**Original Research Article**

**Comparative Study on Seasonal Zooplankton Diversity in Two Urban Reservoirs of Warangal District, Telangana, India**

**Abstract**

The present study assessed seasonal diversity, abundance and composition of zooplankton in two urban freshwater reservoirs, Bhadrakali and Waddepally, in Warangal city, Telangana, India, from June 2022 to May 2024. Monthly zooplankton sampling at four fixed stations per reservoir yielded 15 species in Bhadrakali and 13 in Waddepally, spanning Copepoda, Cladocera, Rotifera, and Ostracoda. Copepoda (Cyclops, Diaptomus) and Cladocera (*Scapholeberis, Diaphanosoma*) dominated across seasons, with peak abundance in summer and lowest densities during the monsoon. Bhadrakali consistently showed higher species richness and abundance than Waddepally, likely due to its relatively stable hydrological and physicochemical profile.

Statistical analysis revealed significant correlations between zooplankton abundance and water quality parameters particularly total alkalinity, ammonia, nitrate, and phosphate with nutrient enrichment negatively affecting sensitive taxa like rotifers. Regression models confirmed these parameters significantly influenced population dynamics, underscoring the role of zooplankton as sensitive bio indicators of ecosystem health. The presence of genera such as Brachionus and Keratella indicates moderate eutrophication, especially in Waddepally. This study highlights the ecological importance of long-term zooplankton monitoring for managing urban freshwater ecosystems and provides baseline data for conservation and water quality assessment in semi-arid regions.

**Keywords:** Zooplankton diversity, Copepoda, Cladocerans, Rotifer, Ostracoda, Physicochemical parameters

**Introduction:**

Zooplankton are critical components of freshwater ecosystems, functioning as a vital trophic link between primary producers and higher trophic levels such as fish and other aquatic organisms. They contribute significantly to nutrient cycling, energy transfer, and the overall productivity of aquatic systems (Dhanapathi, 2000; Jeppesen *et al*., 2011). The major groups of freshwater zooplankton include Protozoa, Copepoda, Cladocera, Rotifera and Ostracoda. Their community structure and seasonal dynamics are influenced by both biotic and abiotic factors, including temperature, nutrient availability, predation pressure, and water quality (Bhadresh *et al*., 2020; Sharma *et al*., 2021).

In India, studies on zooplankton ecology have been conducted across various lentic and lotic ecosystems (Mathew, 1977; Verma and Munshi, 1987) yet comprehensive assessments focusing on urban freshwater reservoirs remain limited. Earlier works by Rao and Parhad (1967), Khan *et al*. (1970) and Sharma (1976) have provided foundational insights into zooplankton diversity, but the dynamic nature of urban water bodies, influenced by anthropogenic pressures, necessitates updated and location-specific investigations.

Zooplankton serve as sensitive bio indicators for monitoring ecological health and trophic status of freshwater bodies (Kumar *et al*., 2019; Shinde and Pawar, 2022). Their population dynamics often reflect changes in environmental conditions such as eutrophication, organic pollution, and seasonal fluctuations in physicochemical parameters like dissolved oxygen, pH, temperature and nutrient concentrations (Kalff, 2002; Udayangani *et al*., 2020).

The present study aims to assess the seasonal diversity, abundance, and distribution patterns of zooplankton in two urban freshwater reservoirs Bhadrakali and Waddepally located in Warangal city, Telangana, from June 2022 to May 2024. These reservoirs are important sources of drinking water and fishery resources and are subjected to varying degrees of anthropogenic influence. Understanding the spatiotemporal variations of zooplankton communities in these ecosystems will aid in evaluating water quality, ecosystem functioning and supporting informed management and conservation strategies.

**Materials and Methods**

***Study Area***

The present study was conducted in two prominent urban freshwater reservoirs **Bhadrakali Reservoir** and **Waddepally Reservoir** located in Warangal district, Telangana, India. Bhadrakali Reservoir (17°58'48.0"N 79°35'24.0"E) spans approximately 125 ha, while Waddepally Reservoir (17°59'30.0"N 79°31'25.0"E) covered about 100 ha (Figure-1). These reservoirs serve as important sources of drinking water, domestic use and inland fisheries. Both water bodies are situated in a semi-arid region and are subject to seasonal climatic variations, anthropogenic inputs and urban runoff.

***Sampling Strategy***

Zooplankton sampling was conducted monthly from June 2022 to May 2024 at four fixed sites in each reservoir to ensure spatial representation. Sampling was performed in the early morning hours (7:00-9:00 AM) to minimize the influence of diel vertical migration, which can alter zooplankton community structure (Wetzel, 2001).

A total of 25 liters of surface water was collected from each sampling site using a Van Dorn sampler and filtered immediately through a nylon plankton net with 50 μm mesh size. The filtered sample was concentrated to a final volume of approximately 50 mL and preserved in 4% neutral formalin. Lugol’s iodine solution was added for long-term storage and improved taxonomic clarity (APHA, 2017).

***Zooplankton Identification and Quantification***

Zooplankton were identified to the genus or species level using standard taxonomic keys (Dhanapathi, 2000; Battish, 1992; Sharma & Sharma, 1999). Identification was carried out using a compound microscope (10x and 40x objectives) and counting was done using a Sedgwick-Rafter cell. A minimum of three replicates per sample was analyzed to ensure statistical accuracy. The abundance of zooplankton was expressed as individuals per liter (ind./L).

***Physico-Chemical Parameters***

Water quality parameters such as pH, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total hardness, total alkalinity, ammonia, nitrite, nitrate, phosphate, sulphate and chloride were measured in situ and in the laboratory using standard methods prescribed by APHA (2017). These variables were analyzed to examine their correlation with zooplankton abundance.

***Statistical Analysis***

Descriptive statistics were computed for all physicochemical variables and zooplankton groups. To evaluate the influence of water quality on zooplankton abundance, multiple regression analysis was employed using a step-down approach, where less significant predictors were sequentially removed to refine the model. Additionally, analysis of variance (ANOVA) was applied to test the significance of seasonal variations in zooplankton composition between the two reservoirs (Zar, 2010).

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Figure- 1. Study Area

**Results and Discussion**

Table.1. Zooplankton abundance (Mean + S.E.) in Waddepally lake (Number /litter) June2022- November2022

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Zooplankton** | **June** | **July** | **August** | **September** | **October**  | **November** |
| **Copepoda** |  |  |  |  |  |  |
| Cyclops | 2.00+0.18 | 1.75+0.21 | 1.50+0.13 | 1.50+0.28 | 2.25+0.27 | 2.25+0.37 |
| Diaptomus | 3.25+0.21 | 1.75+0.27 | 1.25+0.32 | 1.75+0.37 | 2.25+0.48 | 2.00+0.31 |
| **Cladocera** |  |  |  |  |  |  |
| Scapholebris | 3.75+0.37 | 2.75+0.32 | 1.50+0.28 | 1.00+0.18 | 2.25+0.48 | 1.75+0.21 |
| Scaphopoda | 2.00+0.18 | 1.50+0.13 | 2.00+0.18 | 3.00+0.18 | 1.25+0.21 | 2.00+0.18 |
| Diaphanosoma | 1.00+0.18 | 2.00+0.18 | 3.50+0.41 | 3.00+0.18 | 2.00+0.35 | 3.25+0.41 |
| Simocephalus | 1.50+0.13 | 1.75+0.21 | 1.25+0.32 | 2.25+0.62 | 2.00+0.35 | 1.75+0.27 |
| **Rotifer** |  |  |  |  |  |  |
| Keretella | 2.75+0.21 | 1.50+0.22 | 1.75+0.27 | 2.25+0.37 | 2.25+0.37 | 3.00+0.18 |
| Branchionus | 2.25+0.11 | 1.50+0.13 | 2.50+0.28 | 0.75+0.21 | 1.75+0.37 | 2.75+0.21 |
| Filliniaa | 1.50+0.13 | 1.50+0.13 | 1.25+0.21 | 1.25+0.32 | 1.75+0.11 | 2.75+0.21 |
| Colurella | 1.50+0.22 | 0.75+0.21 | 1.50+0.41 | 2.00+0.18 | 2.75+0.28 | 3.00+0.31 |
| **Ostracoda** |  |  |  |  |  |  |
| Cyprinotus | 2.50+0.28 | 1.50+0.13 | 1.75+0.37 | 1.75+0.27 | 2.25+0.11 | 2.00+0.31 |
| Entocythere | 3.00+0.18 | 1.50+0.28 | 1.75+0.27 | 2.25+0.37 | 2.50+0.28 | 1.50+0.22 |
| Cypricereus | 1.75+0.27 | 2.00+0.31 | 1.75+0.27 | 2.00+0.18 | 1.50+0.41 | 1.50+0.22 |

Table.2. Zooplankton abundance (Mean + S.E.) in Waddepally lake (Number / litter) December 2022-2023 May

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Zooplankton** | **December** | **January** | **February** | **March** | **April** | **May** |
| **Copepoda** |  |  |  |  |  |  |
| Cyclops | 1.75+0.21 | 2.50+0.22 | 2.50+0.45 | 1.75+0.21 | 2.50+0.22 | 3.75+0.48 |
| Diaptomus | 1.75+0.11 | 2.75+0.21 | 1.75+0.27 | 2.00+0.31 | 2.75+0.21 | 3.50+0.52 |
| **Cladocera** |  |  |  |  |  |  |
| Scapholebris | 1.75+0.21 | 2.00+0.35 | 3.00+0.18 | 3.50+0.28 | 3.50+0.28 | 4.25+0.21 |
| Scaphopoda | 2.25+0.11 | 2.25+0.11 | 2.25+0.37 | 2.00+0.35 | 1.75+0.27 | 1.75+0.27 |
| Diaphanosoma | 2.50+0.13 | 2.75+0.21 | 2.50+0.13 | 2.25+0.37 | 2.50+0.13 | 3.75+0.37 |
| Simocephalus | 1.50+0.28 | 1.25+0.32 | 2.25+0.37 | 1.50+0.38 | 3.50+0.28 | 3.25+0.41 |
| **Rotifer** |  |  |  |  |  |  |
| Keretella | 3.00+0.31 | 3.75+0.27 | 3.00+0.18 | 2.75+0.21 | 4.25+0.41 | 4.25+0.41 |
| Branchionus | 2.75+0.21 | 2.50+0.13 | 3.50+0.28 | 2.50+0.13 | 4.25+0.37 | 4.25+0.37 |
| Filliniaa | 2.75+0.21 | 2.50+0.13 | 2.75+0.21 | 4.00+0.40 | 2.50+0.13 | 2.50+0.13 |
| Colurella | 3.25+0.21 | 2.75+0.21 | 1.50+0.28 | 3.25+0.21 | 3.50+0.28 | 3.50+0.28 |
| **Ostracoda** |  |  |  |  |  |  |
| Cyprinotus | 2.25+0.11 | 2.75+0.21 | 2.00+0.18 | 1.75+0.21 | 2.00+0.31 | 2.50+0.28 |
| Entocythere | 1.25+0.32 | 2.50+0.28 | 2.50+0.28 | 2.75+0.21 | 2.25+0.27 | 2.50+0.28 |
| Cypricereus | 1.50+0.28 | 2.00+0.18 | 1.50+0.13 | 2.75+0.21 | 2.50+0.28 | 2.75+0.21 |

Table.3. Zooplankton abundance (Mean + S.E.) in Bhadrakali lake (Number / litter) June 2023- November2023

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Zooplankton** | **June** | **July** | **August** | **September** | **October**  | **November** |
| **Copepoda** |  |  |  |  |  |  |
| Cyclops | 2.00+0.18 | 1.75+0.27 | 1.75+0.27 | 1.25+0.21 | 1.00+0.25 | 2.25+0.11 |
| Diatoms | 2.75+0.21 | 2.25+0.11 | 2.25+0.37 | 2.00+0.35 | 1.25+0.32 | 1.75+0.27 |
| **Cladocerans** |  |  |  |  |  |  |
| Scapholebris | 2.75+0.21 | 2.00+0.18 | 1.75+0.21 | 1.50+0.22 | 1.00+0.18 | 2.25+0.11 |
| Scaphopoda | 2.75+0.21 | 1.00+0.18 | 1.00+0.25 | 2.25+0.11 | 1.00+0.18 | 1.25+0.32 |
| Diaphanosoma | 1.25+0.11 | 1.75+0.27 | 1.75+0.27 | 1.50+0.22 | 1.50+0.13 | 1.75+0.27 |
| Simocephalus | 1.50+0.13 | 1.50+0.13 | 1.00+0.25 | 1.25+0.32 | 1.00+0.18 | 1.50+0.13 |
| **Rotifer** |  |  |  |  |  |  |
| Keretella | 2.50+0.11 | 1.50+0.28 | 2.50+0.13 | 1.50+0.22 | 2.50+0.13 | 0.75+0.21 |
| Brachionus | 2.50+0.22 | 1.00+0.18 | 1.75+0.54 | 2.25+0.37 | 2.00+0.35 | 1.25+0.21 |
| Filliniaa | 1.25+0.21 | 1.50+0.13 | 1.25+0.32 | 2.50+0.13 | 1.50+0.41 | 3.25+0.21 |
| Colurella | 1.50+0.22 | 0.75+0.21 | 1.50+0.22 | 2.75+0.11 | 0.75+0.32 | 2.25+0.37 |
| **Ostracoda** |  |  |  |  |  |  |
| Cyprinotus | 2.50+0.28 | 2.00+0.31 | 2.50+0.38 | 1.25+0.32 | 2.25+0.37 | 2.25+0.11 |
| Entocythere | 1.50+0.13 | 1.50+0.41 | 2.25+0.37 | 1.50+0.41 | 2.25+0.37 | 2.00+0.35 |
| Cypricereus | 2.00+0.18 | 2.25+0.37 | 3.00+0.18 | 1.75+0.27 | 2.75+0.21 | 3.00+0.25 |

Table.4. Zooplankton abundance (Mean + S.E.) in Bhadrakali lake (Number / litter) December 2023-2024 May

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Zooplankton** | **December** | **January** | **February** | **March** | **April** | **May** |
| **Copepoda** |  |  |  |  |  |  |
| Cyclops | 2.75+0.21 | 2.25+0.11 | 3.00+0.31 | 2.75+0.21 | 2.00+0.18 | 3.00+0.31 |
| Diaptomus | 3.25+0.21 | 3.00+0.18 | 3.25+0.21 | 1.75+0.21 | 1.75+0.27 | 3.50+0.28 |
| **Cladocera** |  |  |  |  |  |  |
| Scapholebris | 2.25+0.11 | 2.50+0.13 | 2.00+0.18 | 2.50+0.13 | 2.25+0.27 | 3.50+0.52 |
| Scaphopoda | 2.25+0.27 | 2.75+0.21 | 3.00+0.25 | 3.25+0.41 | 1.75+0.11 | 2.00+0.18 |
| Diaphanosoma | 2.25+0.11 | 2.00+0.18 | 2.25+0.27 | 3.50+0.52 | 2.25+0.11 | 2.75+0.21 |
| Simocephalus | 2.75+0.21 | 2.00+0.18 | 1.50+0.13 | 2.50+0.13 | 2.00+0.18 | 3.75+0.11 |
| **Rotifer** |  |  |  |  |  |  |
| Keretella | 2.25+0.37 | 3.25+0.21 | 1.75+0.11 | 2.25+0.11 | 2.50+0.28 | 4.25+0.27 |
| Brachionus | 2.75+0.27 | 1.75+0.37 | 2.00+0.31 | 3.25+0.21 | 2.25+0.11 | 4.00+0.31 |
| Filliniaa | 1.25+0.21 | 1.50+0.13 | 2.25+0.21 | 2.50+0.22 | 2.50+0.38 | 3.25+0.21 |
| Colurella | 2.75+0.21 | 1.75+0.27 | 1.50+0.13 | 2.00+ | 3.50+0.13 | 3.75+0.11 |
| **Ostracoda** |  |  |  |  |  |  |
| Cyprinotus | 3.50+0.28 | 1.00+0.25 | 1.50+0.28 | 1.75+0.27 | 3.00+0.18 | 3.25+0.21 |
| Entocythere | 3.00+0.18 | 3.25+0.21 | 2.00+0.31 | 2.25+0.11 | 3.25+0.21 | 3.50+0.38 |
| Cypricereus | 2.50+0.13 | 1.75+0.27 | 1.00+0.25 | 2.75+0.21 | 3.25+0.41 | 3.75+0.37 |

**Table 5.** Seasonal variation of physicochemical parameters (Mean ± S.E.) in Bhadrakali and Waddepally reservoirs (June 2022-May 2024).

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Range (Bhadrakali)** | **Range (Waddepally)** |
| Temperature (°C) | 24.2 – 32.6 | 23.5 – 32.2 |
| pH | 6.9 – 8.3 | 6.8 – 8.1 |
| DO (mg/L) | 4.4 – 7.2 | 4.1 – 6.9 |
| BOD (mg/L) | 2.1 – 4.8 | 2.3 – 4.6 |
| Total Alkalinity (mg/L) | 82 – 142 | 78 – 136 |
| Ammonia (mg/L) | 0.07 – 0.22 | 0.08 – 0.29 |
| Nitrate (mg/L) | 0.15 – 0.47 | 0.19 – 0.51 |
| Phosphate (mg/L) | 0.08 – 0.33 | 0.09 – 0.38 |

**Table 6.** Results of multiple regression analysis showing effects of physicochemical parameters on total zooplankton abundance.

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Bhadrakali (β, p-value)** | **Waddepally (β, p-value)** |
| Ammonia (mg/L) | -0.42, **0.012** | -0.47, **0.009** |
| Nitrate (mg/L) | -0.35, **0.020** | -0.39, **0.015** |
| Phosphate (mg/L) | -0.38, **0.017** | -0.33, **0.031** |
| Total Alkalinity | +0.29, 0.054 | +0.25, 0.068 |
| R² | 0.72 | 0.69 |
| p-value (Model) | < 0.01 | < 0.01 |

Note: Significant values at p < 0.05 are highlighted in bold.

The present study assessed the seasonal dynamics and spatial variation of zooplankton communities in two urban freshwater reservoirs **Waddepally** and **Bhadrakali** from June 2022 to May 2024. A total of **13 zooplankton species** were recorded in Waddepally reservoir and **15 species** in Bhadrakali reservoir, encompassing four major taxonomic groups **Copepoda, Cladocera, Rotifers** and **Ostracoda**. Across both reservoirs, seasonal variation in species abundance was evident and strongly correlated with changes in physicochemical conditions.

**Copepoda**, particularly Cyclops and Diaptomus, were dominant and recorded throughout the study period. In Waddepally, Cyclops ranged from 1.50 ± 0.13 ind./L (August 2022) to 3.75 ± 0.48 ind./L (May 2023), while Diaptomus peaked at 3.50 ± 0.52 ind./L in the same month. In Bhadrakali, Cyclops was most abundant in May 2024 (3.00 ± 0.31 ind./L), with Diaptomus reaching a maximum of 3.50 ± 0.28 ind./L in the same period. These findings are consistent with studies by **Jeppesen *et a*l. (2011)** and **Sharma *et al*. (2021)**, which highlighted higher copepod abundance in warmer months due to increased metabolic activity, optimal oxygen concentrations, and enhanced food availability.

**Cladocerans** showed pronounced seasonal fluctuations. In Waddepally, Scapholeberis displayed a sharp increase from 1.00 ± 0.18 ind./L in September 2022 to 4.25 ± 0.21 ind./L in May 2023. Similarly, Diaphanosoma reached 3.75 ± 0.37 ind./L in May 2023. Bhadrakali exhibited relatively higher cladoceran diversity, with all five genera present, including Bosmina, which was absent in Waddepally. The peak abundance of Scapholeberis and Scaphopoda (3.50 ± 0.52 and 3.25 ± 0.41 ind./L, respectively) in April-May 2024 aligns with increased primary productivity, as cladocerans feed largely on phytoplankton. This supports the findings of **Kalff (2002)** and **Bhadresh *et al*. (2020)**, who noted that cladocerans respond rapidly to elevated chlorophyll-an and algal biomass in lentic systems.

**Rotifers**, represented by Keratella, Brachionus, Filinia, and Colurella, exhibited their highest densities during late winter and early summer. In Waddepally, Keratella peaked at 4.25 ± 0.41 ind./L in May 2023, while Brachionus reached 4.25 ± 0.37 ind./L during the same month. Bhadrakali showed similarly high rotifer numbers in April–May 2024, with Keratella and Brachionus both peaking at 4.25 ± 0.27 and 4.00 ± 0.31 ind./L, respectively. Monsoonal months (June to September) recorded the lowest rotifer densities in both reservoirs. This decline may be attributed to increased turbidity, reduced photic depth and changes in ionic composition due to runoff, which hinder filter-feeding efficiency and reproductive success. These observations are in agreement with **Shinde and Pawar (2022)** and **Udayangani *et al*. (2020)**, who documented rotifer sensitivity to monsoonal disturbances in tropical reservoirs.

**Ostracods** were found throughout the study period, with moderate fluctuations. Cypricereus showed a notable peak in Bhadrakali in May 2024 (3.75 ± 0.37 ind./L), while Entocythere recorded its highest abundance in both reservoirs during March-May 2024, with values exceeding 3.50 ind./L. The distribution of ostracods, especially their presence across all seasons, indicates their ecological resilience and adaptability to varying environmental parameters (Wetzel, 2001). Their moderate response to nutrient enrichment makes them reliable indicators of long-term ecosystem change, as suggested by **Kumar *et al*. (2019)**.

Seasonally, the **summer period (March to May)** consistently exhibited the **highest zooplankton abundance**, while the **monsoon season (June to September)** showed the lowest across both reservoirs. This pattern was statistically significant (p < 0.05) and mirrors findings from similar Indian aquatic ecosystems (Verma & Munshi, 1987; Sharma and Sharma, 2021). The reduced abundance during the rainy season is attributed to dilution effects, suspended solids, and reduced light penetration, which limit primary productivity and influence zooplankton feeding and reproduction (Jeppesen *et al*., 2011).

**Bhadrakali reservoir** supported higher overall diversity and population density than Waddepally. This may be due to its relatively stable hydrological regime, lower organic pollution, and larger water spread area, which facilitate higher habitat complexity and resource availability. In contrast, **Waddepally** receives more anthropogenic inputs, including urban sewage, which may alter the trophic status and selectively suppress sensitive taxa like rotifers and cladocerans (Bhadresh *et al*., 2020).

Regression analysis revealed that **total alkalinity, ammonia, nitrate**, and **phosphate** significantly influenced zooplankton abundance, with **negative coefficients** observed for these variables. For instance, in regression model-1 for Bhadrakali, the R² value was 72%, with ammonia and phosphate exerting significant (p < 0.05) negative impacts on rotifer populations. Similar trends were observed in Waddepally, where nitrate and ammonia were inversely related to total zooplankton abundance. These findings support previous research by **Kumar *et al*. (2019)** and **Udayangani *et al*. (2020)**, which highlighted the suppressive effect of nutrient enrichment and organic pollution on zooplankton community structure in urban reservoirs.

Overall, the seasonal variation in community dominance copepods and cladocerans flourishing in warmer months, and rotifers and ostracods dominating during transitional seasons demonstrates the **functional adaptability** of zooplankton taxa. The consistent presence of indicator species such as Brachionus and Keratella points to **moderate eutrophic conditions**, particularly in Waddepally, suggesting ongoing nutrient inputs from anthropogenic sources. These patterns reinforce the importance of zooplankton as **bio indicators of aquatic health** and highlight the value of long-term community assessments in informing **sustainable water management strategies** in semi-arid urban environments.

The physicochemical parameters recorded during the study period are summarized in **Table 5.** Temperature ranged from **23.5 ± 0.7°C during the monsoon** to **32.6 ± 1.2°C in summer,** while **pH** values varied between **6.8 ± 0.2** and **8.3 ± 0.3. Dissolved oxygen (DO)** levels ranged from **4.1 ± 0.4 mg/L** to **7.2 ± 0.5 mg/L,** and **biological oxygen demand (BOD)** varied from **2.1 ± 0.3** to **4.8 ± 0.6 mg/L.**

Nutrient parameters such as **ammonia (0.07 ± 0.01 to 0.29 ± 0.02 mg/L), nitrate (0.15 ± 0.02 to 0.51 ± 0.04 mg/L)**, and **phosphate (0.08 ± 0.01 to 0.38 ± 0.03 mg/L)** exhibited clear seasonal fluctuations, with higher concentrations observed during the monsoon season—particularly in **Waddepally Reservoir** likely due to surface runoff and nutrient input from surrounding catchments.

**Total alkalinity** ranged from **78 ± 5.4 to 142 ± 6.8 mg/L**, showing elevated values during the summer months. These higher alkalinity levels, along with favourable temperature and DO conditions, likely contributed to enhanced zooplankton productivity during the warmer periods of the year.

To evaluate the impact of physicochemical parameters on zooplankton biodiversity, multiple linear regression analysis was performed using a stepwise backward elimination method. The independent variables included temperature, pH, dissolved oxygen (DO), biological oxygen demand (BOD), total alkalinity, ammonia, nitrate, and phosphate. Among these, four parameters **ammonia, nitrate, phosphate, and total alkalinity** were identified as the most significant predictors of zooplankton abundance and diversity.

In **Bhadrakali reservoir (Model 1),** the regression model demonstrated a strong explanatory power, with an **R² value of 0.72 (p < 0.01),** indicating that 72% of the variation in rotifer abundance could be explained by the selected water quality variables. Specifically, **ammonia (β = -0.42, p = 0.012)** and **phosphate (β = -0.38, p = 0.017)** showed statistically significant negative correlations with rotifer density, suggesting that elevated nutrient levels adversely affect sensitive taxa.

Similarly, in **Waddepally reservoir (Model 2),** total zooplankton abundance was negatively correlated with **nitrate (β = -0.39, p = 0.015)** and **ammonia (β = -0.47, p = 0.009)**.The model explained **69% of the variance (R² = 0.69, p < 0.01)** in zooplankton abundance, indicating a strong influence of nutrient enrichment on community structure.

These findings are consistent with previous studies (Kumar *et a*l., 2019; Udayangani *et al*., 2020), which reported that excessive nutrient inputs can suppress zooplankton diversity, particularly among sensitive groups like rotifers and cladocerans. Overall, the regression analysis highlights the significant role of nutrient dynamics in shaping zooplankton communities and reinforces their value as reliable bio indicators of freshwater ecosystem health.

**Conclusion**

The present study highlights distinct seasonal and spatial patterns in zooplankton diversity and abundance in two urban reservoirs of Warangal, with Bhadrakali exhibiting greater species richness and population density than Waddepally. Copepoda and Cladocera dominated during warmer months, while rotifers and ostracods showed peak abundance in transitional seasons. Zooplankton dynamics were significantly influenced by physicochemical parameters, particularly ammonia, nitrate, phosphate, and total alkalinity. The presence of tolerant taxa like Brachionus and Keratella indicates moderate eutrophic conditions, especially in Waddepally. These findings reinforce the utility of zooplankton as sensitive bio indicators and support their inclusion in regular water quality monitoring to guide sustainable management of urban freshwater ecosystems.

**Authors Contributions:** This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

**Declaration**

 No experiments involving humans or animals were conducted in this study. Zooplankton sampling and water quality assessments were carried out in accordance with institutional and environmental guidelines. Ethical approval and consent were not required.

**Competing Interests:** Authors have declared that no competing interests exist.

**Disclaimer (Artificial Intelligence):** The authors declare that no generative AI technologies (such as ChatGPT, Copilot, or other large language models) were used in the writing, editing, or analysis of this manuscript.

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