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ORIGINAL ARTICLE **OPEN ACCESS**

Studies on Physico-chemical aspects and Zooplankton diversity of Marehalli Lake, Mandya District, Karnataka, India.

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ABSTRACT
Marehalli Lake in Mandya, Karnataka, India has suffered greatly as a result of human activity. The goal of this study will be to look at and figure out the amount of pollution in the lake system by investigating zooplankton diversity and distribution patterns in Marehalli Lake, as well as interactions between different zooplankton groups and physico-chemical variables, from August 2018 to July 2020. At all four sites where samples were gathered every 24 months, seasonal changes were seen. The presence of zooplankton species such as Rotifers, Cladocera, Copepods, and Ostracods was discovered by sample analysis. The average for the whole group was dominated by Rotifera. The summer season contained the most rotifers, cladocera, copepods, and ostracod variety, while the winter season had the least. In addition, the summer season had the largest density. It's worth mentioning that the Marehalli lake is gradually becoming a mesotrophic habitat.
Keywords: *Marehalli lake, Physico-chemical parameter, Seasonal variation, Zooplankton.*

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INTRODUCTION

"Zooplankton diversity is important for the health of our environment since each species has a unique role in nutrient recycling and providing sustenance for other species in an ecosystem, and certain organisms may help ecological systems run more efficiently" [1,2]. "Zooplankton is an important component of freshwater lake ecosystems since it is the principal source of food for practically every freshwater fish species at some stage during its life cycle"1,2. "Research on zooplankton populations may also help predict changes in lake ecosystems over time since they are sensitive to environmental fluctuations and susceptible to human influences"[1,2].

"Aquatic ecosystems may be monitored using changes in water physico-chemical parameters, which can reveal the exact composition and quantity of organisms that are able to thrive in the environment"1,2. "A healthy environment relies heavily on zooplankton. India's growing population is fueling an increase in industry, which in turn is creating problems with sewage disposal. Because of the frequency with which surface runoff adds an unwanted chemical to the lake, water quality has deteriorated"[2,1].

"Waste water disposal concerns arise when India's population expands as a result of increased industrial activity. The quality of the lake's water is deteriorating due to surface runoff, which introduces toxic substances into the water. Water quality is defined by its chemical, physical, and biological content. Knowledge of water quality and the health of the organisms that dwell in it is essential to any management approach" [2,1].

The most important biological factors were the diversity of freshwater and marine plankton. Taxa and physically different species make up each community's species diversity. When we speak about species diversity, we're referring to the variety of species that may be found in a specific location, both common and unique. Species diversity in tropical and temperate natural ecosystems is higher than in man-made habitats"[1,2]. "The richness of species and the equal distribution of species are two characteristics of species diversity"[3]. "The number of unique species and the size of those species' populations may be characterised as species richness"[3]. To gauge how evenly distributed species are, the phrase "species evenness" is used.

"The diversity of a population's species may be calculated using species richness, evenness, and total diversity"[4]. In this inquiry, Marehalli Lake provides as a natural setting. The freshwater supply of this lake is vital because it employs local fisherman and provides a significant source of income for some of

the region's poorest citizens. This study was carried out to determine how seasonal changes in zooplankton richness influence the lake's biodiversity.

MATERIAL 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 about 680mm, and enormous canals irrigate the bulk of the land. Mandya, Karnataka, India (latitude 12° 31' 25.4316" N, longitude 76° 53' 40.8624" E) is home to the Marehalli Lake environment (Fig. 1). When the city is inundated, the water in this lake spans an area of 2245351 meters2, 2.245 kilometers2, 24168759 feet2, 2685418 yards2, 554.838 acres. Local fisherman go out on a daily basis to fish in the lake.

Water sample collection and analysis

"Water and plankton samples were gathered during a two-year period, 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)"[5].

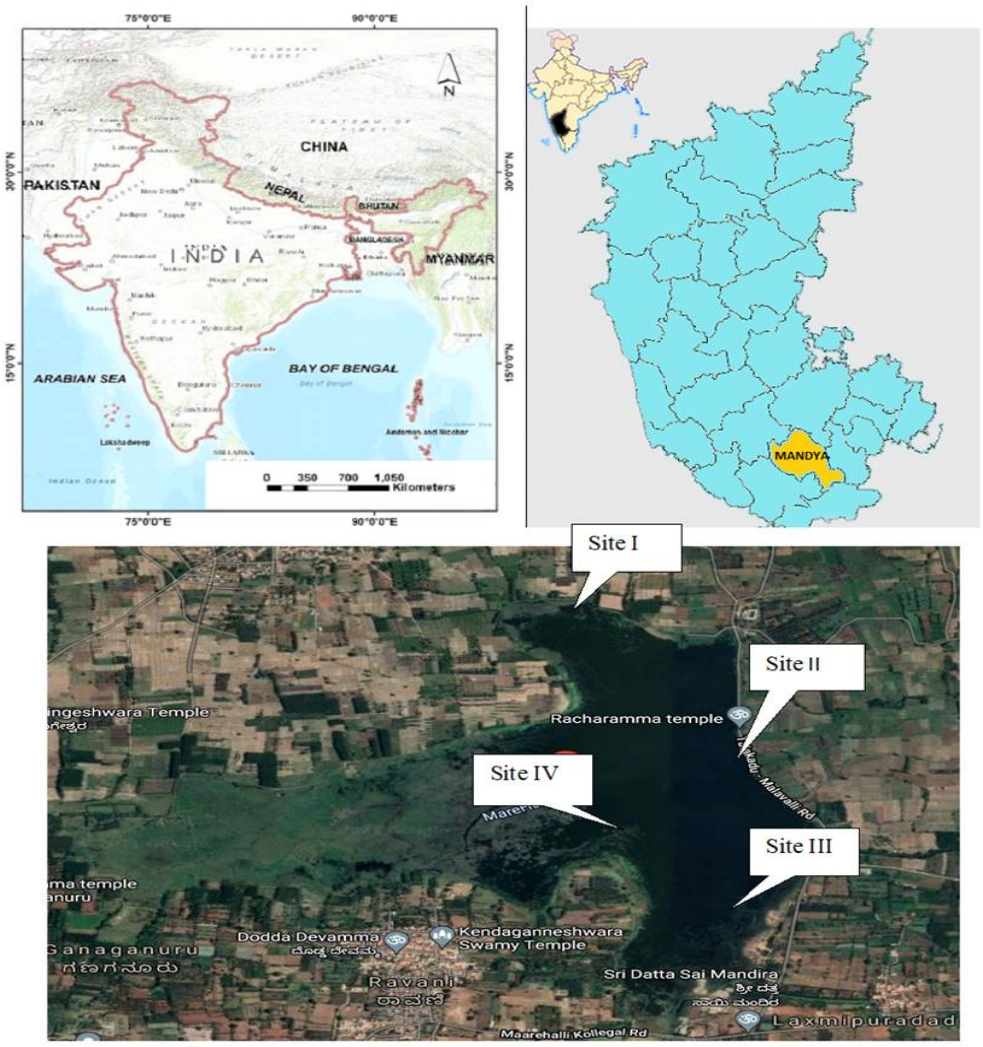

Figure 1: Geographical map location showing sampling sites at the Marehalli lake, Mandya, Karnataka, India.

Parameters

"The water samples were collected in screw-capped wide-mouth vials that were sterile. In the early hours (6:00 a.m. to 8:00 a.m.)" [6–12]. On the same day, lake samples were obtained between one and four metres below the surface, transferred to the laboratory, and analysed"1,2,13. The pH, the atmosphere, and the surface water temperature were all measured at the same time, as was the dissolved oxygen (DO). Physico-chemical characteristics are determined using surface water samples from the Marehalli lakes [2,1].

"Early in the morning, surface water samples will be gathered in 5-liter plastic canisters (6:00 a.m. - 8:00 a.m.)" [6–12]. The temperature of the air, the water, the pH of the water, and the DO of the water were all

measured in the field. "In the laboratory, the remaining parameters were measured."[2].

Zooplankton quantitative analyses

"Quantitative zooplankton was studied using bolting silk plankton nets, and the plankton was deposited in vials (pre-filled with 4 percent formalin) for microscopic examinations after being filtered through 100 litres of water (Olympus Microscope)"[1,2]. "In a stereo zoom binocular dissection microscope, they were separated using a thin needle and brush"[1,2]. "Each plankton species was stained with eosin or rose bengal on a drop of 20% glycerine on microscopic slides" [2]. Zooplankton samples are identified. Textbooks and standard guides have both mentioned plankton.

"The Sedgewick Rafters counting cell was used to collect a 1 ml zooplankton sample"[1,2]. The counting method was done three times for each plankton sample. The statistical analysis was carried out with the help of the GraphPad Prism software tool (8.0.2).

Species diversity indices:

"The PAST software application is used to construct diversity indices such as Dominance, Shannon-Wiener index (1949), Simpson (1949), and Evenness"[14,15,16].

RESULTS

The summer season had the greatest air temperature (30.83) and the winter season had the lowest, according to the results of this research (24.99). "Water temperature was greatest during the summer season (28.03) and lowest during the winter season (22.64), PH was greatest during the summer season (8.29) and lowest during the rainy season (8.03), and conductivity was greatest during the rainy season (2309.50) and lowest during the winter season (1361.78)"[17,18]. "TSS values were greatest (36.34) in the summer and lowest (35.13) in the winter, while DO values were highest (8.10) in the rainy season and lowest (7.14) in the summer"[18,19]. Co2 concentrations were greatest (0.04) during the summer season and lowest (0.0) during the wet and winter seasons. BOD was highest (7.78) in the summer and lowest (4.38) in the winter, COD was highest (10.53) in the summer and lowest (7.50) in the winter, hardness was highest (206.47) in the summer and lowest (167.06) in the winter, rainy chloride was highest (32.81) in the summer and lowest (31.47) in the winter, alkalinity was highest (32.81) in the summer and lowest (31.47) in the winter, and rainy chloride was highest (32.81) (Table: 1)" [17]. Additionally, the water parameters were statistically analysed (Table2)

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

Parameters	Marehalli lake							
	Rainy		Winter		Summer		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Air Temp. (°C)	27.05	0.03	24.99	0.02	30.83	0.06	27.62	2.52
Water Temp. (°C)	24.78	0.01	22.64	0.05	28.03	0.04	25.15	2.32
P^H	8.03	0.01	8.08	0.02	8.29	0.02	8.13	0.12
Conductivity (μS^{-cm})	1919.28	37.73	1361.78	30.37	2309.50	32.59	1863.52	407.34
Turbidity(NTU)	31.84	0.19	26.84	0.26	29.13	0.77	29.27	2.18
TSS(mg/L)	35.41	0.52	35.13	1.28	36.34	0.50	35.63	0.94
DO(mg/L)	8.10	0.03	7.75	0.04	7.14	0.05	7.66	0.42
Co_2(mg/L)	0.00	0.00	0.00	0.00	0.04	0.02	0.01	0.02
BOD(mg/L)	5.59	0.06	4.38	0.10	7.78	0.19	5.92	1.48
COD(mg/L)	8.25	0.23	7.50	0.18	10.53	0.28	8.76	1.36
Hardness(mg/L)	167.06	2.82	170.44	3.25	206.47	3.77	181.32	18.87
Chloride(mg/L)	31.84	0.50	31.47	0.26	32.81	0.38	32.04	0.69
Alkalinity(mg/L)	209.50	1.88	171.69	2.14	236.78	4.28	205.99	28.01
Phosphate(mg/L)	0.05	0.00	0.04	0.00	0.06	0.00	0.05	0.01
Nitrate(mg/L)	0.25	0.00	0.18	0.01	0.27	0.01	0.24	0.04
Sulphate(mg/L)	24.81	0.48	24.66	0.49	31.19	1.95	26.89	3.36
Calcium(mg/L)	25.66	0.43	23.25	0.68	27.00	0.14	25.30	1.68

Table 2: Physico-chemical parameters of lake water and its statistical analysis

Mean & SD of Marehalli lake													
Parameters	Sampling site I			Sampling site II			Sampling site III			Sampling site IV			Total sampling sites
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Row means
Air Temp.	27.62	3.29	24	27.64	3.26	24	27.6	3.28	24	27.63	3.3	24	27.62
Water Temp.	25.13	3.02	24	25.17	2.98	24	25.15	2.98	24	25.15	3.01	24	25.15
PH	8.13	0.18	24	8.14	0.16	24	8.12	0.17	24	8.14	0.18	24	8.13
Conductivity	1837.3	462.6	24	1898.5	468.8	24	1837.5	442.7	24	1880.8	434.7	24	1864
Turbidity	29.13	3.83	24	29.08	4	24	29.58	3.75	24	29.29	3.51	24	29.27
TSS	35.5	3.58	24	36.42	3.02	24	34.96	3.82	24	35.63	3.29	24	35.63
DO	7.63	0.46	24	7.67	0.42	24	7.68	0.49	24	7.67	0.47	24	7.67
Co_2	0	0.02	24	0.01	0.03	24	0.02	0.05	24	0.02	0.05	24	0.01
BOD	6	2.04	24	5.79	1.86	24	6	1.93	24	5.88	1.83	24	5.92
COD	8.71	2.05	24	8.79	1.72	24	8.88	2.03	24	8.67	1.83	24	8.76
Hardness	178.46	25.37	24	181.75	26.46	24	183.21	29.92	24	181.88	25.45	24	181.3
Chloride	31.79	2.6	24	32.13	2.31	24	32.38	2.41	24	31.88	2.27	24	32.04
Alkalinity	205.29	36.15	24	207.5	35.74	24	204	33.05	24	207.17	38.79	24	206
Phosphate	0.05	0.01	24	0.04	0.01	24	0.05	0.01	24	0.05	0.01	24	0.05
Nitrate	0.23	0.07	24	0.23	0.06	24	0.23	0.06	24	0.24	0.07	24	0.24
Sulphate	27	5.3	24	27.63	5.02	24	26.08	4.22	24	26.83	5.05	24	26.89
Calcium	24.79	3.3	24	25.46	3.27	24	25.42	3.49	24	25.54	3.43	24	25.3

Zooplankton species composition and species diversity

"A compound microscope was used to analyse the collected zooplanktons in this investigation. Rotifera is ranked first in the composition, followed by Copepoda, Cladocera, and Ostracoda (Table 3)"[20]. Rotifera was found to be more abundant year-round, while ostracod had the lowest population (Table 3, Figures 2 and 3, respectively).

Table 3: Overall distribution of zooplankton in Marehalli lake Zooplankton

	Marehalli lake				
	Total Mean	SD	CV	Upper Limits	Lower Limits
Rotifers	122.82	67.17	54.68	165.50	80.15
Cladoceras	59.94	25.70	42.87	76.26	43.61
Copepods	80.92	35.82	44.27	103.67	58.16
Ostracods	8.95	1.41	15.78	9.84	8.05

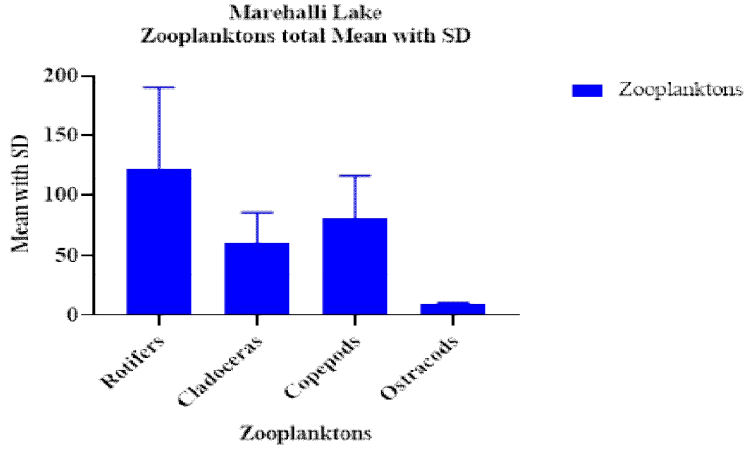

Figure 2: Distribution of Zooplanktons in Marehalli Lake

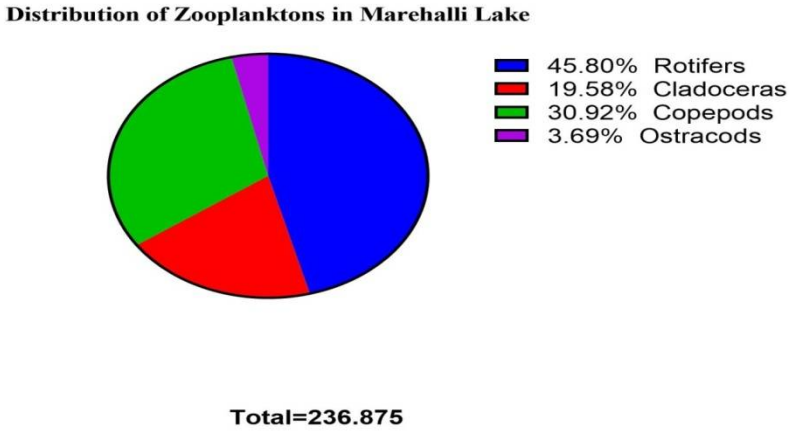

Figure 3: Distribution of Zooplanktons in Marehalli Lake Species diversity indices

"Table 4 summarises the species diversity indexes for zooplankton" [22]. In terms of zooplankton, site I (6627.00) included the greatest number of taxonomic individuals, whilst site IV contained the fewest (6485.00). The dominance index and Simpson index were 0.34 and 0.66 in each site, respectively. The Shannon index revealed that site II had the highest value (1.17) and that all other sites had a consistent value of 1.16. The evenness index was found to be greater (0.81) at site II than at the other sample locations (0.80).

Species Diversity indices	Site I	Site II	Site III	Site IV
Taxa_S	4.00	4.00	4.00	4.00
Individuals	6627.00	6516.00	6544.00	6485.00
Dominance_D	0.34	0.34	0.34	0.34
Simpson_1-D	0.66	0.66	0.66	0.66
Shannon_H	1.16	1.17	1.16	1.16
Evenness_e^H/S	0.80	0.81	0.80	0.80

Table 4: Species diversity indices of Marehalli lake for different sampling sites

DISCUSSION

"Physico-chemical variables and nutrient levels in lake water impact plankton dispersion and species composition" [1,2,23,24–26]. "Environmental factors such as water's physical and chemical properties are critical for phytoplankton growth and distribution in aquatic habitats, which zooplankton rely on for

survival" [,27,28].
"The development and dispersion of flora and fauna in the lake ecosystem are influenced by surface water temperature[29–31]. When the temperature rises, chemical and biological processes speed up [32–34].
"The pH scale measures the concentration of hydrogen ions in water and is used to assess the severity of acidity and alkalinity"[35]. In the summer, a high rate of photosynthesis in bodies of water suggests an increased pH value. "The greatest pH was discovered in the summer and the lowest in the rainy season"[36].
"Due to the high temperatures in the summer, the greatest pH resulted in increased carbon dioxide in the water"[37]]. According to the results of the present research, 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 macro organisms, 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 [38-39].
Increased temperature produced by the discharge of residential waste, according to existing statistics, may exacerbate pollutant levels. As a consequence, it's been shown that in certain circumstances, higher water temperatures paired with toxins might assist zooplankton populations thrive [40].
A high nutrient load may also promote high phytoplankton production, which in turn can sustain zooplankton abundance or population in the long term. According to the results of this research, the overall population density of zooplankton is modest in the winter season, possibly owing to lower light intensity. Similar results have been discovered in previous studies [41].

CONCLUSION

Numerous investigations led to the conclusion that the highest density of zooplanktons was recorded during the summer season as a consequence of the rate of evaporation, and the lowest density was observed during the winter season as a result of the rate of evaporation. As a consequence of the rain, the water concentration will decrease, resulting in a reduction in the density of zooplankton. As a result, it can be argued that water temperature may be beneficial in supporting zooplankton population diversification. As a consequence, in order to guarantee that they are accurately understood, they are being regularly examined in more detail in order to better understand the future implications of climate change on zooplankton diversity in the aquatic environment.

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CONFLICT OF INTEREST

The author(s) declares no conflict of interest.

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