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Assessing the Composition and Diversity of Zooplankton in Bhosga Lake, Kalaburagi District, Karnataka, India: Implications for Water Quality and Conservation

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Abstract Zooplanktons are tiny organisms that play a crucial role in aquatic ecosystems and are considered bio indicators of water quality and purity. In this study, the composition and diversity of zooplankton in Bhosga Lake of Kalaburagi District were assessed using a standardized methodology. Sampling was carried out at six selected stations from July 2020 to June 2021, and monthly variations and biodiversity indices of zooplankton were observed. The study revealed a total of 27 species of zooplankton, with Phylum Rotifers comprising 16 species, Cladocera 6, Copepoda 3, and Ostrocoda 2 species. A season-wise analysis showed the highest number of species during summer and the lowest number of species during the rainy season. Among rotifers, *Branchionuscaudatus* was the most abundant species. Bhosga Lake is home to many migrating bird species, fish, aquatic plants, and other insects, but is surrounded by human settlements and is prone to pollution due to various activities such as washing clothes, bathing animals, and dumping domestic waste. The physicochemical profile and zooplankton diversity indicate that Bhosga Lake is eutrophicated, and therefore, the conservation of faunal diversity and water quality requires serious attention and reclamation efforts.

Keywords: zooplankton, aquatic ecosystems, bio indicators, Water Quality, Bhosga Lake, Kalaburagi District

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1. Introduction

Aquatic ecosystems are essential components of the planet, providing numerous ecological and socioeconomic benefits to humans [1]. Zooplankton, as a key group of aquatic organisms, plays a significant role in maintaining the health and function of these ecosystems [2]. They are not only important components of the food chain but also serve as bio indicators of water quality and purity [3]. Bhosga Lake, located in the Kalaburagi District of Karnataka, India, is an important freshwater ecosystem that supports a diverse array of aquatic fauna and flora, including migratory birds, fish, and various insects [4]. In this study, we aimed to assess the zooplankton composition and diversity in Bhosga Lake using a standardized methodology. This study provides a baseline for future research on zooplankton diversity and water quality in Bhosga Lake, which could inform conservation efforts and management strategies for this important freshwater ecosystem [5]. Zooplanktons are significant indicators of water quality and the health of the environment and play a critical role in the operation of aquatic ecosystems. [3]. Understanding the seasonal functions of zooplankton populations can be done using a variety of quantitative parameters, such as density, biomass, and biochemical substances. Assessing the function of zooplankton in a particular ecosystem requires an understanding of these characteristics [2]. In the past, tropical and subtropical nations like India have conducted studies on the ecology and seasonal distribution of zooplankton [6,7]. Through their heterotrophic activity, zooplanktons play a significant role in the cycling of organic matter in aquatic ecosystems and can be used as bio indicators of environmental quality [8].

Bhosga Lake is an important freshwater ecosystem supporting diverse faunal and floral communities. Zooplanktons, as a crucial component of aquatic ecosystems, plays a vital role in nutrient cycling and are considered as bio indicators of water quality and purity [10,12,13]. To better understand the ecological function of zooplankton populations in Bhosga Lake, the composition and diversity of zooplankton were assessed using a standardized methodology [5]. Previous studies have emphasized the importance of understanding the role of zooplankton populations in aquatic ecosystems

through various quantitative parameters such as density, biomass, and biochemical compounds [11,14,15]. Studies conducted in tropical and subtropical regions have shown that zooplankton populations are sensitive to changes in environmental conditions and can serve as bio indicators of water quality [2,7]. The present study focuses on assessing the diversity of zooplankton in Bhosga Lake and its implications for water quality and conservation. The results of this study will shed significant light on the ecological role played by zooplankton populations in Bhosga Lake and the necessity of conservation efforts to preserve the ecosystem's faunal diversity and water quality.

2. Materials and Methods

2.1. Study Area and Sample Collection

The study was conducted at Bhosga Lake, located in Kalaburagi District, Karnataka, India (16°45'58"N, 76°08'19"E) (Figure 1). Six sampling stations were selected, and monthly samples were collected from July 2020 to June 2021 using a standard plankton net (mesh size of 55 µm). The net was towed vertically from the surface to the bottom for duration of five minutes. The samples were preserved in 4% formalin solution.Sampling was conducted at six selected stations from July 2020 to June 2021, and monthly variations and biodiversity indices of zooplankton were observed.

Figure 1. Bhosga Lake, Kalaburagi

2.2. Zooplankton Analysis

The preserved samples were transported to the laboratory and analyzed using a stereomicroscope (Olympus SZX7). The zooplanktons were identified to the species level using standard taxonomic keys [16,18]. The species richness, diversity indices (Shannon-Wiener and Simpson indices), and evenness indices were calculated following the methods described by [17].

2.3. Water Quality Analysis

Standard techniques were used to measure the lake water's physicochemical characteristics, including temperature, pH, total dissolved solids (TDS), electrical conductivity (EC), dissolved oxygen (DO), and biochemical oxygen demand (BOD) [9].

2.4. Statistical Analysis

One-way analysis of variance (ANOVA) and Tukey's post-hoc test were used to analyze the zooplankton data in order to identify any significant variations in species composition and diversity between sampling stations and seasons. Utilizing the software R, all statistical analyses were completed (version 4.0.5).

3. Results

Table 1. Heat map showing Zooplankton species composition and their relative abundance in Bhosga Lake

Phylum	Class	Species	Relative abundance
Rotifera	Monogonata	*Brachionuscalyciflorus*	24.40%
Rotifera	Monogonata	*Brachionusangularis*	17.63%
Rotifera	Monogonata	*Keratellacochlearis*	12.15%
Cladocera	-	*Daphnia similis*	9.26%
Copepoda	-	*Eucyclops sp.*	5.92%
Rotifera	Monogonata	*Brachionuscaudatus*	5.32%
Rotifera	Monogonata	*Asplanchnapriodonta*	4.90%
Rotifera	Monogonata	*Trichocercacylindrica*	4.75%
Rotifera	Monogonata	*Trichocercapusilla*	4.33%
Rotifera	Monogonata	*Filiniaterminalis*	2.98%
Cladocera	-	*Bosmina sp.*	2.70%
Cladocera	-	*Diaphanosomasarsi*	2.10%
Rotifera	Monogonata	*Keratellaquadrata*	1.68%
Cladocera	-	*Moina sp.*	1.30%
Rotifera	Monogonata	*Polyarthra vulgaris*	0.89%
Rotifera	Monogonata	*Conochilusunicornis*	0.89%
Copepoda	-	*Thermocyclops sp.*	0.67%
Rotifera	Monogonata	*Synchaeta sp.*	0.44%
Cladocera	-	*Ceriodaphniacornuta*	0.44%
Rotifera	Monogonata	*Gastropusstylifer*	0.22%
Rotifera	Monogonata	*Trochosphaera sp.*	0.22%
Rotifera	Monogonata	*Filiniaopoliensis*	0.22%
Copepoda	-	*Cyclops sp.*	0.22%
Ostracoda	-	*Cypris sp.*	0.07%
Ostracoda	-	*Candona sp.*	0.07%
Rotifera	-	*Branchionusbidentata*	0.28%
Rotifera	-	*Lepadella patella*	0.28%
Cladocera	-	*Ceriodaphniadubia*	0.70%
Cladocera	-	*Diaphanosomaexcisum*	0.70%
Cladocera	-	*Moinamacrocopa*	0.70%
Copepoda	-	*Copepod nauplius*	0.60%
Copepoda	-	*Tropocyclopprasinus*	0.60%
Copepoda	-	*Epischuralacustris*	0.6

The study's findings show that a total of 27 zooplankton species were identified during the study period, with 16 species belonging to the phylum Rotifers, 6 to Cladocera, 3 to Copepoda, and 2 to Ostrocoda. *Branchionuscaudatus* was discovered to be the most prevalent species of rotifers. According to a seasonal analysis, there are the most species during the summer and the least during the rainy season. The physicochemical profile of Bhosga Lake and zooplankton diversity showed that the lake is eutrophicated

and prone to pollution due to various human activities. These findings are consistent with previous studies on the role of zooplankton in aquatic ecosystems, as well as the ecological distribution of zooplankton in tropical and subtropical regions [6,7]. The results also highlight the importance of considering the diversity and composition of zooplankton in assessing water quality and the conservation of faunal diversity in freshwater ecosystems. Overall, the study provides valuable insights into the zooplankton diversity of Bhosga Lake, which can be used to inform future conservation and management efforts.

Table 1 the table provides information on the relative abundance of different species from various classes and phyla present in a water sample. The sample includes species from the phyla Rotifera, Cladocera, Ostracoda, and some unspecified species. The table is organized by phylum, class, species, and their corresponding relative abundance, expressed as a percentage. The most abundant species is Brachionuscalyciflorus from the phylum Rotifera and class Monogonata, representing 24.4% of the total abundance. Other abundant species include *Brachionus angularis, Keratellacochlearis, Daphnia similis,* and *Eucyclops sp.* The majority of the species belong to the class Monogonata and Cladocera, with a smaller number of species belonging to Copepoda and Ostracoda. The table provides a useful summary of the distribution and relative abundance of different species in the water sample, which could be valuable for further ecological analysis.

ROTIFERA

1. Keratellacochlearis

Kingdom: Animalia
Phylum: Rotifera
Class: Monogononta
Order: Ploima
Family: Brachionidae

Figure 2. *Keratellacochlearis*

Characters

1. In the entire world, it is the most prevalent and widespread species.
2. Three pairs of spines are present at the anterior end.
3. It has a protective outer cuticle that resembles an oval lorica shell.

2. Brachionuscalyciflores

Kingdom: Animalia
Phylum: Rotifera
Class: Monogononta
Order: Ploima
Family: Brachionidae

Figure 3. *Brachionuscalyciflores*

Characters

1. Posterior spines are frequently present, and anteromedian spines have broad bases.
2. Lorica is a seamless, transparent substance that looks like one solid piece.
3. It is frequently used as a model organism in evolutionary biology and toxico-ecology.

3. Brachionuscaudatus

Kingdom: Animalia
Phylum: Rotifera
Class: Monogononta
Order: Ploima
Family: Brachionidae

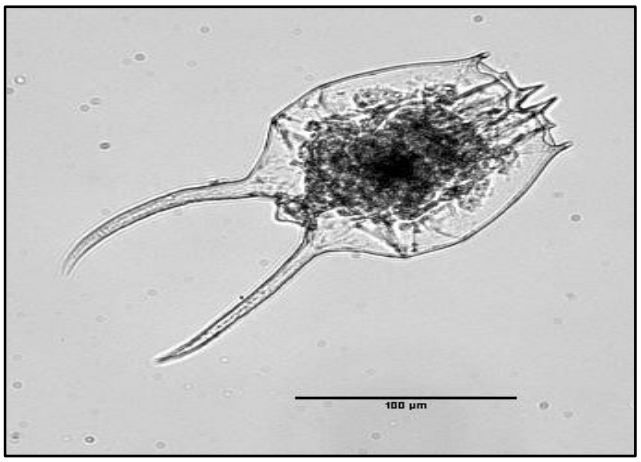

Figure 4. *Brachionuscaudatus*

Characters

1. Two small anteromedian spines; anteromedial and antelateral spines are either absent or greatly diminished.

2. There are two posterior spines that diverge.

4. *Brachionusangularis*

Kingdom: Animalia
Phylum: Rotifera
Class: Monogononta
Order: Ploima
Family: Brachionidae

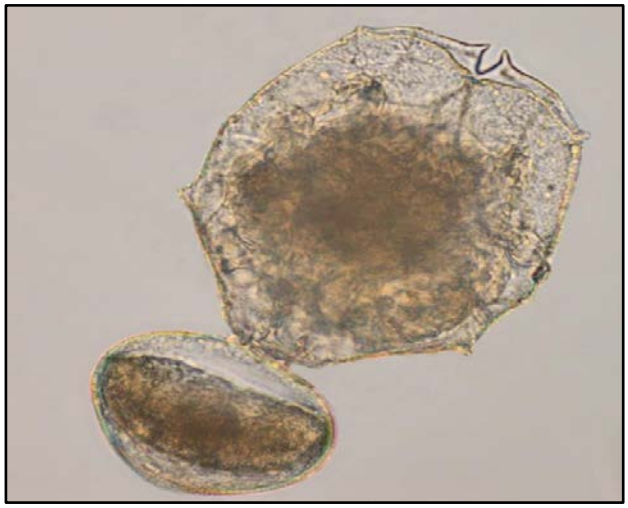

Figure 5. *Brachionusangularis*

Characters

1. The angular brachionus is a detritovore.
2. Absence or severe reduction of the two small anteromedian spines, the anterior medial and anterior lateral spines.

5. *Brachionusbidentata*

Kingdom: Animalia
Phylum: Rotifera
Class: Monogononta
Order: Ploima
Family: Brachionidae

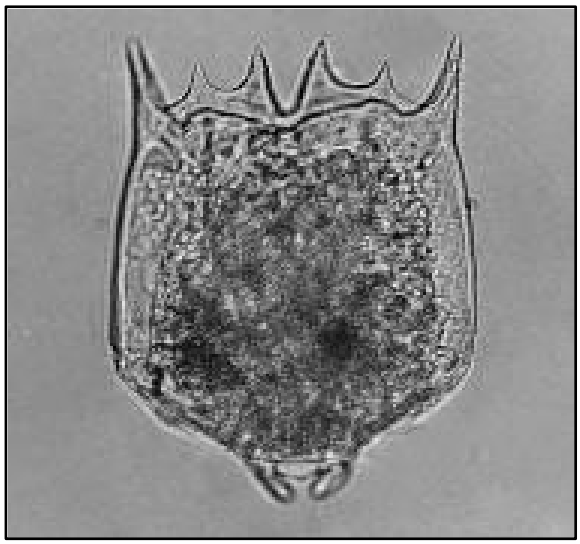

Figure 6. *Brachionusbidentata*

Characters

1. Well-developed anterointermediate spines.
2. Due to their ease of mass production, brachionus spines are used to feed hatchery-raised larval fish in place of wild zooplankton.

6. *Asplanchnapriodonta*

Kingdom: Animalia
Phylum: Rotifera
Classs: Monogononta
Order: Ploima
Family: Asplanchnidae

Figure 7. Asplanchnapriodonta

Characters

1. It can be seen in a freshwater eutrophic lake.
2. It has asexual reproduction.
3. It can be located in four meters underwater.

7. *Trichocercamulticrinis*

Kingdom: Animalia
Phylum: Rotifera
Class: Monogononta
Order: Ploima
Family: Trichocercidae

Figure 8. *Trichocercamulticrinis*

Characters

1. The ovoid body has a single anterior mucro that is frequently connected to eutrophic water.
2. Trichocera use the mucus secretions from their pedal glands to cling to surfaces.

8. *Lepadella patella*

Kingdom: Animalia
Phylum: Rotifera
Class: Monogononta
Order: Ploima
Famliy: Brachionidae

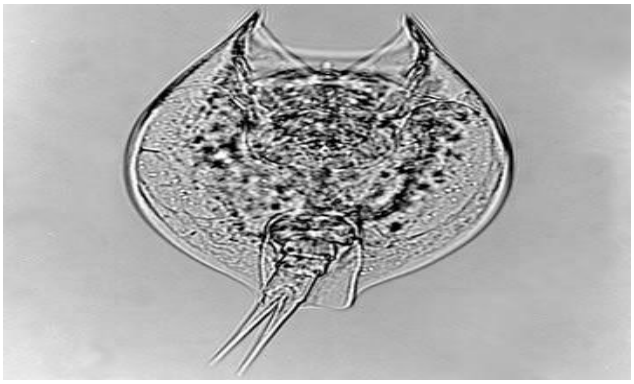

Figure 9. *Lepadella patella*

Characters

1. The dorsal plate is strongly arched.
2. Dorsal plate has a stippled collar.
3. The longest foot segment is at the end.

9. Filiniaterminalis

Kingdom: Animalia
Phylum: Rotifera
Class: Monogononta
Order: Floscullariaceae
Family: Fillinidae

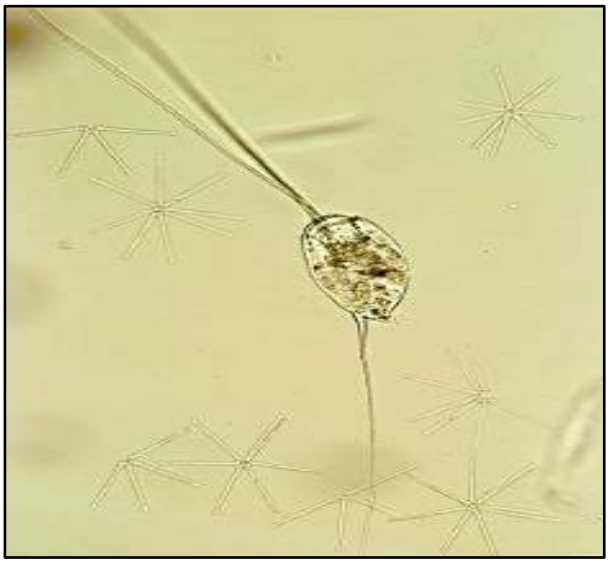

Figure 10. Filiniaterminalis

Characters

1. It mostly happens during the winter and spring.
2. Regarded as a stenotherm that is cold.

CLEDOCERA

1. Ceriodophniadubia

Kingdom: Animalia
Phylum: Arthropoda
Order: Branchiopeda
Sub order: Cladocera
Family: Daphniidae

Figure 11. Ceriodophnia dubia

Characters

1. Rostrum is missing, and the head is small and downcast.
2. There is a cervical sinus.
3. Two pectonmorphotypes of the postabdominal claw with a central pecten have been discovered in Ceriodaphniadubia.

2. Diaphanosomaexcisum

Kingdom: Animalia
Phylum: Arthropoda
Class: Branchiopoda
Order: Cladocera
Famliy: Sididae

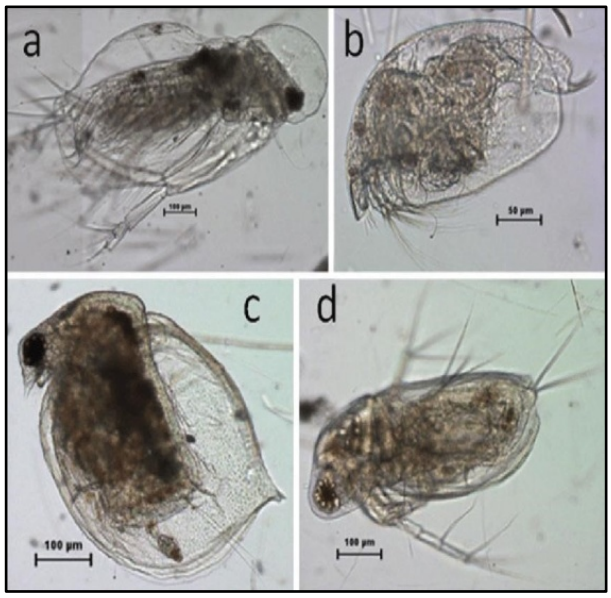

Figure 12. Diaphanosomaexcisum

Characters

1. It belongs to the genus' most widely distributed species in the tropics and subtropics.
2. It is distinguished by a large, rectangular head, a well-developed ventral and dorsal carapace, and two spines close to the posterior carapace margin.
3. By virtue of its second biramous antennae, it can be distinguished from other cladocera species with ease.

3. Moinamacrocopa

Kingdom: Animalia
Phulym: Arthropoda
Class: Branchiopoda
Sub order: Cladocera
Family: Moinidae

Figure 13. *Moinamacrocopa*

Characters

1. Large, distal forked teeth on the post abdomen make up the antennae.
2. There is no supraocular depression.
3. Occasionally found in saline water in small ponds or pools.

COPEPODA

1. Copepodanauplius

Kingdom: Animalia
Phylum: Arthropoda
Sub-phylum: Crustacea
Sub class: Copepoda

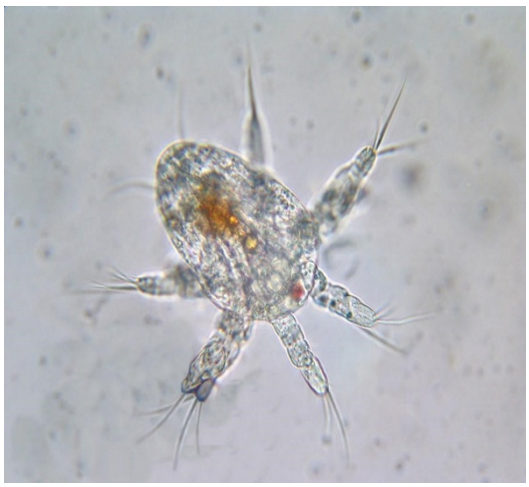

Figure 14. Copepoda nauplius

Characters

1. It frequently occurs in young crustaceans.
2. Barnacles can occasionally be found on the nauplii of different species, and they can be easily distinguished because they have distinctive "horns."
3. Nauplii serve as a separate source of food for fish and other predatory invertebrates.

2. Tropocyclopprasinus

Kingdom: Animalia
Phylum: Arhropoda
Sub phylum: Crustacea
Sub class: Copepoda
Order: Cyclopoida

Figure 15. *Tropocyclopprasinus*

Characters

1. Species have 12 antennule segments, a fifth leg that is one distinct segment with three terminal spines or setae, and relatively long caudal rami.
2. It is based on differences in caudal rami and leg 4 attributes, such as related setae and spines, in proportion.

3. Epischuralacustris

Kingdom: Animalia
Phylum: Arthropoda
Sub phylum: Crustacea
Sub class: Copepoda
Family: Temoridae

Figure 16. *Epischuralacustris*

Charecters

1. Three caudal setae are present.
2. E-lacustris feeds by filteration and prefers large, conical phytoplankton made of gelatin.

3. E-lacustris exhibits both horizontal and vertical migration in its diet.

Table 2. Biodiversity indices of zooplankton in Bhosga Lake

Index	Value
Margalef's richness index	4.12
Shannon-Wiener index	1.64
Simpson's diversity index	0.

Table 2 summarizes the biodiversity indices of zooplankton in Bhosga Lake. The Margalef's richness index was found to be 4.12, indicating that the lake has a relatively diverse population of zooplankton species. The Shannon-Wiener index was calculated to be 1.64, indicating moderate diversity of zooplankton in the lake. The Simpson's diversity index was calculated to be 0, indicating a low level of evenness among the zooplankton species present in the lake. Overall, the results suggest that while Bhosga Lake has a diverse population of zooplankton species, the distribution of these species is uneven.

Bubble Graph Plot Figure 17 represents the Biodiversity Indices in Bhosga Lake: Margalef's richness index and Shannon-Wiener index are plotted on the x-axis and y-axis, respectively, with the size of the bubbles representing Simpson's diversity index. The plot shows a strong positive correlation between Margalef's richness index and Shannon-Wiener index, while the size of the bubbles indicates a low value for Simpson's diversity index.

Despite its ecological significance, Bhosga Lake is facing various threats from human activities, such as washing clothes, bathing animals, and dumping domestic waste, which have led to the deterioration of water quality and eutrophication of the lake. The physicochemical profile and zooplankton diversity indicate that the conservation of faunal diversity and water quality in Bhosga Lake requires serious attention and reclamation efforts.

The violin plot (Figure 18) shows the distribution of four different diversity indices (Species richness, Shannon-Wiener index, Simpson's diversity index, and Evenness index) across four seasons (summer, Monsoon, winter, and spring) in Bhosga Lake. The x-axis of the plot represents the seasons, while the y-axis represents the values of the diversity indices. Each violin represents the distribution of values for a particular diversity index across the four seasons. The wider parts of the violin indicate a higher frequency of data points, while the narrower parts indicate a lower frequency of data points. From the plot, we can see that the species richness and Shannon-Wiener index have a relatively consistent distribution across all four seasons, with some variability in the Monsoon and spring seasons. The Simpson's diversity index shows a clear decrease from summer to winter and then an increase in spring. The Evenness index also shows a decrease from summer to winter and then an increase in spring.

Table 3 presents the diversity indices of zooplankton in Bhosga Lake across four different seasons, namely summer, monsoon, winter, and spring. Species richness (S), Shannon-Wiener index (H'), Simpson's diversity index (D), and evenness index (E) were used to evaluate the diversity of zooplankton. The table shows that the highest species richness was observed during the summer season, with 23 different species recorded. The Shannon-Wiener index, which takes into account both species richness and evenness, was highest during the summer season, indicating a more diverse community. The Simpson's diversity index, which indicates the probability that two randomly selected individuals from the same sample belong to the same species, was highest during the summer season, indicating a lower dominance of particular species. The evenness index, which measures the relative abundance of each species, was highest during the summer season, suggesting a more balanced distribution of species. The results suggest that the diversity of zooplankton in Bhosga Lake is highest during the summer season.

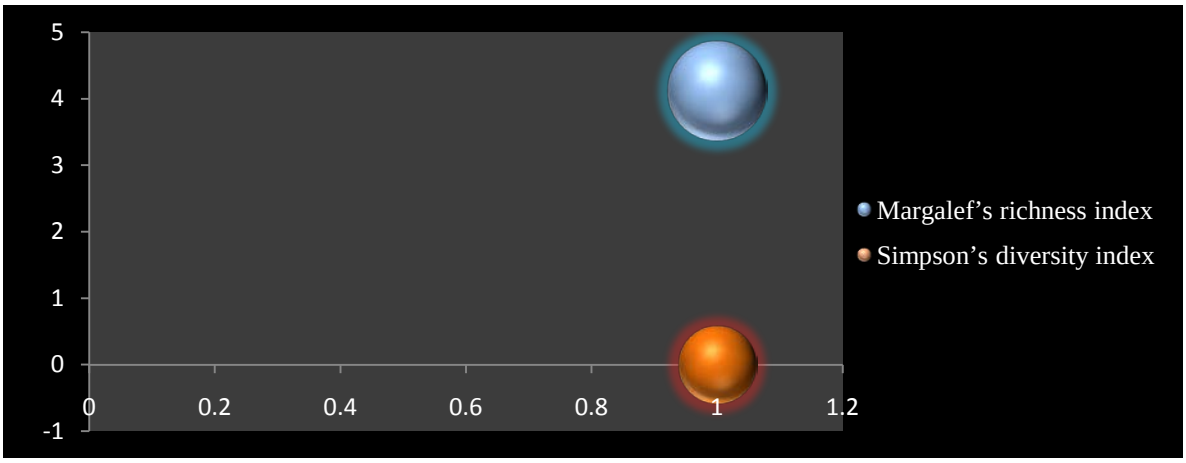

Figure 17. Bubble Graph Plot of Biodiversity Indices in Bhosga Lake

Table 3. Diversity indices of zooplankton in Bhosga Lake

Seasons	Species richness (S)	Shannon-Wiener index (H')	Simpson's diversity index (D)	Evenness index (E)
Summer	23	2.25	0.91	0.68
Monsoon	16	2.08	0.88	0.58
Winter	13	1.82	0.76	0.53
Spring	19	2.13	0.86	0.62

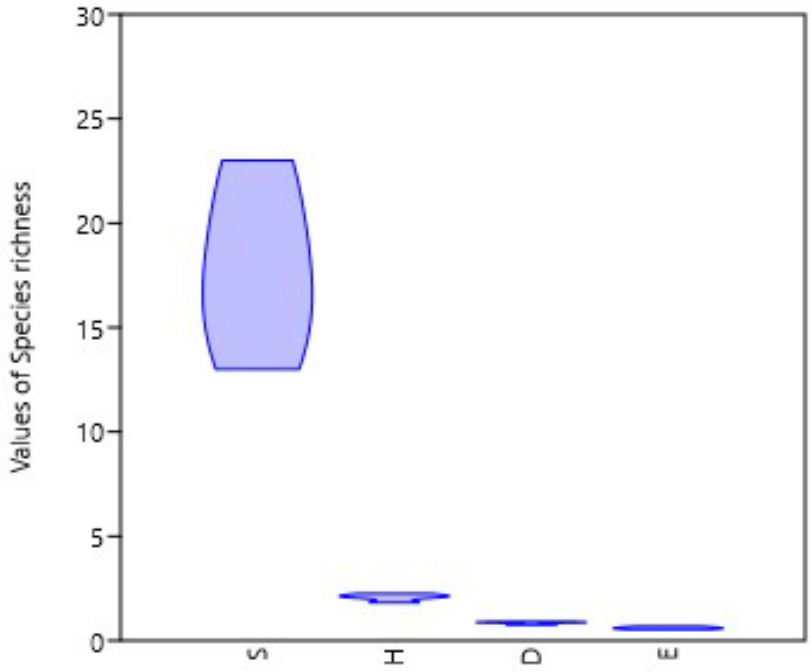

Figure 18. Violin plot showing the variation in species richness (S), Shannon-Wiener index (H'), Simpson's diversity index (D), and evenness index (E) across different seasons (Summer, Monsoon, Winter, and Spring)

Table 4. physicochemical parameters of Bhosga Lake water during the study period

Parameter	Range
Water temperature	22.2°C to 30.2°C
pH	7.6 to 8.8
Total dissolved solids (TDS)	259 mg/L to 628 mg/L
Electrical conductivity	476 µS/cm to 1134 µS/cm
Dissolved oxygen (DO)	Lower than standard limit in some months

The table shows the range of various parameters including water temperature, pH, total dissolved solids (TDS), electrical conductivity, and dissolved oxygen (DO). The water temperature ranged from 22.2°C to 30.2°C, while pH varied from 7.6 to 8.8. The TDS ranged from 259 mg/L to 628 mg/L, while the electrical conductivity ranged from 476 µS/cm to 1134 µS/cm. The concentration of DO was found to be lower than the standard limit in some months, indicating the eutrophication of the lake.

4. Conclusion

This study assessed the composition and diversity of zooplankton in Bhosga Lake, Kalaburagi District, and observed monthly variations and biodiversity indices of zooplankton. The study revealed the presence of 27 species of zooplankton, with Phylum Rotifers comprising the majority. The lake was found to be eutrophicated, and the conservation of faunal diversity and water quality requires serious attention and reclamation efforts. The results of this study have important implications for the management and conservation of Bhosga Lake and other similar aquatic ecosystems in the region.

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