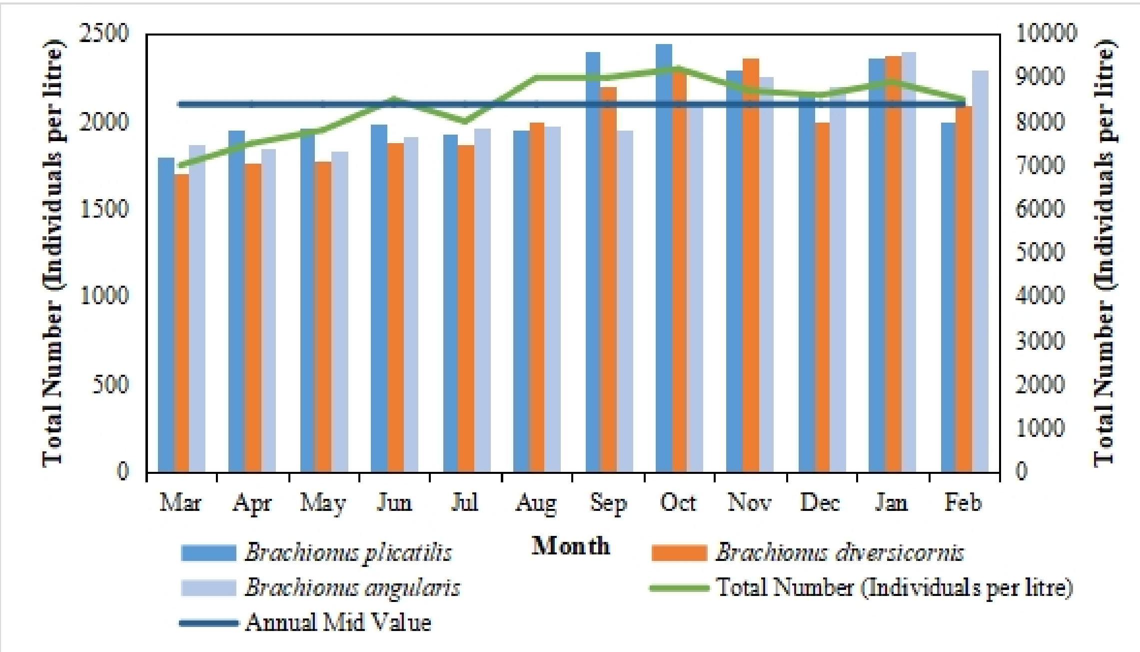


**Figure 2: Diversity of Rotifers in the study Ponds at New Barrackpore 1**

In the first pond in New Barrackpore, the copepods were mostly Cyclops and *Calanus*, with the latter species showing a dramatic rise in the winter. This pattern highlights the significance of physiological adaptations that are individual to each species and goes against the usual belief that zooplankton do better in warmer environments. *Calanus* seems to take advantage of its cold resistance and resting egg production in the Kolkata environment, too. It thrives when temperatures drop and competition go, much like it is known to do in other freshwater systems. These changes show how diverse copepods are evolutionary and help to explain why they continue to play a significant role in many different kinds of water environments. Once again, the ostracods, represented by nauplius larvae, showed a late-year increase, proving that this group's reproductive activity is in sync with cooler weather. Three protozoa—*Euglena*, *Vorticella*, and *Paramoecium*—contributed microbiological diversity to the zooplankton food web. *Euglena's* ability to switch between autotrophy and heterotrophy, depending on the season, allowed it to remain dominant in the food web. We are reminded that microbial interactions are just as crucial as macro-zooplankton dynamics in defining community structure by the fall of *Paramoecium* over the year, which suggests competitive displacement.

Rotifer diversity was significantly higher in the second pond at New Barrackpore, where many species of *Brachionus*, *Asplanchna*, and *Keratella* predominated. Once again, a general tendency of increasing abundance towards late fall and winter was noticeable. However, the intricate interplay of competition, predation, and environmental tolerance was highlighted by the small variances in timing of species peaks. The predatory nature of *Asplanchna* allowed them to impact the population dynamics of rotifers and add a regulatory component to their diet. Its population stability points to a balancing function, keeping prey species from dominating the ecosystem. The cladocerans in this pond did not follow the same pattern as the ones in New Barrackpore Pond One; for example, *Moina* and *Diaphanosoma* both peaked in the winter. Differences in seasonal apex between the two ponds show how animals have adapted to microhabitats with little but significant differences in things like dissolved oxygen, nutrition levels, and predator presence. During winter, the copepod population shrank dramatically, surpassing concentrations seen in other ponds. Cyclops was the dominant species. The ability of copepods to take over in an ideal environment is demonstrated by this extraordinary surge; the phytoplankton population in the pond was likely reshaped by the copious amounts of copepods that existed during this time. The ostracods and protozoa introduced additional levels of variability; the former showed seasonal shifts dependent on life stage, while the latter showed moderate increases again in the winter. This highlights the larger ecological rhythm in which the colder months produce conditions that are favourable for the proliferation of zooplankton.

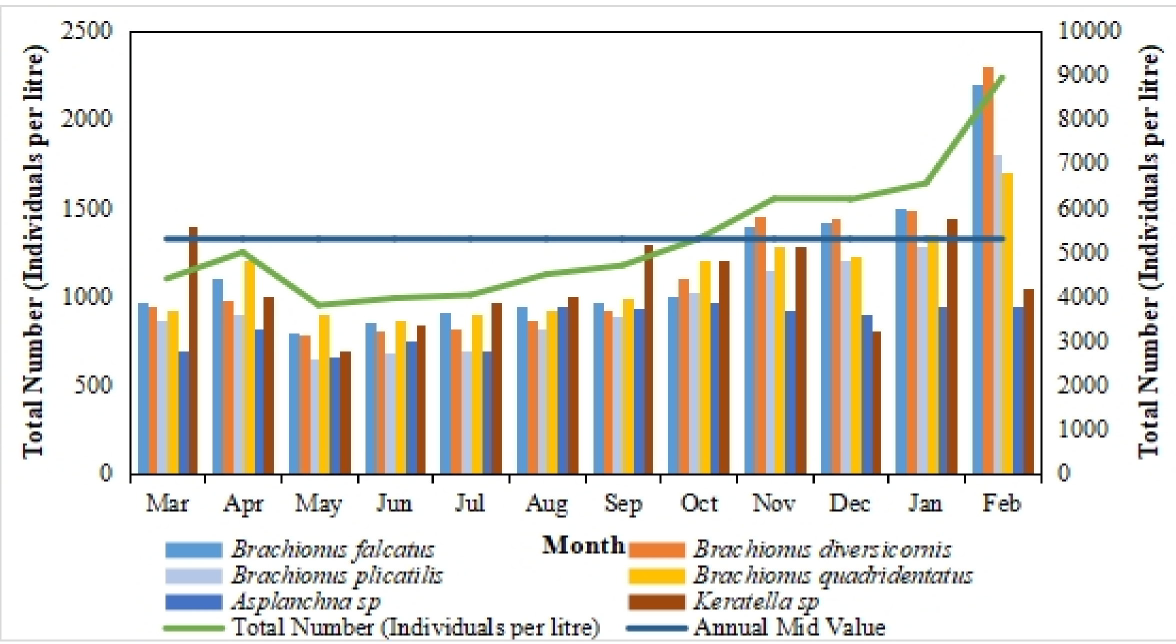


**Figure 3: Diversity of Rotifer in the study Ponds at Madhyamgram**

The Madhyamgram pond shed light on an additional set of complex dynamics. Similar to what was seen in Birati and New Barrackpore pond two, the rotifers here increased dramatically throughout winter, with several species of *Brachionus* going into overdrive at the same time. But the constant, modest presence of *Asplanchna* in the rotifer colony brought to mind the predatory checks that exist within it. While most rotifers follow a strict seasonal pattern, *Keratella* showed signs of variability that did not always line up with the overall community trend. Some taxa react mainly to food availability, some to predators, and yet others to physicochemical characteristics like pH and conductivity; this diversity can be explained by ecological plasticity. *Diaphanosoma* peaked in August and then declined gradually during the winter months, following a summer dominance pattern among the cladocerans of Madhyamgram pond. This break with rotifer patterns demonstrates how various taxonomic groupings schedule ecological opportunities so that at all times one functional group is in high abundance. The stability of food web dynamics is enhanced by staggered peaks, which guarantee a continuous transmission of energy to higher trophic levels.

The winter dominance tendency was also strengthened by the copepods of Madhyamgram, where *Cyclops* reached extraordinarily high numbers as the year went on. Their hegemony at this time is ecologically important because it keeps fish larvae fed even while other zooplankton populations are declining. *Cypris* and nauplius larvae, which make up the ostracods in this pond, showed life-stage specific dynamics, with the adults reaching their peak in the late summer and the larvae in the winter. In order to maximize their chances of survival, different life phases are divided by time. Adults take advantage of the warmer months to reproduce, while larvae stay put through cooler weather when predator pressures are lower. Seasonal fluctuations in *Paramoecium* and *Vorticella*, two protozoa that provide a microbial backdrop to the zooplankton tapestry, ensure that microbial feeding and nutrient recycling continue year-round.

Taken as a whole, these results provide a startling story. The zooplankton communities in all of the ponds follow a seasonal pattern that is very similar to Kolkata's weather; for example, several groups always have higher abundances in the cooler months. But even within this general trend, there are distinct trajectories for different ponds and taxonomic groups, formed by things like interspecies interactions, species-specific adaptations, and environmental factors. The end product is a patchwork of seasonal dynamics, with some species having their peak in the summer, some in the winter, and yet others showing little variation throughout the year. The functional stability of the ecosystem is ensured by the diversity of reactions, which also represents ecological resilience. Energy flows continuously through the food chain because even when one group decreases, another rises. Anthropogenic stresses including nutrient enrichment, sewage inflows, and industrial effluents are common in urban and suburban freshwater bodies, making these supplementary dynamics all the more important.

Furthermore, these seasonal patterns are relevant to management of water quality, productivity in fisheries, and biodiversity conservation efforts; they are not just theoretical findings. The abundance of zooplankton peaks during winter, especially copepods and rotifers, indicates that this is a crucial time for fish recruitment support, as these prey items are strongly relied upon by larvae. Thus, fisheries and aquatic biodiversity could be severely affected if winter weather is disrupted in any way, whether by increasing pollution, changes in rainfall patterns, or the warmth caused by climate change. Similarly, rotifers like Brachionus are a great way to evaluate water quality with simple plankton surveys since they are dominant in nutrient-rich environments, which shows that they are bio-indicators of eutrophication. The microbial component of aquatic ecology is highlighted by the varying pond protozoa fortunes; even little changes in nitrogen cycling or bacterial populations can have far-reaching effects on the planktonic community.

Ecological adaptation to seasonality is a living narrative that is supplemented by species-specific tactics and constrained by environmental forces; this is revealed in the results and discussion of zooplankton diversity in the ponds of Kolkata and its suburbs. Though the stories told by the individual ponds are distinct, when taken as a whole, they provide a clear picture of the dynamics at work in urban and suburban areas where freshwater zooplankton communities are impacted by both natural and human-made factors. Rotifers, cladocerans, copepods, ostracods, and protozoa show how diverse and adaptable life can be through their interactions, and how ecological stability may be achieved through the cyclical rhythms of their populations. This research highlights the larger value of zooplankton diversity monitoring as a tool for understanding and protecting the ecological health of freshwater bodies in areas that are fast becoming urbanized, as well as a window into how aquatic ecosystems work.

## 4. Conclusions:

Seasonal zooplankton diversity in Kolkata and its suburbs reveals how climatic rhythms, biological strategies, and anthropogenic stressors change aquatic ecosystems. Zooplankton are sensitive environmental indicators that link phytoplankton to higher trophic levels. Their seasonal dominance and decrease reflect ecological health according to temperature, nutrition, predation, and interspecific competition. It can be seen from the results that Zooplankton proliferation rises in cooler months, especially for rotifers and copepods, but site-specific variances remain. Seasonal complementarity stabilizes ecosystems by ensuring at least one group is abundant. Winter zooplankton maxima feed fish larvae, and rotifers' dominance in nutrient-rich settings suggests eutrophication. Adaptable cladocerans and copepods show how biodiversity survives environmental changes. Seasonal variation alters zooplankton communities and preserves Kolkata's freshwater ponds biological balance. Local pond-specific conditions and species-level adaptations create seasonal fluctuations, whereas broader climatic rhythms drive general patterns. These findings highlight the need of long-term zooplankton diversity monitoring for water quality evaluation and urban and peri-urban aquatic ecosystem ecology.

## References:


- Arya, R., & Mehra, R. (2020). Abundance and diversity of zooplankton in Baini Stream at Tarai Region, Uttarakhand, India. *International Journal of Ecology and Environmental Sciences*.
- Banerjee, K., Adhikary, S., & Bhattacharyya, P. A. (2020). Dynamics of zooplankton diversity in freshwater ecosystems across seasons: Impact of phosphate and other factors. *Uttar Pradesh Journal of Zoology, 45*(14), 324–331.
- Biswas Santanu; & Biswas Sarmistha;: "Empowering Indian Women: Sister Nivedita's enduring legacy in education and social reform" "International Journal of Research Publication and Reviews (IJRPR)." 5(6), 2024, Page: 1230 – 1235.
- Biswas Santanu; & Kumari Madhu;: "Integrating indigenous wisdom: transforming higher education with Bhartiya knowledge systems." "American Journal of Social and Humanitarian Research." 5(2), 2024, Page: 132-142.
- Biswas Santanu; & Kumari Madhu;: "The Burden of care: A systematic review of parental stress in families of children with intellectual disabilities." "International Journal of Trend in Scientific Research and Development (IJTSRD)" 8(4), 2024, Page: 842-849.
- Biswas Santanu; Banerjee Rabin; "Attitude towards integrating ICT in the teaching learning in the higher secondary level: A survey, " "International Journal of Research Publication and Reviews (IJRPR)", 5(6), 2024, Page: 1-4.

- Biswas, Santanu; & Chatterjee, Pankaj;: “Students’ Attitudes towards E-Learning from a Socio-Economic Perspectives.” “Bharati International Journal of Multidisciplinary Research & Development (Bijmrd)”. 2(11), 2024, Page: 1-12.

- Brraich, O. S., & Akhter, S. (2019). Diversity and distribution of zooplankton in Ropar Wetland (Ramsar site), Punjab, India. *Nature Environment and Pollution Technology, 18*(2), 451–458.

- Chatterjee, N., Mukherjee, M., & Bhattacharjee, B. (2014). Abundance and diversity of zooplankton and its seasonal variation in the water of Sahebbandh, Purulia, India: A quantitative study. *The International Journal of Science & Technoledge, 2*(12).

- Daripa, Soumili; Khawas, Koomkoom; Das, Sanatanu., Dey; Ratan. Kumar; & Kuila, Biplab Kumar; “Aligned Proton Conducting Graphene Sheets via Block Copolymer Supramolecular Assembly and Their Application for Highly Transparent Moisture Sensing Conductive Coating.” *“CHEMISTRY SELECT, C”* 4, 2019*,* Page: 7523 -7531.

- Kasi Padhye, S. M. (2020). Seasonal variation in functional composition and diversity of cladoceran zooplankton of a lotic eutrophic habitat from India. *Annales de Limnologie – International Journal of Limnology, 56*, 11.

- Khan Ebne, Saud; & Biswas Santanu; “ WOMEN EMPOWERMENT AND THE IMPACT OF EDUCATION IN THE DISTRICT OF BIRBHUM IN WEST BENGAL IN INDIA.“ “International Journal of Humanities, Engineering, Science and Management.” 3(2), 2022, Page 10 – 15.

- Khawas, Koomkoom.; Daripa, Soumili.; Kumari, Pallavi.; Bera, Manas Kumar; Malik, Sudip; & Kuila, Biplab Kumar; : “Simple Synthesis of End Functionalized Regioregular Poly(3-Hexyl thiophene) by Catalytic-Initiated Kumada Catalyst Transfer Polymerization.” JOURNAL OF POLYMER SCIENCE, PART A: POLYMER CHEMISTRY” 57, 2019, Page: 945- 951.

- Koomkoom Khawas: “The Evolution of Green Chemistry: A Historical Perspective” “BHARATI INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH & DEVELOPMENT (BIJMRD)” 8(2), 2024, Page: 155 – 159.

- Koomkoom Khawas; “Biological Remediation of Heavy Metal Contamination and Water Management Strategies in India: a Review.” “Spanish Journal of Innovation and Integrity” 36, 2024, Page: 26 – 31.

- Kumari, N., & Pathak, R. N. (2018). Study on the diversity and seasonal variation of zooplankton in Bhusara Maun under Muzaffarpur, Bihar. *Journal of Drug Delivery and Therapeutics, 8*(5-S), 329–331.

- Lalitha, H. M., & Ramakrishna, S. (2021). Diversity and seasonal variations of zooplankton community in Kunigal Tank, Tumkur District, Karnataka. *Uttar Pradesh Journal of Zoology, 42*(24), 165–179.

- Pal, Dibyarupa; & Khawas, Koomkoom; : “Potential Sources and Uses of Chitin and its Polymers: a Review.” **“**JOURNAL OF DISCOVERIES IN APPLIED AND NATURAL SCIENCE” 2, 2024*,* Page: 1-12.

- Pandey, S., Ray, P., and Pal. D., 2023. Influence of Sustainable Biocoagulants *Trigonella foenumgraecum* and *Moringa oleifera* for Improving Water Potability.

- Paul, B., Das, D., Aich T., and Pal, D. 2024. Plant Based Biocoagulants from *Cucurbita pepo* and *Cicer arietinum* for Improving Water Quality. International Journal of Agriculture Environment & Biotechnology (IJAEB). 17 (1): 29-36.

- Sahu, G., Mohanty, A. K., et al. (2010). Zooplankton diversity in the nearshore waters of Bay of Bengal, off the Rushikulya Estuary. *The IUP Journal of Environmental Sciences, 4*, 61–85.
- Samir Chattopadhyay; & Santanu Biswas; "Pedagogical and Structural Changes in Schools in Light of NEP 2020." "Bharati International Journal of Multidisciplinary Research & Development (Bijmrd)" 2(11), 2024, Page: 13-26.
- Sarkar, S. 2017. Characterisation of pond water quality in the freshwater intensive culture of Indian Major Carps (IMC). International Journal of Advanced Research and Development. 2 (6): 262 – 268.
- Sarkar, S. 2018. Hourly Variations of Dissolved Oxygen in the Intensive Culture of Indian Major Carps. Education Plus. 8 (1): 210-216.
- Sarkar, S. and Mal, B. C. (2005). The Status of Aquaculture in India: Development, Adoption and Constraints. Agricultural Engineering Today. 29 (5): 46-52.
- Sarkar, S., Bayen, S., Samanta, S. and Pal, D. (2024). Spent Mushroom Substrate- Prospects and Challenges of Agrowaste management into sustainable solutions: A Review. Int. J. Ag. Env. Biotech., 17(04): 731-741.
- Shivashankar, P., & Venkataramana, G. V. (2013). Zooplankton diversity and their seasonal variations of Bhadra Reservoir, Karnataka, India. *International Research Journal of Environmental Sciences, 2*(5), 87–91.
- Shyam, R., Kumar, P., & Badola, S. (2020). Seasonal variation in the planktonic diversity of Tumaria reservoir of Kashipur, Uttarakhand, India. *Environment Conservation Journal, 21*(3), 119–125. https://doi.org/10.36953/ECJ.2020.21314
- Sinha, Amardeep; Kumari, Nilu; & Khawas, Koomkoom; : "Role of Nuclear Chemistry in Environmental Applications." "BHARATI INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH & DEVELOPMENT (BIJMRD)" 2, 2024, Page: 61-70.