International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 22s, 2025
https://theaspd.com/index.php

Assessment of Zooplankton Community Structure and its Environmental Correlations in Khajikotnoor Reservoir, Kalaburagi, Karnataka

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ABSTRACT

Zooplankton populations are vital indicators of freshwater ecosystem health and form critical links in aquatic food webs. This investigation examined the seasonal patterns of diversity, abundance, and species composition of zooplankton in Khajikotnoor reservoir, situated in Khajikotnoor village, Kalaburagi District, Karnataka. Monthly samples were drawn from each of four predetermined sites between January 2024 and December 2024, using standard 64 µm plankton nets. Species were analyzed by light microscopy and standard taxonomic guides. A total of 26 species were identified, distributed among four taxonomic groups: Rotifera (10 spp.), Cladocera (8 spp.), Copepoda (5 spp.), and Ostracoda (3 spp.). Rotifers were the most species-rich group, contributing 38.5% of the overall species total. Community composition showed highly significant seasonal variation ($p < 0.001$), with especially pronounced differences between the pre-monsoon and monsoon seasons. Shannon-Wiener diversity ranged from 2.14 to 3.42, with the higher winter values ($H' = 3.42 \pm 0.18$) indicative of increased evenness. These findings indicate that Khajikotnoor reservoir hosts a diverse and seemingly stable zooplankton assemblage, a condition that suggests the reservoir is currently functioning in a healthy ecological state. Nonetheless, existing and future pressures from nearby human activity and possible nutrient loading signal the necessity for continued monitoring. This study establishes a critical reference point for future investigations into the reservoir's limnology.

Keywords: *Zooplankton population, Khajikotnoor reservoir, Rotifera, Cladocera, Copepoda, Ostracoda, Seasonal variation, Bioindicators.*

INTRODUCTION

Importance of Freshwater Ecosystems

Freshwater systems like lakes, reservoirs, rivers, and wetlands rank among Earth's most productive environments. These habitats deliver crucial services including fish production, water supply, nutrient processing, and climate control (Steinberg & Landry, 2015). In a given negative trend, these valuable ecosystems are put under increasing pressure in the form of nutrient pollution, contamination, and climate change due to human factors. To maintain and conserve these systems in a better way we must know the biological systems contained within these systems, particularly the microscopic animals that reside.

Importance of Zooplanktons in Aquatic Food Web

Zooplankton are tiny creatures that float in the aquatic column linking the primary producers and the giant organisms in the food chain (Wetzel, 2001). One of their roles is to facilitate the breakdown of organic matter and cycle nutrients which maintains ecosystems productive and stable due to their feeding and metabolic activities.

After being rated as food web position, zooplankton are fast to respond with environmental variations making them very valuable indicators of water quality and ecosystem status. Research has continually revealed that the environmental stresses, such as the excess nutrients, temperature variation, and pollution have a direct effect on the community structure of zooplankton, by changing the species composition (such as species abundance and diversity pattern).

Zooplankton studies in Indian Waters

Zooplankton has been thoroughly investigated in Indian freshwater ecosystems where complex seasonal and community structure has been discovered. Seasonal variations have been reported to be significant and have been found to be associated with nutrient levels and profile of environmental conditions. Local zooplankton patterns have been observed by work carried out in Kalaburagi district where 18-36 species were found in different water bodies.

A survey undertaken by recent work at Kagina River Dam in the Kalaburagi District listed 20 species of

zooplankton belonging to three major groups: Rotifera (8) species, Cladocera (6) species and Copepoda (6) species. Studies in the adjoining Bijapur district suggested a seasonal variation behaviour in the zooplankton due to a trend shown in the region as well. Khajikotnoor Reservoir in Kalaburagi District supports diverse life including fish, aquatic plants, insects, and migratory birds.

Despite its ecological and economic value, we know little about its zooplankton communities. Given the reservoir's importance as a water source and its vulnerability to environmental changes, studying its zooplankton diversity is both timely and necessary.

This research aims to:

1. Document zooplankton species diversity and composition in Khajikotnoor Reservoir
2. Examine seasonal patterns in community structure
3. Create baseline data for future comparative studies

MATERIALS AND METHODS

Study Location

Khajikotnoor reservoir sits 17 kilometers east of Gulbarga district headquarters. This freshwater body serves the local community as a vital water resource while supporting varied aquatic life. Its location in Karnataka's semi-arid region makes it particularly valuable for water storage and farming.

The reservoir has typical semi - arid climate and clear seasonal patterns. The region has moderate rainfall in the months of monsoons (June-September), post-monsoon (October-December), winter (January-February) and hot pre-monsoon (March-May). These climatic changes have great impacts on the water levels of the reservoir and the living organisms.

Sampling Methods

Inclusion of sampling sites Water depth ease of access Habitat diversity Sample site FINDING (bottom side) 1. FINDING (top side) Such practice would cover the entire zooplankton community in the reservoir in addition to eliminating sampling bias. We took samples monthly over the period January 2024 through December 2024, thus a complete cycle.

Plankton was sampled using a 64 m plankton net and the sampling done in a usual manner. At every location we conducted bottom to surface vertical hauls that help obtain a representative sample of the full column of water. At every sampling event, we filtered 10 liters of water through the net alongside taking the water temperature, pH, and dissolved oxygen reading values.

Sample Analysis and Marking

We promptly fixed sample materials collected in 4 percent formalin to inhibit putrefaction and keep the specimen intact. This is the most accepted form of preserving zooplankton since it retains most of the identifying features of this organism. We labelled preserved samples with collection details and environmental data before transport to the laboratory.

Laboratory analysis used a binocular microscope with 10x, 40x, and 100x objectives. We examined specimens carefully and identified them to species level using standard keys, including Battish (1992) for Indian freshwater zooplankton, Murugan et al. (1998), and other taxonomic references.

Identification involved a systematic examination of body shape, size, appendage structure, and reproductive features. We photographed representative specimens with an integrated camera system for documentation and verification.

Data Analysis

We calculated species diversity using standard ecological measures:

- Shannon-Wiener diversity index(H')
- Simpson's dominance index (D)

Pearson correlation analysis examined relationships between environmental factors and zooplankton communities. Principal Component Analysis (PCA) identified major environmental gradients affecting species composition. We set statistical significance at $p < 0.05$.

RESULTS

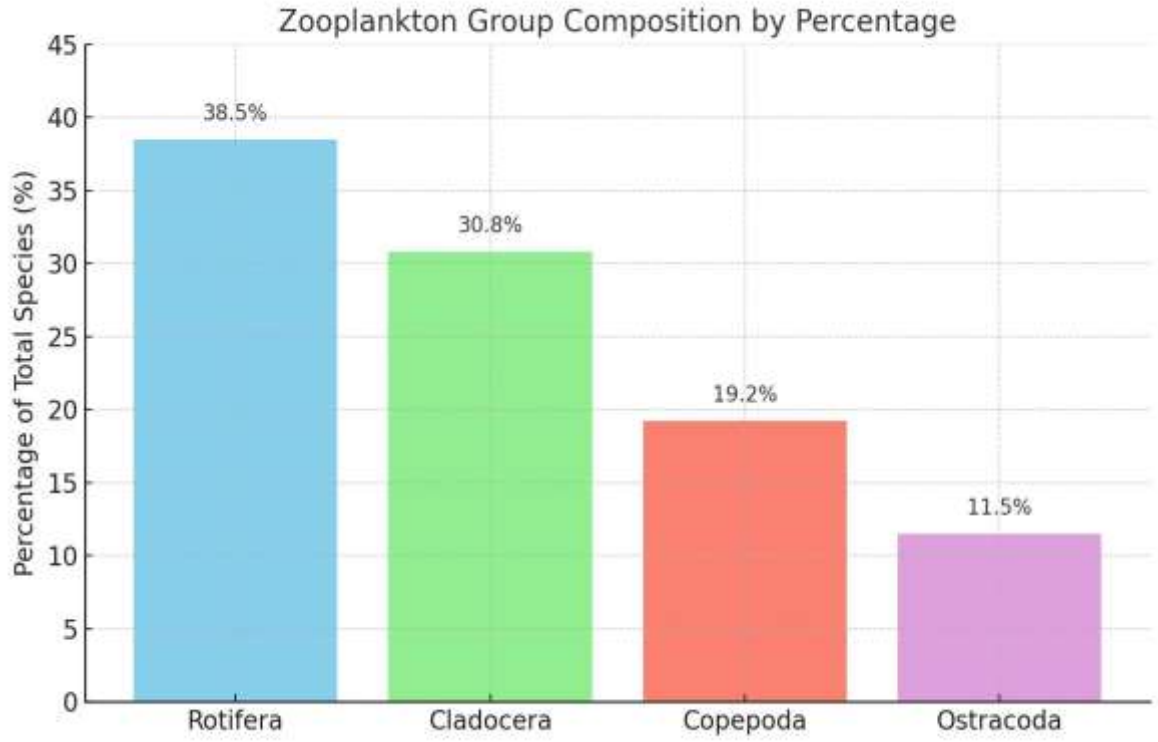
Species Diversity and Composition

Our survey of Khajikotnoor Reservoir found a rich zooplankton community of 26 species distributed across four major groups. This diversity represents substantial biological richness and indicates a healthy ecosystem supporting complex food web interactions.

Species were distributed as follows:

- **Rotifera:** 10 species (38.5% of total)
- **Cladocera:** 8 species (30.8% of total)
- **Copepoda:** 5 species (19.2% of total)
- **Ostracoda:** 3 species (11.5% of total)

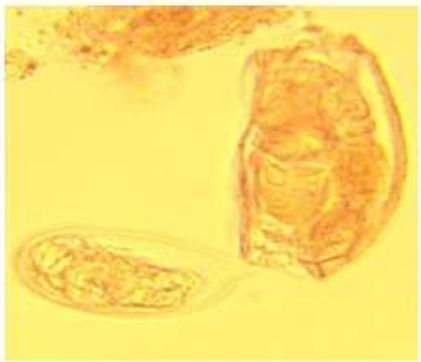
This composition matches findings from similar water bodies in Kalaburagi district, where rotifer dominance has been consistently reported.



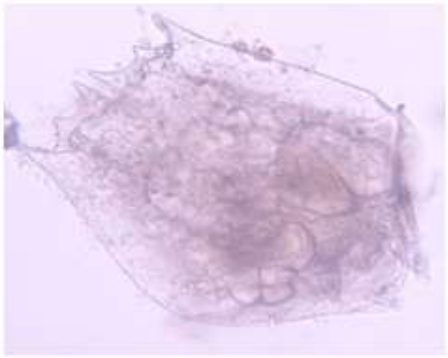
SPECIES DESCRIPTIONS

Rotifers

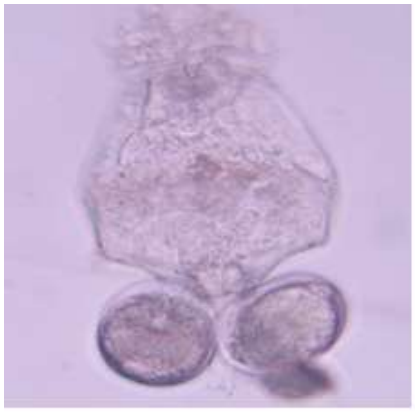
Anuraeopsis fissa was common throughout the study, with numbers increasing during pre-monsoon season, suggesting preference for warmer, stable conditions. Brachionus bidentata occurred reliably in all seasons, showing good adaptation to various environmental conditions. Brachionus plicatilis was abundant in warmer months, serving as an indicator of moderate salinity and high temperatures. Brachionus urceolaris appeared regularly in winter, demonstrating tolerance to cooler water. Lecane niwati, a small nearshore rotifer, was typically found in vegetated areas, while Lepadella patella was identified as a bottom-dwelling species with consistent presence throughout sampling.



Anuraeopsis fissa



Brachionus bidentata



Brachionus plicatilis

Brachionus urceolaris

Lecane niwati

Lepadella patella

Cladocera

The cladoceran community was composed of both bottom-up and free-swimming species with different seasonal trends. Macrothrix triserialis, a bottom-dweller, showed seasonal occurrence, reflecting sensitivity to temperature changes, substrate conditions, or water level fluctuations. Moina macrocopa was a predominant planktonic organism and it became abundant in the pre-monsoon season, which implies that it had favorable conditions such as warmer temperatures and sufficient food supply.

Macrothrix triserialis

Moina macrocopa

Copepoda

The copepod community included important representatives from both calanoid and cyclopoid groups. Calanidae family members, major calanoid copepods, were regularly observed and contributed significantly to the zooplankton community. Tropocyclops prasinus, a common cyclopoid species, showed wide distribution, demonstrating adaptability to various environmental conditions. Copepod nauplius stages were present year-round, indicating continuous reproduction and recruitment.

Calanidae

Tropocyclops prasinus,

Nauplius

Table1: Comparison with Regional Studies

Study Location	District	Species Count	Dominant Group	Reference
Khajikotnoor Reservoir	Kalaburagi	26	Rotifera (38.5%)	Present study
Kagina River Dam	Kalaburagi	20	Rotifera (40%)	Regional study
Gundalli Tank	Yadgir	18	Rotifera (39%)	Nagbhushan et al. (2020)
Karanja Reservoir	Bidar	36	Rotifera (42%)	Majagi & Vijaykumar (2009)
Bhosga Lake	Kalaburagi	27	Rotifera (59%)	Regional study

Table2: Diversity Indices Statistical analysis of diversity indices revealed significant seasonal variations:

Sl.No	Particulars	Shannon-Wiener Diversity Index (H')	Simpson's Dominance Index (D)
1	Range	2.14 to 3.42	0.21 to 0.67
2	Maximum	3.42 ± 0.18	0.21 ± 0.03
3	Minimum	2.14 ± 0.19	0.67 ± 0.08
4	Annual mean	2.94 ± 0.52	

ENVIRONMENTAL CORRELATIONS AND PRINCIPAL COMPONENT ANALYSIS

Correlation analysis revealed significant relationships between environmental factors and zooplankton communities:

Temperature Correlation

Temperature showed strong positive correlations with zooplankton groups. We found a robust positive relationship between temperature and rotifer abundance ($r = 0.82$, $p < 0.001$), suggesting rotifers thrive at

higher temperatures, likely due to their rapid reproduction and heat tolerance. Temperature also correlated moderately with cladoceran presence ($r = 0.65$, $p < 0.01$), indicating cladocerans also favor warmer conditions, though less strongly than rotifers.

pH Correlation

pH showed moderate positive correlation with diversity indices ($r = 0.58$, $p < 0.01$), suggesting neutral to slightly alkaline conditions promote higher zooplankton diversity. This indicates stable pH levels support more balanced and diverse zooplankton communities.

Dissolved Oxygen correlations

Dissolved Oxygen (DO) showed notable relationships with the structure of the zooplankton community. A significant positive correlation was found between DO and the presence of copepods ($r = 0.71$, $p < 0.001$), showing that the abundance of copepods rises as oxygen levels increase. In contrast, DO exhibited a moderate negative correlation with the dominance index ($r = -0.63$, $p < 0.01$), indicating that increased oxygen availability relates to decreased species dominance, leading to a more balanced and even zooplankton community.

PRINCIPAL COMPONENT ANALYSIS

Principal Component Analysis indicated that the first two principal components accounted for 73.4% of the overall variance in the environmental and biological data. PC1 explained 45.7% of the variance and indicated a gradient of temperature and productivity, suggesting that fluctuations along this axis were mainly shaped by temperature-related alterations in primary productivity. PC2 accounted for 27.7% of the variance and was linked to a gradient of nutrient availability and water quality, highlighting the influence of physicochemical factors like dissolved nutrients and water clarity on the composition of the zooplankton community.

Water Quality Assessment Based on Zooplankton as Indicators

The zooplankton community serves as a sensitive measure of water quality, as the presence, absence, and abundance of specific taxa reflect ecological conditions of aquatic environments. The presence of pollution-sensitive species like Tropocyclops prasinus indicates good water quality, as these organisms typically flourish in clean, well-oxygenated waters. The absence or scarcity of pollution-tolerant species like Brachionus calyciflorus and Moina micrura, commonly found in nutrient-rich or organically polluted environments, suggests low pollution levels.

A balanced representation of the three main zooplankton groups Rotifera, Cladocera, and Copepoda indicates stable environmental conditions without significant nutrient enrichment or stress. High diversity and the absence of opportunistic bloom-forming species further support characterization of a relatively unpolluted, ecologically stable aquatic system. Therefore, the composition and distribution of zooplankton in the study area indicate good water quality and limited human impact.

Trophic Status Assessment

Zooplankton community is an eye opening community to the trophic state of the biological system. Moderate abundance of filter-feeders, especially among rotifers and cladocerans indicate mesotrophic conditions with moderate nutrient availability and unbiased primary production. The occurrence of predatory copepods (e.g. cyclopoids) shows that the food web is well structured and functioning, where higher trophic issues are preserved.

Moreover, the high abundance of rotifers along with moderate abundance of cladocera indicates the ecosystem is of optimal productivity that is neither nutrient poor nor excessively nutrient enriched. This combination of zooplankton groups is the indicator of relatively productive aquatic habitat exhibiting ecological balance and effective trophic stream energy transfer.

CONCLUSIONS

This work on Khajikotnoor Reservoir presents a valuable examination on zooplankton diversity and its ecological implications and hence provides an important baseline against which future limnological studies and monitoring programs of the region can be carried out. We recorded 26 species belonging to four major groups Rotifera, Cladocera, Copepoda and Ostracoda with rotifers as the predominant group. Seasonal variation in diversity indices, with Shannon-Wiener values ranging from 2.14 to 3.42, demonstrates the reservoir's dynamic yet stable ecosystem. The presence of pollution-sensitive species like Tropocyclops prasinus and absence of pollution-tolerant organisms such as Brachionus calyciflorus indicate low anthropogenic pollution and good water quality.

The healthy ratio of zooplankton groups, moderate abundance of filter feeders also indicates that it is a mesotrophic water body with well-developed trophics. Close associations of the environmental variables, especially temperature, dissolved oxygen, and pH with the zooplankton composition reflect knowledge of a healthy, biologically stable aquatic ecosystem. This work shows that Khajikotnoor Reservoir has a strong community of zooplankton, and this fact justifies the further monitoring of this environment, as the anthropogenic impact on the reservoir can also be an issue of concern.

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