Iranian Journal of Fisheries Sciences
http: doi.org/ 10.22092/ijfs.2026.135188 2026, 25(2) 333-347

Research Article

A study on zooplankton abundance, diversity, and physicochemical parameters in Ranganathittu Bird Sanctuary, India

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Keywords

Zooplankton diversity,
Ranganathittu Bird Sanctuary (RBS),
Abundance,
Physico-chemical parameters

Article info

Received: January 2025
Accepted: May 2025
Published: March 2026

Abstract

Zooplankton are among the most important microscopic animals in aquatic ecosystems, playing a crucial role in maintaining water quality and serving as a vital link in the food chain. Water quality parameters play a crucial role in regulating the abundance and diversity of zooplankton. This study was conducted over a period of three months at three different locations within the Ranganathittu Bird Sanctuary (RBS), Karnataka, India, to assess the diversity and abundance of zooplankton. Key physicochemical parameters including water and atmospheric temperature, electrical conductivity, pH, turbidity, total dissolved solids, carbon dioxide, biological oxygen demand, dissolved oxygen, phosphate, and nitrite were analyzed. The zooplankton community was represented by four major taxa: Copepoda, Cladocera, Rotifera, and Ostracoda, comprising a total of 34 species. The analysis revealed a total of 34 zooplankton species across all sampling sites. Among these, Cladocera emerged as the dominant and most species-rich taxon, represented by 14 species, followed by Copepoda (10 species), Rotifera (8 species), and Ostracoda (2 species). The present study contributes to understanding zooplankton diversity and abundance in relation to physicochemical parameters of surface water across the islands of Ranganathittu Bird Sanctuary (RBS), highlighting the influence of environmental factors on community structure.

Introduction

Earth is unique among celestial bodies because of its abundant supply of water, which covers about 75% of the planet's surface and constitutes nearly 60–70% of the composition of living organisms. Although water is continuously renewed through the processes of evaporation and precipitation, only about 1% of the Earth's water is readily available for human consumption. The remaining water is predominantly saline, found in oceans, or sequestered in glaciers and polar ice caps. Assessing the quality of water bodies necessitates the analysis of physicochemical, biological, and microbiological parameters, which collectively offer insights into the water's overall health. These physicochemical characteristics, along with their seasonal fluctuations, significantly influence the population dynamics of zooplankton. Lakes serve as excellent environments for studying ecosystem dynamics, as the interactions among biological, chemical, and physical processes within them often differ either quantitatively or qualitatively from those occurring in terrestrial or atmospheric systems. Biological diversity is intrinsically linked to the health and stability of ecosystems, influencing nearly every component of their structure and function (Gorde and Jadhav, 2013). Zooplankton are microscopic animals widely distributed across diverse freshwater habitats worldwide. Their distribution, abundance, and community composition are strongly influenced by water quality, particularly the presence of nutrients and pollutants. Therefore, they are commonly used as indicators to assess the conditions and changes in freshwater environments, particularly in the northern regions of the world (Ismail and Zaidin, 2015; Roy *et al*., 2025). Zooplankton play a significant role in aquatic environments by shaping phytoplankton communities (Timms and Moss, 1984) and by transferring energy to higher trophic levels within open-water food webs (Barnett and Beisner, 2007). They use both chemical and mechanical receptors to select their prey, and they may preferentially feed on certain algal species over others, as well as on plastic beads or detritus (Cole *et al.,* 2013). Zooplankton function as grazers that regulate populations of algae and bacteria, serve as a food source for higher trophic levels, and contribute to the cycling and release of dissolved nutrients. Therefore, understanding their role in nutrient distribution and flow within aquatic systems is essential for effective lake management (Braun *et al*., 2021). Zooplankton communities are highly sensitive to water quality, and changes in their species composition are often used as indicators of eutrophication in freshwater ecosystems (Raina *et al*., 2013).

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their species composition are often used as indicators of eutrophication in freshwater ecosystems (Raina *et al*., 2013).
When ecosystems undergo stress due to changes in physical properties and other influences, species that are sensitive and less able to cope typically disappear, whereas those that are more tolerant remain present (Verma *et al.,* 2024). Environmental parameters such as temperature, light, and nutrient availability significantly influence the distribution and abundance of plankton, thereby shaping the functional diversity of zooplankton (Santo *et al*., 2025). Terrestrial environments also play a significant role in nutrient variation, which in turn affects the birds inhabiting adjacent aquatic ecosystems. These birds enrich the nutrient content of the water, which can alter water quality and promote an increase in zooplankton populations in those regions. Such tolerant species can serve as biological indicators of pollution (Gebrekidan *et al*., 2024).

Although extensive information is available on zooplankton abundance in the freshwater lakes of Mysore, limited data exist on how the composition and distribution of zooplankton are correlated with physico-chemical parameters, particularly in the fragile island waters of the Ranganathittu Bird Sanctuary (RBS). The present study was conducted to assess the species abundance and diversity of zooplankton in relation to physico-chemical parameters over three-months in the RBS. As the RBS is the largest breeding site for migratory birds in the region, their nesting activity is expected to influence zooplankton density and species composition by altering the physico-chemical characteristics of the water. In this study, we report the response of the zooplankton community to both ornithological and anthropogenic activities. Zooplankton are recognized as biological indicators of aquatic ecosystems, as they are highly sensitive to changes in water quality.

Materials and methods

Study area

The present study was conducted at three different sites of RBS located in Mysuru, Karnataka. The renowned sanctuary situated 19 km from Mysuru and 4 km from Srirangapatna, is named after Sri Ranganatha Swamy, an incarnation of the Hindu God Vishnu. Situated on the island in the Cauvery River, it covers a total area of 16 Ha and consists of 6 islands. The sanctuary was declared a bird sanctuary in 1940 and serves as an essential nesting and breeding site for a wide variety of bird species.

Sampling sites

The sampling sites were selected based on their physical characteristics and observed bird activity. These selected sites were positioned in a triangular arrangement relative to each other and exhibited different levels of biological and physicochemical characteristics. The sites were selected based on the intensity of human and ornithological activities. Site 1 was located in the Boating area, where anthropogenic activities were higher and comparatively lower bird activities. Site 2 was selected as the Island where there are low activities of birds with little human interaction. Site 3 was the Island with high ornithological activities and where we can expect bird droppings from the nest with no human interference.

Sampling methods

The sample collection was carried out at three sites, four times every 15 days from March 2023 to May 2023. Both water and zooplankton samples were collected early mornings between 8:00 am and 10:00 am. To analyze water quality parameters, samples of water were collected in a clean polythene bucket and then transferred to polythene containers with a capacity of 5 liters. A total of three to 5-liter containers were filled with samples for further analysis. For the zooplankton analysis, the standard conical-shaped plankton net with a mesh size of 50 μm was used to capture the zooplankton from all three different locations of the water body. The zooplanktons were collected by towing the plankton net at a depth of one meter below the water surface and the towing time was set as 10 seconds for each sampling, and the quantity of the sample was approximately 1 litre. The samples were collected in clean glass bottles and preserved with 4% formalin for further analysis. The samples were preserved in 10% Lugols-Iodine solution to facilitate the settling of cells. The preserved samples were concentrated by using the sedimentation method, allowing each sample to settle for 24 hours. The sediment was concentrated to 40ml by carefully removing the remaining 960 mL of supernatant.

Physico-chemical parameters

The 10 major physicochemical parameters analyzed in the present study were water and atmospheric temperature, pH, turbidity, electrical conductivity, dissolved oxygen, CO_2, biological oxygen demand, phosphate, and nitrate. Water and atmospheric temperature were measured in ^{0}C using an electrical thermometer. The pH is measured in the range of the pH scale by using the pH meter (model 132, Systronics India Ltd, Bangalore). Turbidity is determined in Nephelometric Turbidity Unit (Systronics India Ltd, Bangalore) using a Nephelometer and electrical conductivity was measured using an Electrical Conductivity meter (model 306, Systronics India Ltd., Bangalore), DO and BOD were determined by the iodometric titration analytical method using the Winkler technique. Phosphates and nitrates were determined by the spectrophotometric method using the UV-Vis spectrophotometer (Shimadzu UV-160, Japan). All physico-chemical analyses were carried out in accordance with the standard procedure prescribed by the American Water Works Association (AWWA) and the Central Pollution Control Board (CPCB) manuals.

Biological analysis

The zooplankton samples were analyzed using a microscope attached to a camera to identify zooplankton. The zooplankton species identification was done with the concentrated sediment and the slides used to project the samples under the microscope with a frequency of 5 trials per sample. The abundance of zooplankton in the different samples was counted using a 1 mL capacity Sedgewick Rafter cell counting unit under a microscope for 3 times, a trail per sample.

Abundance and diversity of four groups of zooplankton were calculated as follows.

Quantification

In this present study, we used the Sedgewick-Rafter Counting Chamber to determine the abundance of zooplankton. We identified them by following the American Public Health Association (APHA). The density of zooplankton was calculated by using the formula:

$$Density\ (Individuals/\ L^{-1}) = \frac{C \times V_1}{V_2 \times V_3}$$

Where C is the Number of individuals counted, V_1 is the volume of concentrated sample (100 mL), V_2 is the volume of sample counted (3 mL), V_3 is the volume of sample (100 mL). Finally, to determine the organism/L/L, the number of organisms per m^3 was divided by one thousand.

Result

Physicochemical parameters

The summary of water analysis for the determination of physicochemical parameters in RBS is grouped into three major locations with four trials per sampling site. The summary of the water analysis of three different sites in RBS (Fig. 1) is given in Table 1.

Table 1: Average values of physicochemical parameters of water samples from the three studied sites.

Physicochemical Parameters	Average values		
	Site 1	Site 2	Site 3
Atmospheric temperature (°C)	30.58 ± 0.36	31.62 ± 0.32	30.45 ± 0.21
Water temperature(°C)	30.25 ± 0.12	32.15 ± 0.10	30.8 ± 0.06
pH	7.62 ± 0.21	7.47 ± 0.24	7.6 ± 0.16
Conductivity (mS/cm^3)	2.42 ± 0.45	2.41 ± 0.46	2.34 ± 0.39
Total dissolved solids	23 ± 0.06	36.5 ±0.08	34 ± 0.16
Turbidity (NTU)	6.8 ± 1.3	7.5 ± 1.16	8.7 ± 1.4
Dissolved Oxygen (mg/L)	3.65 ±0.02	2.5 ± 0.01	1.74 ± 0.01
CO_2 (mg/L)	1.2 ± 0.017	1.62 ± 0.005	2.4 ± 0.024
Biological oxygen demand (mg/L)	1.33 ± 0.13	2.3 ± 0.08	3.2 ±0.10
Nitrate (mg/L)	0.88 ± 0 013	1.65 ± 0.007	3 ± 0.009
Phosphate (mg/L)	0.007	0.031	0.093

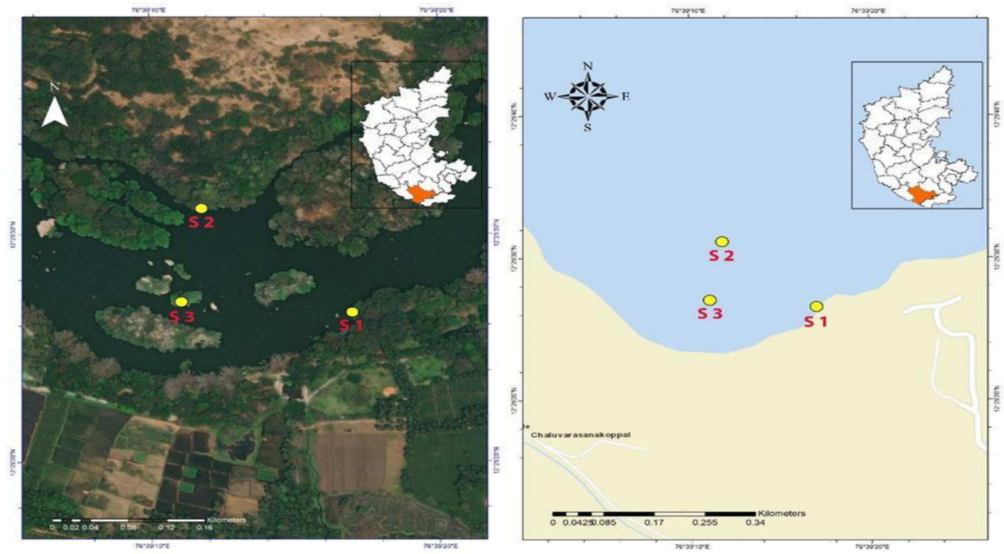


Figure 1: Sampling sites in the RBS of Mysuru.

Temperature

Temperature is an important factor in aquatic environments, as it significantly influences biological processes. The temperature is an important factor in any aquatic ecosystem, as it affects biological processes. In the present investigation, the water temperature varied from 28.8ºC to 33.5ºC, similar observations were also determined by Ramanathan *et al*. (2018). At sampling site 1 with an average of 30.25ºC, at sampling site 2, the average temperature is found to be 32.15ºC and at site 3, the average temperature is 30.8, which is suitable for the development of planktonic species. The increase in the growth of planktonic species will also support the growth of zooplankton. So the water temperature found between site 1 ranged from 30ºC to 31.8ºC, in site 2 it ranged from 30.4ºC to 33.4ºC, and in site 3 it varied from 28.8 to 31.8ºC.

pH

The pH level of water is a crucial parameter in determining its suitability for various ecological processes, as it influences the metabolic activities and survival of aquatic organisms. The pH of a pond is influenced by factors such as water flow and nutrient availability (Ramanathan *et al*., 2018). The concentration of hydrogen ions significantly affects the biological processes of nearly all aquatic organisms (Puri *et al.*, 2011). Temperature, salinity, and alkalinity can affect pH. The maximum pH value of 7.4 to 8.1 in site 1, followed by 7.1 to 7.8 in site 2, and 7.9 to 7.3 in site 3. The average pH in site 1 was found to be 7.6, followed by the average pH of site 7.4 and the average pH of site 3, respectively. The pH of the water in most months ranged from 7.2 to 8.1 (Table 1)

Conductivity (µS/cm)

The electrical conductivity of water is an indicator of its purity and its ability to conduct electricity. It reflects the concentration of dissolved salts present in the water (Puri *et al.*, 2011). Water with a high electrolyte concentration may be indicated by high electrical conductivity during the dry season, which could be due to a high rate of evaporation. (Bain *et al.*, 2018). The maximum conductivity value of 2.12(µS/cm) to 2.87(µS/cm) in site 1, followed by 2.09 (µS/cm) to 2.90 (µS/cm) in site 2, and 2.08 (µS/cm) to 2.87 (µS/cm) in site 3. The average was found to be, respectively. The conductivity of the water in most of the months ranged from 2.08 to 2.90 as noted in Table 1.

Dissolved oxygen (mg/L)

Water quality, ecological status, productivity, and health of the water body are indicated by dissolved oxygen. Good aquatic life is associated with higher values of dissolved oxygen (Tyagi *et al.*, 2018). The maximum DO value is varied from 3.12 to 3.96 mg/L in site 1, followed by 2.3 to 2.7 mg/L in site 2 and 1.57 to 1.86 mg/L in site 3. A similar level of observations was also found by Sulekha Rani Pandey and team, 2016 (Pandey and Tiwari, 2016). The average was found to be 3.65 mg/L in site 1, 2.5 mg/L in site 2 & 1.74 mg/L in site 3, respectively. The DO of the water in most of the months ranged from 3.96 to 1.57 mg/L.

Biological oxygen demand (mg/L)

Biochemical oxygen demand is the amount of oxygen required by microorganisms to perform the biological decomposition of dissolved solids or organic matter in wastewater under aerobic conditions. The maximum BOD value ranges from 1.22 to 1.54 (mg/L) in site 1, followed by 2.1 to 2.5 (mg/L) in site 2 and 3.1 to 3.4 (mg/L) in site 3. The average was found to be 1.33 in site 1, 2.3 in site 2 & 3.2 (mg/L) in site 3. The BOD of the water in most of the months varied from 1.22 to 3.4 (mg/L).

Nitrate (mg/L)

The amount of nitrate required varies depending on the season and the source of the water, but it is an essential nutrient for both aquatic plants and animals. Nitrates are generally not harmful to human health; however, they can become toxic when converted into nitrites and contribute to eutrophication in stagnant water bodies (Bera, 2021). The maximum Nitrate value in the water sample is varied from 0.8 to 1 (mg/L) in site 1, followed by 1.4 to 1.8 (mg/L) in site 2, and 2.8 to 3.3 (mg/L) in site 3. The average was found to be 0.88 (mg/L) in site 1, 1.6 (mg/L) in site 2 & 3 (mg/L) in site 3. The Nitrate of the water in most of the months varied from 0.88 to 3.3.

Phosphate (mg/L)

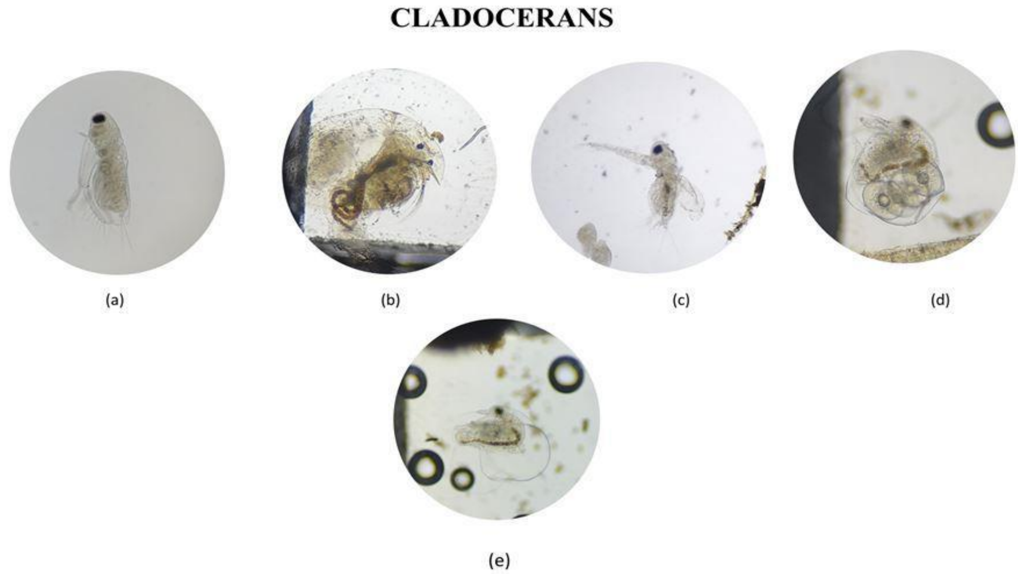
Phosphate is an essential nutrient for plants, and its availability directly influences algal growth and phytoplankton abundance in the lake. The maximum Phosphate value ranges from 0.006 to 0.008 (mg/L) in site 1, followed by 0.023 to 0.041(mg/L) in site 2 and 0.089 to 0.098 (mg/L) in site 3. The average was found to be 0.007 (mg/L) in site 1, 0.031 (mg/L) in site 2 & 0.093 (mg/L) in site 3. The phosphate of the water in most of the months varied from 0.006 to 0.098. The result describes that the concentration of nutrients seemed to be high in site 3, followed by sites 2 and 1.

Turbidity (NTU)

Turbidity refers to the reduction in light transmission through water caused by suspended substances. Turbidity serves as an indicator of various biological, physical, and chemical processes, depending on the origin, concentration, and composition of suspended particles (Boenigk and Novarino, 2004). Turbidity is a measure of the relative clarity of water (Gyllström *et al.*, 2005). The maximum turbidity value in the water sample is varied from 6.7 to 6.9 NTU in site 1, followed by 7.1 to 8.1 NTU in site 2 and 8.1 to 9.2 NTU in site 3. The average was found to be 6.8 NTU in site 1, 7.5 NTU in site 2 & 8.7 NTU in site 3. The turbidity of the water in most of the months varied from 6.7 to 9.2 NTU, as quoted in Table 1.

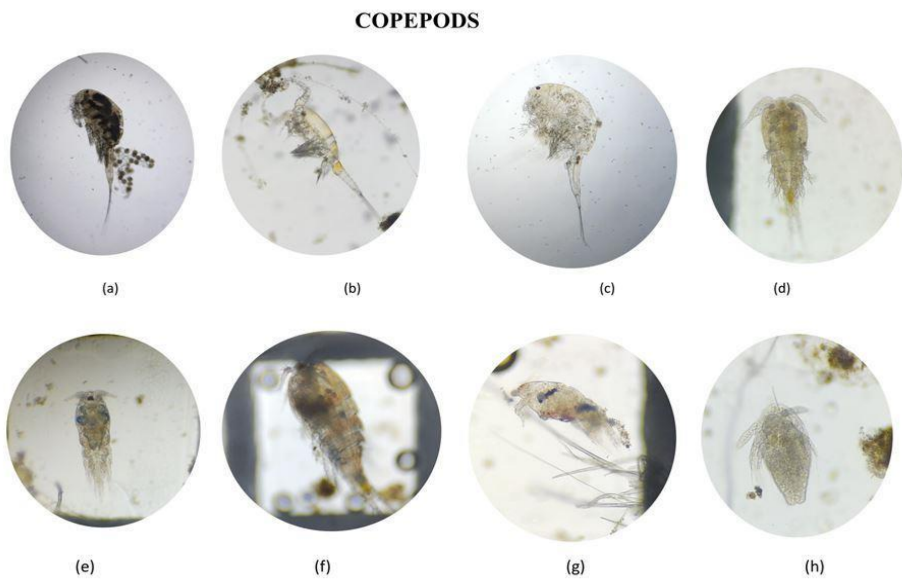
Discussion

In the present study, 32 different species of zooplanktons were identified, belonging to four different taxonomic groups: cladocera, copepoda, rotifer, and ostracod. The highest number of species belonged to Cladocera (14 species), followed by Copepod (10 species), Rotifera (8 species), and Ostracod (2 species), and are presented in Figures 2 to 5. Among the Cladocera group, the top two most abundant families identified were Daphniidae and Chydoridae. The major genus belonging to these families are *Moina* spp, *Ceriodaphnia* spp, *Daphnia* spp*,* *Pleuroxus* spp*,* *Simocephalus,* and *Leydigia.*The next dominant group of zooplanktons identified was Copepods, with species of *Diacyclops sp* and *Pseudodiaptomus* species were recorded frequently, occurring in 4 instances.



(a. Diaphanosoma sp , b. Daphnia sp ,c. Moina macrocopa, d. Bosminopsis sp, e. Bosmina longirostris.)

Figure 2: Cladocera species.



(a. Pseudodiaptomus speciosus, b. Calanoides acutus , c. Pseudodiaptomus trihamatus, d., e. Calanus finmarchicus , f. Daicyclops sp, g. Harpacticoida sp, h. copepod nauplius stages)

Figure 3: Copepod species.

At Site 1, copepod species were the most dominant, followed by Cladocera and Rotifera." In sites 2 and 3, the Cladocera species are dominant followed by other zooplankton groups. Site 3 has a large number of species with diversity and abundance because of the higher concentration of phosphate and nitrate from the bird droppings.

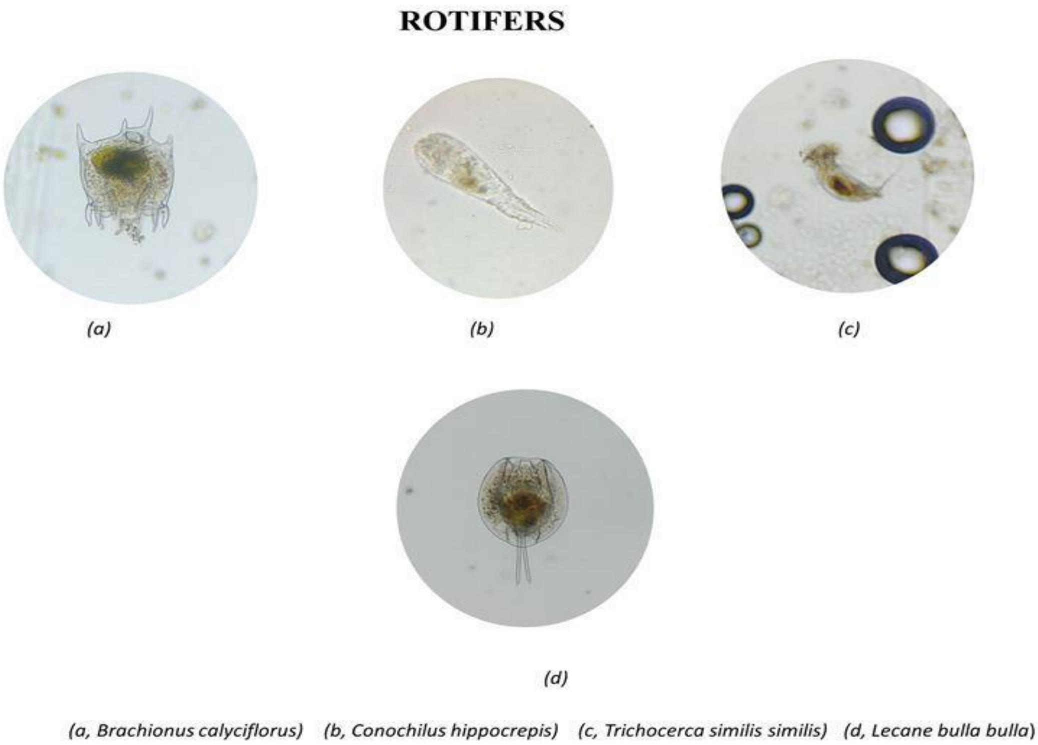


Figure 4: Rotifer species.

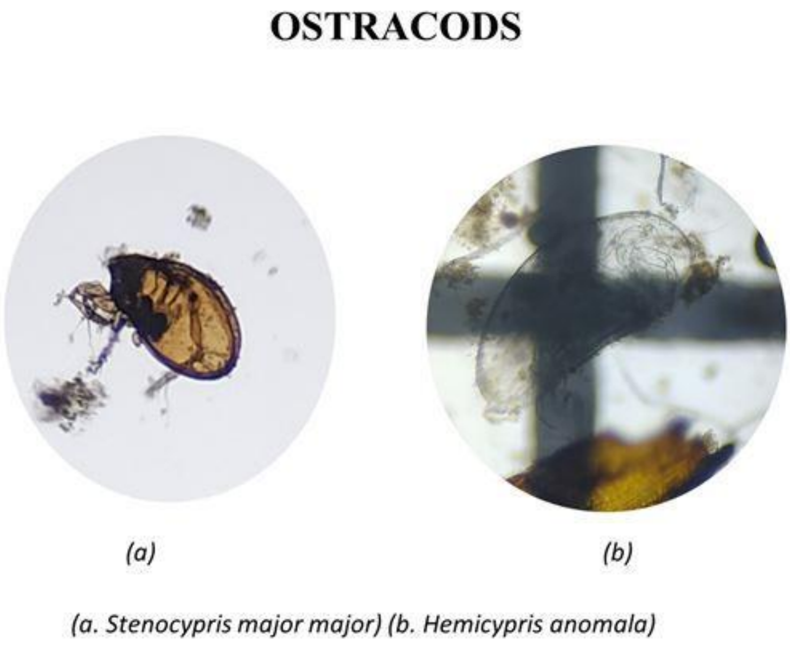


Figure 5: Ostracod species.

Narasimman Manickam *et.al* reported a similar observation that an increase in nutrients will increase the growth of phytoplankton, and it will help the zooplankton abundance (Manickam *et al.*, 2018; Arya and Mehra, 2025). So, where there is availability of good resources for the development of zooplankton communities, we can expect a large number of species diversity. The diversity of the zooplankton species is presented in Table 2. Zooplanktons are sensitive aquatic species that show variation in abundance and variance with the change in physicochemical parameters (Gebrekidan *et al.*, 2024). The highest species diversity and abundance were recorded in site 3, which shows a positive correlation with the concentration of phosphate (0.093 mg/L) and nitrate (3 mg/L). In comparison to other sample collection sites, the concentration of the nutrients was higher because of the high activity of birds on the island. Higher nutrient availability in a water body promotes phytoplankton growth and increases organic debris, which supports a greater abundance of Cladocera and Copepod species. Adhikari *et. al* reported similar observations of dominance of Cladocera and copepod species. The species of copepod were highly affected by the concentration of phosphate and nitrate, with an increase in the nutrients, the abundance of Cladocera also seems to have decreased. The species distribution of Copepods depends on the phytoplankton availability and nutrient concentration (Adhikari *et al.*, 2017). The BOD and DO in the water sample represent the positive correlation with the zooplankton abundance and diversity in the sample sites. Copepod species were strongly influenced by BOD, DO, and electrical conductivity in the water sample. An increase in BOD and DO was associated with greater zooplankton activity with microorganisms at these sites utilising more dissolved oxygen compared with other locations. The DO is not showing a negative correlation with zooplankton. When biological activities increase, the consumption of dissolved oxygen in water will be reduced. Growth of Cladocera species is obstructed by low oxygen (Sharma and Noroh, 2020). Conductivity, Turbidity, and TDS also showed an overall positive correlation with zooplankton presence. A similar phenomenon, in which an increase in turbidity also increases the TDS, was reported by Kumar *et al.* (2012). The TDS at site 2 did not show any significant effect on the growth of zooplankton. The conductivity of the water samples from each sample shows a very slight variance from each other, so the conductivity doesn't have a significant effect on the zooplankton abundance. The pH and temperature across all sites remained at moderate levels and therefore, had no significant influence on zooplankton abundance and diversity. As given in Table 2, the zooplankton abundance and diversity are very less compared to the other sampling sites, it may result in the indication of anthropogenic pollution. Site 1 is situated near the human intervention area, so it might also be a reason for the species reduction in that area. The absence of ostracods indicates the sensitivity of these species towards municipal wastewater.

According to Sedgwick, rafter counting revealed an average of 5 species of zooplanktons at site 1, 13 species at site 2, and 21 species at site 3. Table 3 shows that the zooplankton abundance varies from 4spp to 8 spp in site 1, 11 spp to 15 spp in site 2, and 18 spp to 23 spp in site 3. Zooplankton abundance at the sampling sites was 15 sps/m³ at site 1, 39 sps/m³ at site 2, and 63 sps/m³ at site 3, showing how the organisms are distributed per cubic meter.

Table 2: Checklist of zooplankton diversity recorded in RBS.

Zooplankton groups	Order	Family	Scientific name	No.of species
Copepoda	Cyclopoida	Cyclopidae	*Daicyclops* (Kiefer, 1927) *Harpacticoida sp.* *Diacyclopsthomasi* (S.A. Forbes, 1882)	10 species
	Calanoida	Centropagidae	*Sinocalanuslaevidactylus* (Shen & Tai, 1964) *Neodiaptomusyangtsekiangensis* (Mashiko, 1951)	
		Oithonidae	*Limnoithonasinensis* (Burckhardt, 1913)	
		Calanidae	*Calanusfinmarchicus* (Gunnerus, 1770) *Calanoidesacutus* (Giesbrecht, 1902)	
		Pseudodiaptomidae	*Pseudodiaptomusspeciosus* (Dang, 1967) *Pseudodiaptomustrihamatus* (Wright, 1937)	
Rotifera	Bdelloida	Philodinidae	*Philodinasps*	8 species
	Ploima	Asplanchnidae	*Asplanchnabrightwelli* (Gosse, 1850)	
		Brachionidae	*Brachionus sp.* (Pallas, 1766) *Brachionuscalyciflorus*(Pallas, 1766) *Brachionusplicatilis* (Muller, 1786)	
		Mytilinidae	*Mytilinaventralis* (Ehrenberg, 1830)	
	Monogononta	Conochilidae	*Conochilushippocrepis* (Schrank, 1803)	
		Trichocercidae	*Trichocercasimilissimilis* (Wierzejski, 1893)	
Cladocera	Anomopoda	Daphniidae	*Daphnia magna* *Daphnia pulicaria*	14 species
		Bosminidea	*Bosminasp* (Barid, 1845)	
		Bosminidae Baird	*Bosminopsisdeitersi* (Richard, 1897) *Bosmina longirostris* (O.F. Müller, 1785)	
	Diplostraca	Daphniidae	*Ceriodaphniapulchella* (Sars, 1885) *Ceriodaphniacornuta* (Sars, 1885) *Moinamacrocopa* (Straus, 1820) *Daphnia lumholtizi* (Sars, 1885)	
	Cladocea	Chydoridae	*Pleuroxus sp.* (Sars, 1862)	

Table 2 continued

Zooplankton groups	Order	Family	Scientific name	No.of species
			Leydigiaacanthocercoides (Fischer, 1854)	
			Simocephaluselizabethae (King, 1853)	
			Pleuroxuslaevislaevis (Sars, 1862)	
		Sididae	*Diaphanosomasarsi* (Richard 1895)	
Ostracod	Podocopida	Cyprididae	*Hemicyprisanomala* (Klie, 1938) *Stenocypris sp.* (Baird, 1859)	2 species

Table 3: Occurrence and frequency of zooplanktons at RBS.

Zooplankton species	Site 1	Site 2	Site 3
Daicyclops	+	+	+
Harpacticoida sp.	–	+	+
Diacyclopsthomasi	–	–	+
Sinocalanuslaevidactylus	–	–	+
Neodiaptomusyangtsekiangensis	+	–	–
Limnoithonasinensis	–	–	+
Calanus finmarchicus	–	+	+
Calanoidesacutus	–	+	–
Pseudodiaptomusspeciosus	+	–	–
Pseudodiaptomustrihamatus	–	–	+
Philodinasps	–	+	–
Asplanchnabrightwelli	–	–	+
Brachionus sp.	–	–	+
Brachionuscalyciflorus	–	+	–
Brachionusplicatilis	+	–	–
Mytilinaventralis	–	–	+
Conochilushippocrepis	–	–	–
Trichocercasimilissimilis	–	+	–
Daphnia magna	+	+	+
Daphnia pulicaria	–	–	+
Bosmina sp.	–	–	+
Bosminopsisdeitersi	–	+	+
Bosmina longirostris	–	+	+
Ceriodaphniapulchella	–	–	+
Ceriodaphniacornuta	+	–	+
Moinamacrocopa	+	–	–
Daphnia lumholtizi	–	+	+
Pleuroxus sp.	+	–	+

Site 3 shows a higher number of species distribution compared to the other two sites because of the higher availability of nutrients and phytoplankton. The bird nests present in the trees which are situated above the water body will have a higher amount of a mount of bird droppings. Cladocera species exhibit a higher growth rate in nutrient-rich water (Kumar *et al.*, 2012). The higher amount of phosphate and nitrate in the water will promote the growth of phytoplankton and detritus bacteria, it will increase the growth and reproduction rate of the zooplankton. Singh *et al*. (2018) have also determined a similar level of phosphate concentration within the water body.

Site 2 is situated near an island where there are very few signs of bird activities, so the nutrient availability in the water seems less compared to site 3, where more bird nests were found on the trees, which adds huge bird droppings in the samples. When the activity of birds decreases, the amount of bird droppings will also be reduced, so the nutrient level in the water will be less compared to Site 1. This leads to slow growth of the planktons in the particular area which will reduce the density of plankton-hunting zooplanktons.

Analysis of zooplanktons and physico-chemical parameters from three locations within the RBS indicated the presence of four groups: Cladocera, Copepoda, Rotifera, and Ostracoda. Among these, Cladocera was found to be the most abundant and diverse of species present in the RBS sites, followed by Copepoda, Rotifera, and Ostracoda. nutrients like phosphate and nitrate play an important role in determining species dominance across the three sites. Site 1, with low nutrient concentrations, showed lower zooplankton abundance. In contrast, site 2 exhibited higher zooplankton counts due to greater nutrient availability, while site 3 supported both high diversity and abundance. The concentration of nutrients in site 3 is higher because of the bird droppings and the deposit of manure in the water body, so the zooplankton growth and reproduction are dependent upon the availability of nutrients. The higher number of species present in this site is the Cladocera and copepods; these two groups of zooplankton are mainly dependent upon the phytoplankton and detrital bacteria. Phytoplankton and bacteria will generate more because of the higher nutrient availability, and it will serve as a food source for the zooplankton. A positive correlation was observed between zooplankton presence and nutrient concentration.

Zooplanktons serve as bioindicators of an aquatic ecosystem. The analysis indicates that the water body is naturally maintained and well-balanced due to natural filtration processes. The presence of zooplankton in high-nutrient concentrated water shows how the natural maintenance of the ecosystem takes place. When the concentration of nutrients in the water body increases, the activity of phytoplankton and other microbes will also increase, and to maintain the ecological balance the zooplankton will graze on it so the maintenance of an aquatic ecosystem takes place. A minute variation in this process will affect the zooplankton's diversity and abundance. From all of this information, we can state that the zooplanktons indicate a healthy aquatic ecosystem in RBS. The water body is providing a good environment for the growth and reproduction of zooplankton, and the ecological balance is well maintained. The physicochemical parameters of the water body appeared to be within a normal range with stable pH, turbidity, conductivity, and total dissolved solids. The study documented a wide range of zooplankton species and their frequency distribution across three sites with various conditions. It also revealed the relationship between zooplankton and physicochemical parameters, providing insights into the surface water quality of RBS.

Acknowledgements

The authors thank the Research and Development Cell, Karnataka State Open University, for providing financial support for this research.

Conflicts of interest

There is no conflict of interest.

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