International Journal of Lakes and Rivers.
ISSN 0973-4570 Volume 14, Number 2 (2021), pp. 195-210

http://www.ripublication.com/ijlr.htm

# Assessment of Physico-chemical Properties with Zooplankton of Sooley Lake, Mandya District, Karnataka, India

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## Abstract

Water is a renewable natural resource that is essential to all life-supporting systems on the planet. Due to over-exploitation and pollution, freshwater has become a scarce resource. Industries have been expanding since the industrial revolution, resulting in millions of anthropogenic chemicals entering our environment. Industries, agriculture, and residential activities are the main causes of water contamination. Furthermore, industrial development and the resulting pollutants introduced into the freshwater system in the form of sewage pose a threat to this delicate environment.

The goal of this study is to look at and figure out the zooplankton diversity an d distribution pattern in Sooley Lake, as well as the interactions between differ ent zooplankton groups and Physico-chemical parameters, from August 2018 to July 2020. Seasonal variations were found at all four sites where samples were taken every 24 months.

Rotifers, Cladocera, Copepods, and Ostracods were discovered among the zooplankton species discovered in the samples. For the whole group, Rotifera dominated the average. Summer had the most rotifers, cladocera, copepods, and ostracods, while winter had the least. The maximum density was likewise found during the summer months. It's important to mention that Sooley Lake is gradually becoming mesotrophic.

**Keywords:** Sooley lake, Physico-chemical parameter, Seasonal variation, Zooplankton.

"One of the most important biological markers of the aquatic environment is zooplankton biodiversity. Zooplankton biodiversity is critical for maintaining the health of our environment since each species plays a unique role in recycling nutrients and food for other species in the ecosystem, and certain species can help the natural ecosystem work properly. Zooplankton is an essential component of freshwater lake ecosystems because it occupies the center of the aquatic food web at some stage in its life cycle and provides food for nearly all freshwater fish species. Furthermore, because zooplankton populations are very sensitive to environmental variations and are susceptible to anthropogenic effects, their research might be valuable in forecasting long-term changes in lake ecosystems." [1–5,6,7,8,9,10] .

"Changes in Physico-chemical conditions in aquatic systems cause changes in the relative composition and amount of species that survive in the water, making them valuable as a monitoring tool for aquatic ecosystems. As a result, zooplankton is a vital component of the ecosystem. The rising population of India is generating a rise in industrialization, which is producing sewage disposal issues. Surface runoff regularly introduces an undesirable element into the lake water, resulting in deterioration of the water quality. Aquatic quality is defined by the chemical, physical, and biological components of water." [1,6,10, 13,28–30].

The goal of this study was to see how seasonal changes in zooplankton biodiversity affected biodiversity in a perennial lake in Mandya, Karnataka, India.

## MATERIALS AND METHODS

### Study area

Mandya district is located between 12°31'20.28" N latitude and 76°53'50.86" E longitude in Karnataka state's southern area. The average annual rainfall is around 680mm, and huge canals irrigate the majority of the region. Mandya, Karnataka, India (latitude 12.515362366142533 N, 76.99120045278171 E) is located in the Sooley Lake environment (Fig. 1). When the city is inundated, the water in this lake spans an area of 2847218 meters2, 2.847 kilometers2, 30647203 feet2, 3405245 yards2, 703.563 acres. Local fisherman goes out daily to fish in the lake.

### Water sample collection and analysis

Water and plankton samples were collected during two years, from August 2018 to July 2020, at four different sites. The lake may be split into four zones based on its geographical position (Figure 1).

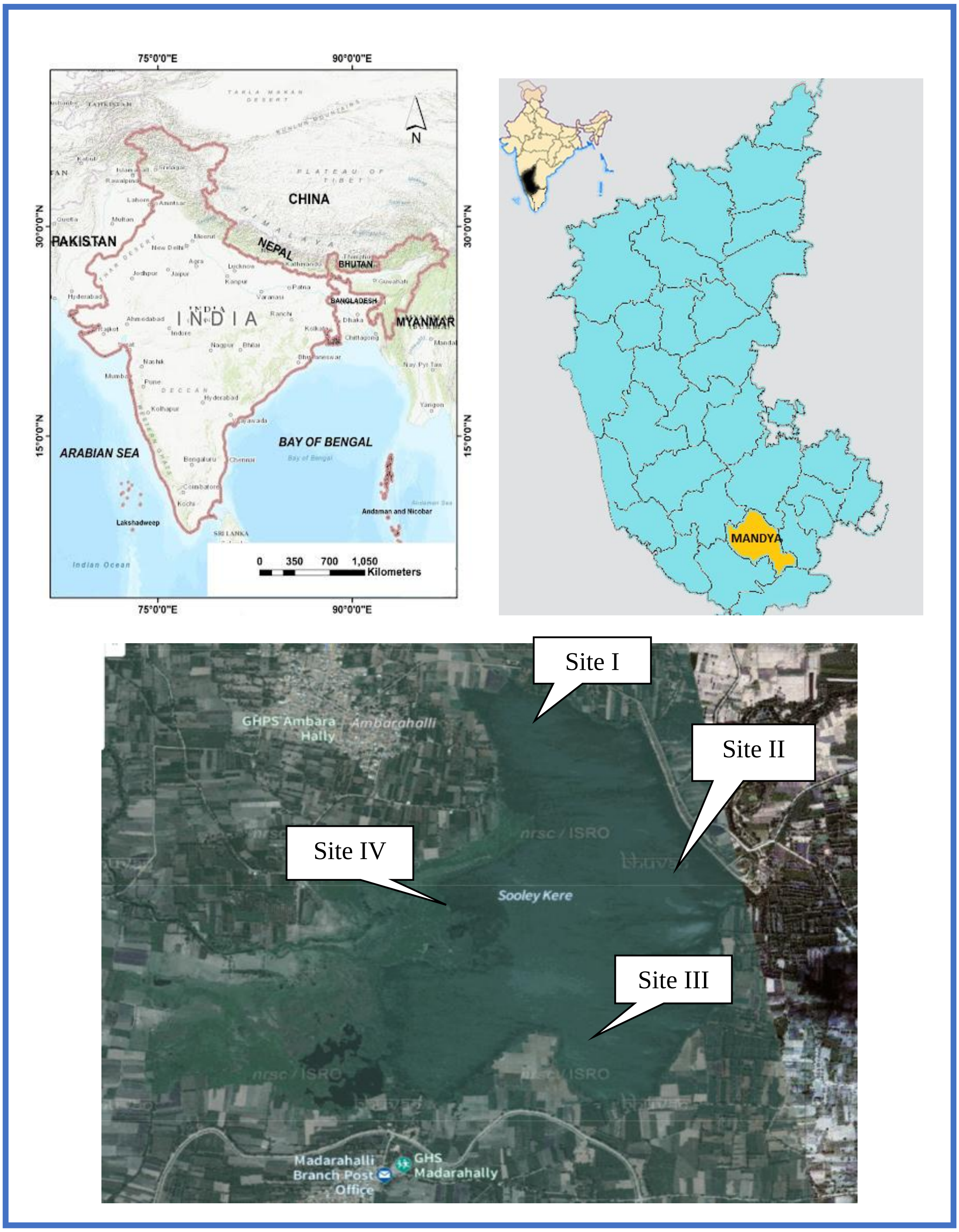


***Figure 1: Geographical map location showing sampling sites at the Sooley lake, Mandya, Karnataka, India.***

## Parameters

"The water samples were collected in sterile screw-capped wide-mouth polythene vials. During the early morning hours (6:00 a.m. to 8:00 a.m.), samples from the lake were obtained vertically between 1 and 4 m depth with a few metres between the samples from the surface and the bottom, brought to the laboratory, and tested on the same day." [1,9,16]. The pH, the atmosphere, and the surface water temperature were all measured at the same time, as was the dissolved oxygen (DO). To evaluate physico-chemical properties, surface water samples from the Sooley lakes are obtained.

Surface water samples will be taken in 5-liter plastic canisters early in the morning (6:00 a.m. - 8:00 a.m.). In the field, the temperature of the air, water, pH of the soil, and DO of the soil were all measured. Conductivity, turbidity, total suspended solids (TSS), dissolved oxygen (DO), carbon dioxide (CO2), biological oxygen demand (BOD), chemical oxygen demand (COD), chloride, hardness, alkalinity, phosphate, nitrate, sulphate, and calcium were all examined separately in the laboratory. [8,31].

**Zooplankton quantitative analyses**

"100 l of water was filtered through a plankton net made of bolting silk (No: 05; mesh size 50 m) for quantitative zooplankton analysis, and the plankton was put into sample vials (pre-filled with 4 percent formalin). and put through a microscopic examination (Olympus Microscope). They were separated with a tiny needle and brush under a binocular stereo zoom dissection microscope (Magnus, Technology). On microscopic slides, each plankton species were stained with eosin or rose bengal on a drop of 20% glycerine. Samples of zooplankton are identified. Plankton has been discovered in textbooks and standard guides." [1,21,32,33,34,35,36].

"A 1 ml zooplankton sample was taken using a wide neck pipette and placed into the Sedgewick Rafters counting cell, where it was allowed to settle for a while before being counted. For each plankton sample, the counting procedure was repeated three times. The total number of plankton present in 1 litre of water using the following formula: N = n v / V, where N is the total number of plankton per litre of filtered water, n is the average number of plankton in a 1 ml plankton sample, v is the concentrated plankton volume (ml), and v is the total filtered water volume (liters)" [1]. The statistical analysis was carried out with the help of the GraphPad Prism software application (8.0.2).

**Species diversity indices:**

Diversity indices such as Dominance, Shannon-Wiener index (1949)[37], Simpson (1949) [38], and Evenness are calculated using the PAST software programme.

## RESULTS

The air temperature was highest in the summer season (30.50) and lowest in the winter season, according to the findings of this study (24.70). Water temperature was greatest in the summer season (27.79) and lowest in the winter season (22.39), PH was highest in the summer season (8.16) and lowest in the rainy season (7.83), and conductivity was highest (2077.41) in the summer season and lowest (1314.69) in the winter season.The rainy season had the greatest turbidity (11.31) while the winter season had the lowest (8.03). The rainy season had the highest TSS (35.28) while the winter season had the lowest (29.44). DO is highest in the rainy season (8.03) and lowest in the summer season (6.83). Summer had the greatest levels of CO2 (0.09), while rainy and winter seasons had the lowest levels (0.0). The summer season had the greatest BOD (6.28) while the winter season had the lowest (4.97). The summer season had the highest COD (8.78) while the winter season had the lowest (7.66). The maximum level of hardness (131.03) was recorded during the summer season, while the lowest level was recorded during the winter season (79.53) Rainy Chloride was highest in the summer season (63.06) and lowest in the winter season (47.67), whereas alkalinity was highest in the summer season (166.53) and lowest in the summer season (143.29).Phosphate levels were highest in the summer (0.07) and lowest in the winter (0.03). The greatest concentration of nitrate (0.30) was found in the summer while the lowest concentration (0.16) was found in the winter. Sulphate levels were highest in the summer season (31.69) and lowest in the rainy season (23.91). Calcium levels were highest in the summer season (36.96) and lowest in the rainy season (32.41) (Table: 1).

**Table 1:** Physico-chemical parameters of lake water in Different Seasons.

| **Parameters** | **Sooley lake** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Rainy** | | **Winter** | | **Summer** | | **Total** | |
| | **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** |
| **Air Temp.** | 27.01 | 0.16 | 24.70 | 0.11 | 30.50 | 0.10 | 27.40 | 0.07 |
| **Water Temp.** | 24.79 | 0.09 | 22.39 | 0.04 | 27.79 | 0.07 | 24.99 | 0.02 |
| **$P^H$** | 7.83 | 0.03 | 7.92 | 0.04 | 8.16 | 0.03 | 7.97 | 0.02 |
| **Conductivity** | 1754.44 | 36.27 | 1314.69 | 43.89 | 2077.41 | 30.09 | 1715.50 | 21.61 |
| **Turbidity** | 11.31 | 0.05 | 8.03 | 0.10 | 9.11 | 0.05 | 9.49 | 0.03 |
| **TSS** | 35.28 | 1.24 | 29.44 | 1.45 | 33.88 | 0.85 | 32.87 | 0.88 |
| **DO** | 8.03 | 0.03 | 7.59 | 0.10 | 6.83 | 0.06 | 7.48 | 0.05 |
| **$Co_2$** | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.03 | 0.03 | 0.01 |
| **BOD** | 5.38 | 0.10 | 4.97 | 0.16 | 6.28 | 0.12 | 5.54 | 0.10 |
| **COD** | 8.06 | 0.44 | 7.66 | 0.46 | 8.78 | 0.28 | 8.17 | 0.36 |
| **Hardness** | 103.97 | 2.58 | 79.53 | 4.70 | 131.03 | 4.40 | 104.85 | 1.42 |
| **Chloride** | 49.72 | 2.90 | 47.67 | 2.04 | 63.06 | 1.36 | 53.48 | 1.65 |
| **Alkalinity** | 143.29 | 3.27 | 144.19 | 2.77 | 166.53 | 3.90 | 151.35 | 3.03 |
| **Phosphate** | 0.04 | 0.00 | 0.03 | 0.00 | 0.07 | 0.00 | 0.05 | 0.00 |
| **Nitrate** | 0.24 | 0.00 | 0.16 | 0.00 | 0.30 | 0.00 | 0.23 | 0.00 |
| **Sulphate** | 23.91 | 0.41 | 25.38 | 0.18 | 31.69 | 0.33 | 26.99 | 0.13 |
| **Calcium** | 32.41 | 0.44 | 34.57 | 0.78 | 36.96 | 2.03 | 34.65 | 0.52 |

**Zooplankton species composition and species diversity**

In this study, the collected zooplanktons were examined using a compound microscope. According to the findings, Rotifera is at the top of the composition, followed by Copepoda, Cladocera, and Ostracoda (Table 2). According to observations, the highest density of zooplankton was observed in the summer and the lowest in the winter (Figure 2). Rotifera was observed to be more numerous throughout the year, whereas ostracod had the lowest population (Table 2, Figures 3 and 4 respectively).

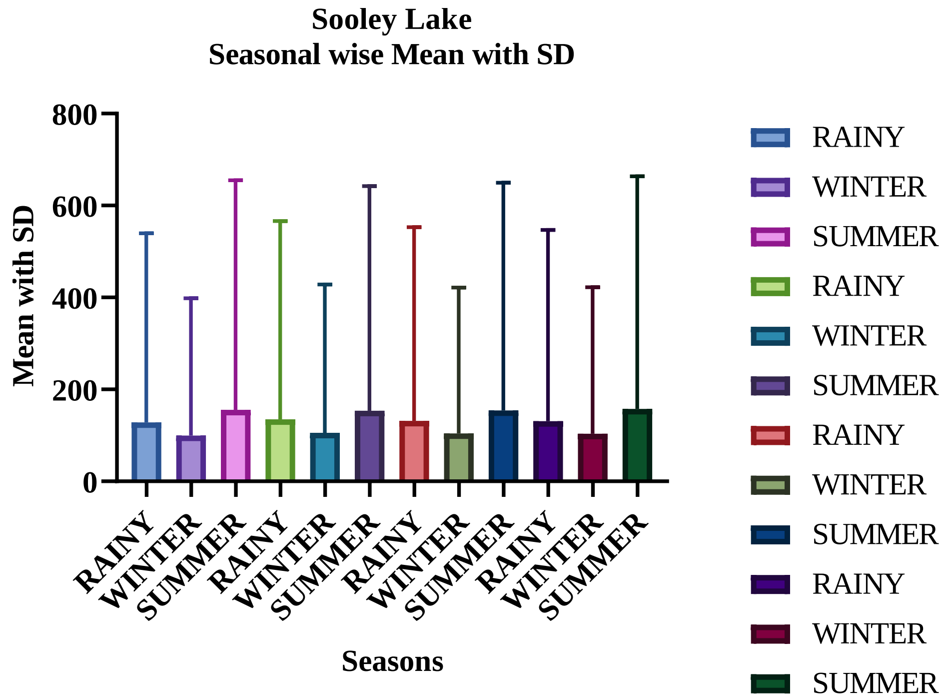


***Figure 2: seasonal wise distribution of Zooplanktons in Sooley Lake in different sampling sites***

**Table 2:** Overall distribution of zooplankton in Sooley lake

| Zooplankton | Sooley lake | | | | |
|---|---|---|---|---|---|
| | **Mean** | **SD** | **CV** | **Upper Limits** | **Lower Limits** |
| **Rotifers** | 129.38 | 65.16 | 50.37 | 170.78 | 87.97 |
| **Cladoceras** | 55.41 | 28.00 | 50.53 | 73.19 | 37.62 |
| **Copepods** | 99.59 | 43.75 | 43.93 | 127.39 | 71.80 |
| **Ostracods** | 6.67 | 0.60 | 8.95 | 7.05 | 6.29 |

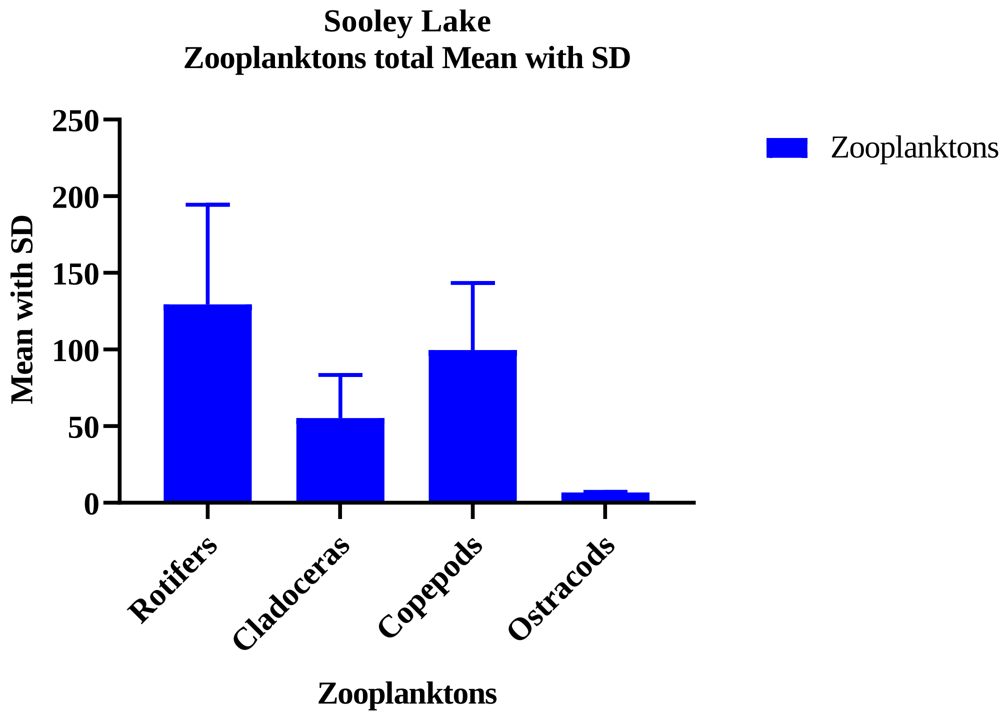


*Figure 3: Distribution of Zooplanktons in Sooley Lake*

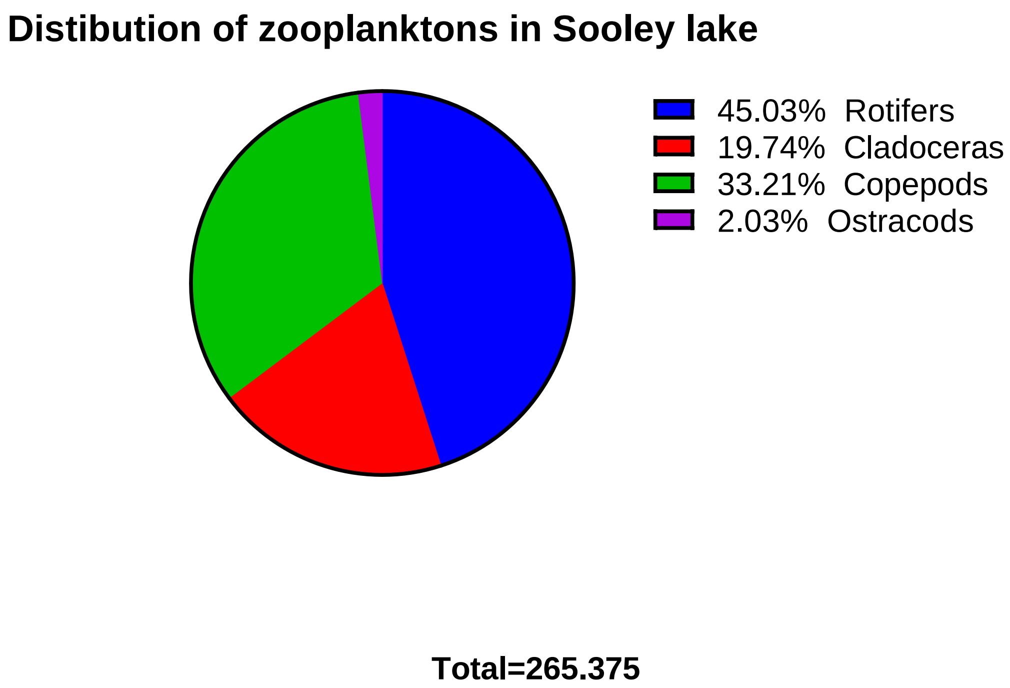


*Figure 4: Distribution of Zooplanktons in Sooley Lake*

**Canonical Correspondence Analysis (CCA)**

The ordination of the Canonical Correspondence Analysis (CCA) indicated a substantial connection between zooplankton distribution and environmental factors. In sampling site III, cladocera zooplankton ostracods showed the best explanatory connection with calcium. In sampling site IV, carbon dioxide, air temperature, phosphate, conductivity, nitrate, DO, and cladoceran all exhibited a positive connection, whereas in sample site II, sulphate, chloride, alkalinity, turbidity, BOD, TSS, and water temperature all showed a positive correlation (Figure 5).

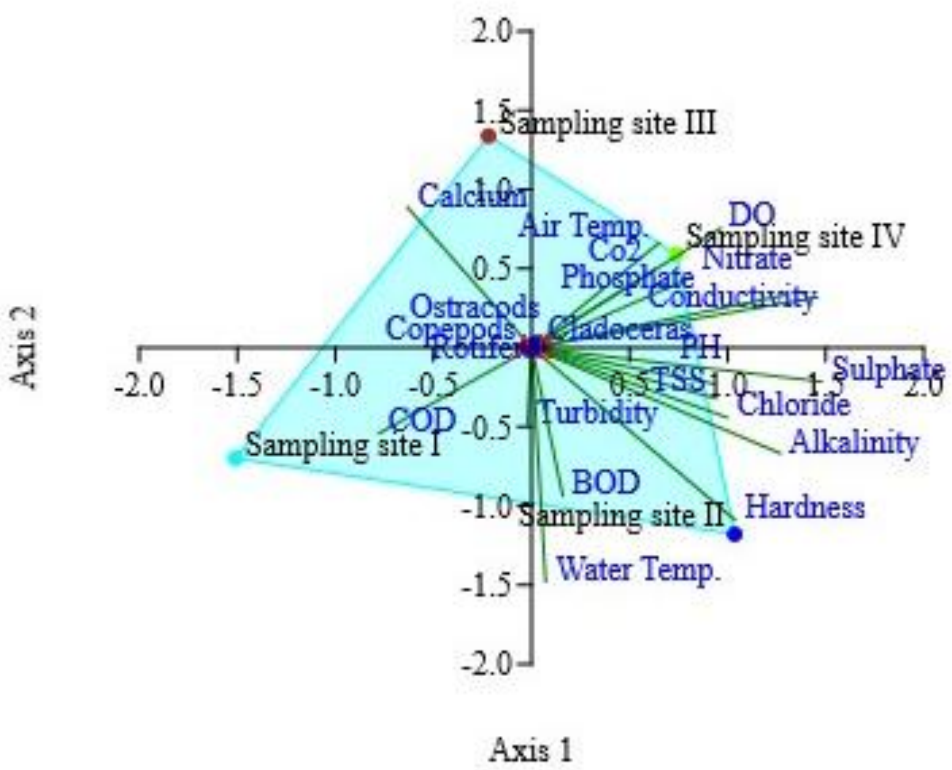


***Figure 5: The canonical correspondence analysis (CCA)association between zooplankton and water quality variables for the first two axis***

**Species diversity indices**

In Tables 3 for zooplankton, a summary of the Taxa S, Individuals, Dominance D, Simpson 1-D, Shannon H, and Evenness eH/S 13 is shown. In terms of zooplankton, the site I (7171.00) had the most taxonomic individuals while site III had the least (6872.00). In all of the locations, the dominance index and Simpson index were 0.35 and 0.65 except Site I (0.36 and 0.64), respectively. The Shannon index indicated the highest value in site IV (1.14) and lowest value of 1.12 in site II location. The evenness index was found to be higher in site III and site IV (0.78) than in the other sampling sites (site I and site II 0.77).

**Table 3:** Species diversity indices of Sooley lake for different sampling sites

| Species Diversity indices | Site I | Site II | Site III | Site IV |
|---|---|---|---|---|
| **Taxa_S** | 4.00 | 4.00 | 4.00 | 4.00 |
| **Individuals** | 7171.00 | 7000.00 | 6872.00 | 6897.00 |
| **Dominance_D** | 0.36 | 0.35 | 0.35 | 0.35 |
| **Simpson_1-D** | 0.64 | 0.65 | 0.65 | 0.65 |
| **Shannon_H** | 1.12 | 1.13 | 1.13 | 1.14 |
| **Evenness_e^H/S** | 0.77 | 0.77 | 0.78 | 0.78 |

## DISCUSSION

"The distribution patterns and species composition of plankton are influenced by Physico-chemical factors and the number of nutrients in lake water [1,39–41]. Environmental factors such as water's physical (gases and solids solubility, light penetration, temperature, and density) and chemical (pH, hardness, phosphates, and nitrates) properties are critical for phytoplankton growth and distribution in aquatic habitats, which zooplankton rely on for survival."[1,28,42,43].

"Surface water temperature, which is one of the most important and changeable environmental factors, influences the growth and dispersion of flora and animals in the lake ecosystem. Stratification, gas solubility, pH value, conductivity, and planktonic dispersion have all been proved to be influenced by surface water 1,39,46. When the temperature rises, chemical and biological reactions speed up"[1,16,23,27,29,44,45,47,48].

The pH scale measures the concentration of hydrogen ions in water and is used to assess the severity of acidity and alkalinity. In the summer, a high rate of photosynthesis in bodies of water implies an increased pH value. In this study, the greatest pH was discovered in the summer and the lowest in the wet season [1,5,15,46,47,49,57–59].

The highest pH value with enhanced photosynthesis resulted in increased carbon dioxide consumption in the aquatic environment as a result of the high temperatures in the summer. According to the findings of the present study, the summer season has the greatest average, while the rainy season has the lowest. The use of DO and the decomposition of organic material, as well as the respiration of micro and macroorganisms, resulted in an increase in DO content during the rainy season due to increased mixing of water with the atmospheric air, and a decrease in DO content during the summer season due to increased BOD and COD content due to the use of DO and the decomposition of organic material.[11,12,14,17-20,25,29,39,61,62].

“In this study, the maximum electrical conductivity was observed in the summer months and the lowest in the winter months. Increased temperature induced by the discharge of residential waste, according to existing statistics, may enhance pollutant levels. As a result, it's been proven that in some situations, higher water temperatures mixed with pollutants might assist zooplankton populations increase.”[1,22,24-26,63-76].

A high nutrient load can also promote high phytoplankton production, which in turn can sustain zooplankton abundance or population in the long term. According to the findings of this study, the overall population density of zooplankton is modest in the winter season, likely due to lower light intensity. Similar findings have been discovered in previous studies. A high nutrient load can also promote high phytoplankton production, which in turn can sustain zooplankton abundance or population in the long term. According to the findings of this study, the overall population density of zooplankton is modest in the winter season, likely due to lower light intensity. Similar findings have been discovered in previous studies [16,42,50-56,66,72,73,74].

## CONCLUSION

Numerous tests revealed that the highest density of zooplankton was found in the summer season owing to evaporation rates, and the lowest density was found in the winter season due to evaporation rates. As a consequence of the rain, the water concentration will dilute, decreasing the density of zooplankton; hence, water temperature might favorably promote zooplankton population diversification. As a result, they are continuously researched in greater depth to better understand the future effects of climate change on zooplankton diversity to ensure that they are accurately interpreted.

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