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An assessment of Zooplankton diversity and abundance in Lakhota Lake, Jamnagar

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Abstract
Planktons are essentially roving organisms that travel small distances and are typically found at the epilimnion. Understanding planktonic community variety, ecosystem health or disturbance, ecotoxicity, and sustainability are the main goals of the current work. The water and plankton samples were taken over the course of two years, from September 2020 to October 2021, between the hours of 6:00 and 9:00 a.m., from the Lakhota Lake in Jamnagar, Gujarat, India. The majority of the physicochemical factors are ideal for the growth of phytoplankton. The findings demonstrated that during the study period, there were highly significant variations in alkalinity, pH, BOD, DO, COD, TDS, TH, P, nitrate, calcium, magnesium, color, and turbidity between seasons and lake sites. Phytoplankton and environmental parameters showed a positive association, as determined by Karl Pearsson's correlation coefficient analysis. Fifteen distinct species were discovered during the study period that may be There are four main groups: Copepods (03), Rotifers (06), Protozoa (02) and Cladocera (04). The studied area exhibits moderate contamination and high diversity, as indicated by various diversity indices and the saprobic index.

Keywords: Zooplankton, lakhota lake, physicochemical parameter, DO and BOD

Introduction

The crucial element of aquatic fauna and a key link in the aquatic food chain is zooplankton. Additionally, it keeps the biotic and abiotic elements of the aquatic ecosystem in appropriate balance. The three main categories of invertebrate organisms that make up freshwater zooplankton are rotifers, copepods, and crustocerans. They are widely distributed in all kinds of aquatic environments, play a crucial part in the transmission of energy within an aquatic ecosystem, and serve as bio-indicators of pollution. It holds a middle place in the food chain, where a large number of them eat algae and bacteria, which are then eaten by fish, birds, and other invertebrates.

Understanding the fundamental characteristics and overall economy of aquatic environments is considerably aided by the diversity and ecology of zooplankton. Zooplankton population in a body of water is also regulated by physical and chemical variables. Numerous scientists conducted studies on the zooplanktons in various freshwater environments. In the Kayadhu River, close to Hingoli, The present work is aimed at understanding the variation in planktonic communities, health of ecosystem or disturbance, Eco-toxicity and sustainability. Thus, with the following goals and objectives, the current study was also conducted to examine the zooplankton diversity of Lakhota Lake, a freshwater body in Gujarat, India's Jamnagar District.

1. The gathering and conservation of freshwater zooplankton from lakhota lake.
2. Zooplankton identification using accepted techniques.
3. Analysis of the zooplankton diversity in the water body of Lakhota Lake

Materials and Methods

The water and plankton samples were collected from a Lakhota Lake of Jamnagar city, Gujarat, India for a period of two year from sept 2020 to oct 2021 between 6:00 A.M and 9:00 A.M. Rain water is the only source of water for this lake. The data were taken thrice in month and interpreted seasonally, like winter (December - February). Water sample collected by grab sample method and manual sampling (APHA Standard). Collect a 1-L sample for most physical and chemical analyses. Sample packed in crushed ice and store at 4 to 5 degrees Celsius. Water parameter like BOD, COD, DO, pH, Mg, Ca, Alkalinity, Total hardness, TDS, Colour, Total phosphorus, nitrate and turbidity analysed using APHA standard method. Plankton is counted using a binocular compound microscope with various eyepieces, such as 10X and 40X. Estimating the populations of each species allows for thorough assessments of planktonic communities. Diversity index is calculated using PAST software. Saprobic index is calculated using Pantle and buck method.

Result and Discussion

Most of the physicochemical parameters are very suitable for phytoplankton growth. The result showed that there were highly significant differences in Alkalinity, pH, BOD, DO, COD, TDS, TH, P, Nitrate, calcium, magnesium, colour and turbidity among seasons and between sites of lake during year oct-2020 to sep-2021. Higher Alkalinity 53.6 ± 0.37 mg/L was recorded during in May (Summer season) and a low Alkalinity 32.6 ± 0.17 mg/L during August (Rainy season) at station A of lake. While Higher Alkalinity 50.3 ± 0.15 mg/L was recorded during in April (Summer season) and a low Alkalinity 44.7 ± 0.20 mg/L during July (Rainy season) at station B of lake. Higher BOD 22.3 ± 0.05 mg/L was recorded during in June (Summer season) and a low BOD 14.0 ± 0.11 mg/L during Jan (Winter season) at station A of lake. While in station B Higher BOD 5.8 ± 0.15 mg/L was recorded during in June (Summer season) and a low BOD 2.7 ± 0.05 mg/L during Dec (Winter season). Higher

COD 97.6 ± 1.1 mg/L was recorded during in Aug (Rainy season) and a low COD 40.6 ± 1.1 mg/L during May (Summer season) at station A of lake. While in station B Higher COD 18.6 ± 0.05 mg/L was recorded during in July (Rainy season) and a low COD 13.06 ± 0.05 mg/L during Apr (Summer season). Higher Calcium 57.6 ± 0.5 mg/L was recorded during in Aug (Rainy season) and a low Calcium 34.6 ± 0.5 mg/L during Apr (Summer season) at station A of lake. While in station B Higher Calcium 28.6 ± 0.5 mg/L was recorded during in Aug (Rainy season) and a low Calcium 11.6 ± 0.5 mg/L during Apr (Summer season). Higher colour 13.2 ± 0.01 mg/L was recorded during in Aug (Rainy season) and a low Colour 10.01 ± 0.07 mg/L during Apr (Summer season) at station A of lake. While in station B Higher Colour 7.21 ± 0.01 mg/L was recorded during in Aug (Rainy season) and a low Colour 5.72 ± 0.01 mg/L during Apr (Summer season). Higher DO 7.16 ± 0.15 mg/L was recorded during in Feb (Winter season) and a low DO 4.03 ± 0.05 mg/L during Aug (Rainy season) at station A of lake. While in station B Higher DO 11.1 ± 0.05 mg/L was recorded during in Feb (Winter season) and a low DO 7.03 ± 0.05 mg/L during Aug (Rainy season). Higher Mg 32.3 ± 0.5 mg/L was recorded during in Aug (Rainy season) and a low Mg 14.6 ± 1.1 mg/L during Apr (Summer season) at station A of lake. While in station B Higher Mg 16.3 ± 0.5 mg/L was recorded during in Aug (Rainy season) and a low Mg 7.6 ± 1.5 mg/L during Apr (Summer season). Higher Nitrate 64.8 ± 0.20 mg/L was recorded during in Sep (Rainy season) and a low Nitrate 45.4 ± 0.25 mg/L during May (Summer season) at station A of lake. While in station B Higher Nitrate 25.3 ± 0.20 mg/L was recorded during in Sep (Rainy season) and a low Nitrate 45.4 ± 0.25 mg/L during May (Summer season). Higher Turbidity 8.1 ± 0.0 mg/L was recorded during in Aug (Rainy season) and a low Turbidity 5.3 ± 0.11 mg/L during Feb (Winter season) at station A of lake. While in station B Higher turbidity 5.2 ± 0.05 mg/L was recorded during in July (Rainy season) and a low Turbidity 3.4 ± 0.00 mg/L during Jan (Winter season). Higher pH 8.2 ± 0.05 mg/L was recorded during in May (Summer season) and a low pH 6.1 ± 0.11 mg/L during Jul (Rainy season) at station A of lake. While in station B Higher pH 8.3 ± 0.05 mg/L was recorded during in Apr (Summer season) and a low pH 7.0 ± 0.11 mg/L during Aug (Rainy season). Higher TDS 623.6 ± 1.5mg/L was recorded during in Sep (Rainy season) and a low TDS 490 ± 1.5 mg/L during Apr (Summer season) at station A of lake. While in station B Higher TDS 471 ± 0.00 mg/L was recorded during in Sep (Rainy season) and a low TDS 370 ± 0.05 mg/L during Apr (Summer season). Higher Total hardness 276±3.0 mg/L was recorded during in Aug (Rainy season) and a low Total hardness 146.6 ± 5.6 mg/L during Apr (Summer season) at station A of lake. While in station B Higher Total hardness 138.3 ±3.5 mg/L was recorded during in Aug (Rainy season) and a low Total hardness 60.3 ± 5.8 mg/L during Apr (Summer season). Higher Phosphorus 0.18 ± 0.032 mg/L was recorded during in Sep (Rainy season) and a low Phosphorus 0.08 ± 0.0 mg/L during Mar (Summer season) at station A of lake. While in station B Higher Phosphorus 0.061± 0.0 mg/L was recorded during in Sep (Rainy season) and a low Phosphorus 0.025 ± 0.0 mg/L during Feb (Summer season). During year 2021-2022 there is also variation in physicochemical parameters among different season In the current research fifteen species of Zooplankton were recorded in the lakhota lake during year 2020-2021 represented by Four major groups, Cladocera (04), Copepod (03), Rotifers (06) and Protozoa (02). Zooplankton species observed during research period were *Daphnia sp., Moina sp., Diaphanosoma sp., Ceriodaphnia sp., Mesocyclops sp., Heliodiaptomus sp., Calonoid sp., Mesocyclops sp., Brachinous sp., Asplanchna sp., Filinia sp., Horella sp., Keratella sp., Platyias sp., Vorticella sp., Euglipha sp.* Among them *Daphnia sp., Moina sp., Diaphanosoma sp. and Ceriodaphnia sp* belongs to group Cladocera while *Mesocyclops sp., Heliodiaptomus sp., Calonoid sp.* belongs to Copepoda and*., Mesocyclops sp., Brachinous sp., Asplanchna sp., Filinia sp., Horella sp., Keratella sp., Platyias sp.* belongs to groupo rotifers and *Vorticella sp., Euglipha sp.* belongs to group protozoa. In this study dominant plankton is due to nutrients rich water. The polluted water is the source of nutrients like nitrate phosphorus etc., which help in the growth of phytoplankton. In this study most of species are pollution indicator species but not only their presence but there abundance also responsible for pollution of lake. The maintenance of ecosystem depends on abiotic factor as well as biotic community of system Total Zooplankton density 6283 Org/L was observed at station A while total Zooplankton density 3598 Org/L was observed at station B during year 2020-2021. Maximum density was observed during April month (Summer season) while minimum density was observed during November month (Winter season) at station A and B reveal in figure 1. it starts declining from may onwards and attain lowest ebb during Oct-Nov (winter months). Again, zooplankton an increase in their density in early summer season.

During 2020-2021 In station A Rotifera Contribute 40% (2521 Org/L) which is followed by Cladocera 29% (1845 Org/L), Copepoda 21% (1307 Org/L), Protozoa 10% (610 Org/L) showed in figure 2. In station B Rotifera Contribute 44% (1554 Org/L) which is followed by Cladocera 26% (932 Org/L), Copepoda 19% (675 Org/L), Protozoa 11% (415 Org/L) showed in figure 3.

Karl Pearson correlation coefficients, or r-values, are computed to quantify the link between different chemical and physical factors. Figure 4 reveled that total Zooplankton positively correlated with pH(0.75), DO(0.254), Nitrate (0.86), Phosphorus (0.73), Turbidity (0.50), TDS (0.88), Alkalinity (0.77) while negatively correlated with BOD (-0.10), COD (-0.83), Total hardness (-0.84), Ca (-0.80), Mg (-0.87) and Color (-0.68) at station A during 2020-2021. While Karl Pearson correlation coefficients, or r-values, are computed to quantify the link between different chemical and physical factors. Figure 5 reveled that total Zooplankton positively correlated with pH(0.74), DO(0.33), Nitrate (0.79), Phosphorus (0.52), Turbidity (0.22), TDS (0.72), Alkalinity (0.39) while negatively correlated with BOD (-0.69), COD (-0.13), Total hardness (-0.73), Ca (-0.70), Mg (-0.75) and Color (-0.45) at station B during 2020-2021.

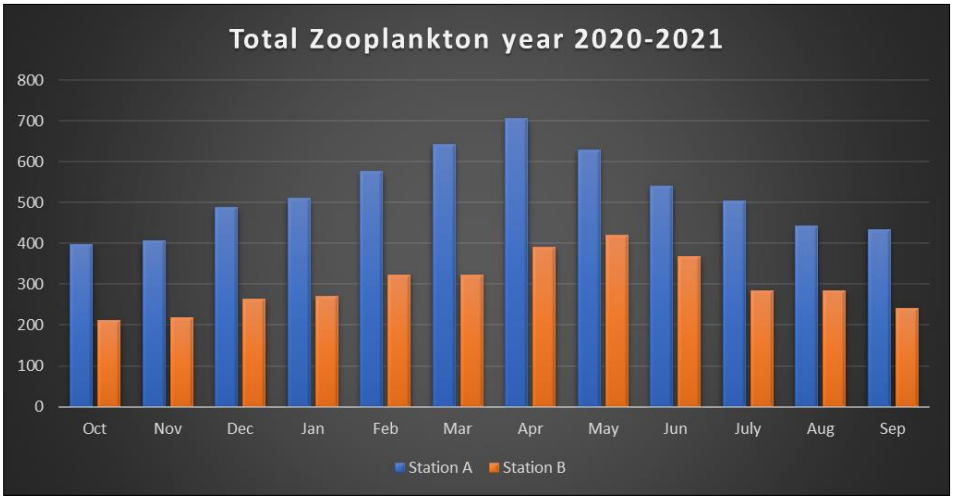

Fig 1: Monthly variation of Total Zooplankton of lakhota lake water, Jamnagar from September 2020 to October 2021

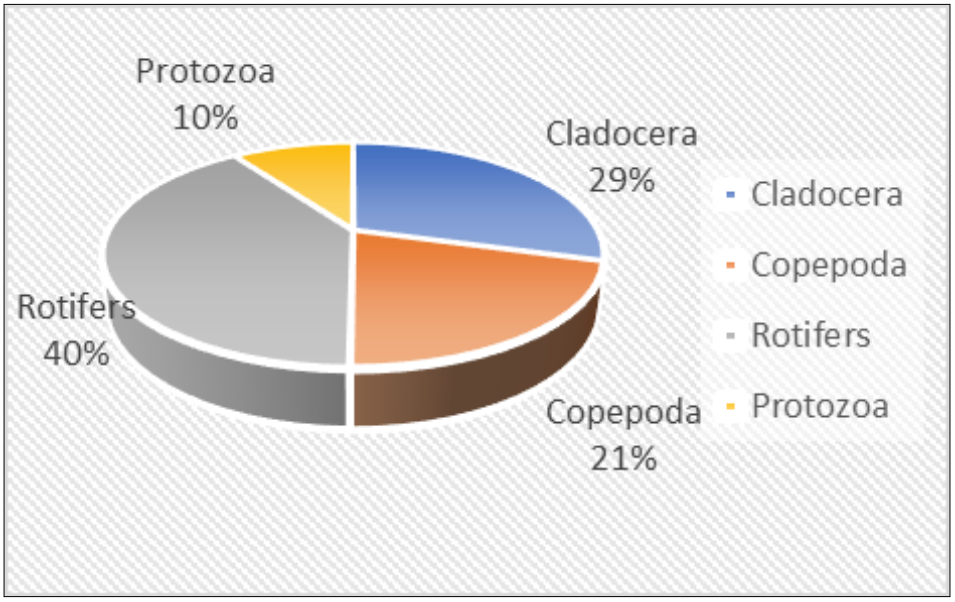

Fig 2: percentage contribution of different classes of Zooplankton at station A of lakhota lake water, Jamnagar

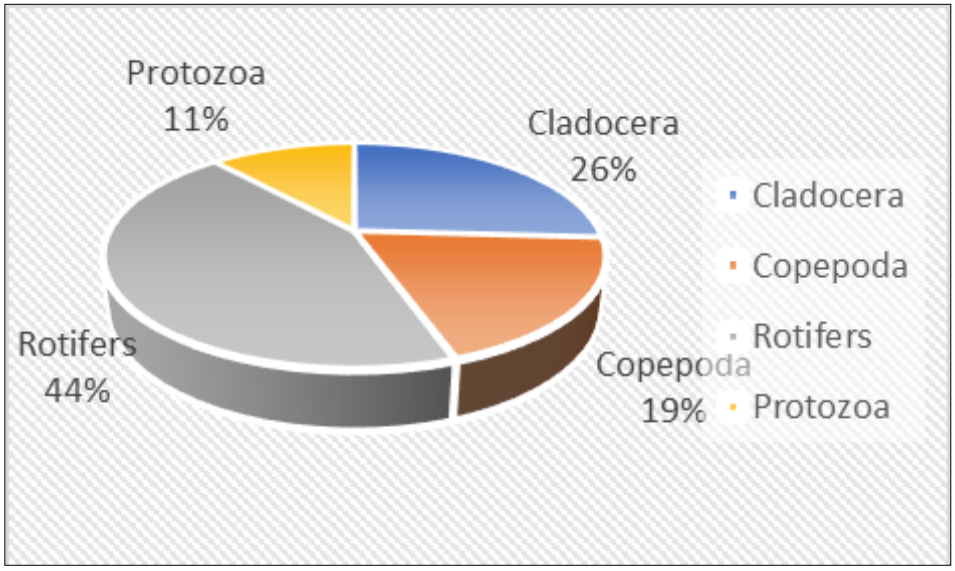

Fig 3: Percentage contribution of different classes of Phytoplankton at station B of lakhota lake water, Jamnagar.

	Total zooplank	pH	DO	BOD	COD	tal hardnes	Calcium	Vlagnesium	Colour	Nitrate	Phosphorus	Turbidity	TDS	Alkalinity
Total zoop	1													
pH	0.757655	1												
DO	0.25024	0.615276	1											
BOD	-0.10453	-0.42538	-0.94308	1										
COD	0.834915	-0.95419	-0.4409	0.225212	1									
Total hardı	-0.84954	-0.92415	-0.64489	0.469105	0.929694	1								
Calcium	-0.80988	-0.93339	-0.68941	0.528239	0.918721	0.993646	1							
Magnesiun	-0.87951	-0.90311	-0.59622	0.411691	0.927422	0.99501	0.977663	1						
Colour	-0.68806	-0.89267	-0.78294	0.623429	0.852394	0.947453	0.951891	0.929779	1					
Nitrate	0.860953	-0.8252	-0.41155	0.214187	0.898206	0.900318	0.877218	0.911893	0.786214	1				
Phosphoru	0.739641	-0.76408	-0.46859	0.298654	0.801295	0.838077	0.82711	0.838115	0.796181	0.939783	1			
Turbidity	0.502698	-0.77787	-0.91556	0.82258	0.676719	0.823819	0.857651	0.785085	0.879395	0.708678	0.735438	1		
TDS	0.881552	-0.77138	-0.30924	0.13096	0.85182	0.847293	0.812431	0.870762	0.718988	0.970418	0.9266	0.616903	1	
Alkalinity	0.778016	0.897811	0.399382	-0.18619	-0.95371	-0.87825	-0.87324	-0.87141	-0.77018	-0.93265	-0.83663	-0.66975	-0.881	1

Fig 4: Karl Pearson coefficient Analysis of environmental factor and different taxa of Zooplankton at station A during year 2020-2021

	Total zooplank	pH	DO	BOD	COD	tal hardnes	Calcium	Vlagnesium	Colour	Nitrate	Phosphorus	Turbidity	TDS	Alkalinity
Total zoop	1													
pH	0.742141	1												
DO	0.332511	0.541636	1											
BOD	0.698288	0.243172	-0.34977	1										
COD	-0.13368	-0.60695	-0.82151	0.539396	1									
Total hardı	-0.73009	-0.82059	-0.79415	-0.14344	0.667238	1								
Calcium	-0.7068	-0.80287	-0.80754	-0.11127	0.674999	0.997311	1							
Magnesiun	-0.75554	-0.83837	-0.76941	-0.18343	0.652948	0.994777	0.984923	1						
Colour	-0.45424	-0.74	-0.90728	0.224615	0.834683	0.879747	0.9002	0.844651	1					
Nitrate	0.796749	-0.78803	-0.59508	-0.38707	0.37138	0.898629	0.902989	0.882054	0.757004	1				
Phosphoru	0.525695	-0.61108	-0.95036	0.17161	0.78555	0.869134	0.873855	0.856883	0.874947	0.662555	1			
Turbidity	0.229711	-0.15322	-0.76904	0.817094	0.784956	0.325068	0.358031	0.278618	0.665766	0.082265	0.624549	1		
TDS	0.728291	-0.78401	-0.8465	-0.06567	0.677942	0.941728	0.945248	0.931345	0.880231	0.849246	0.933701	0.425903	1	
Alkalinity	0.399424	0.77776	0.793409	-0.28293	-0.90827	-0.71312	-0.71587	-0.70326	-0.85952	-0.50811	-0.7892	-0.67464	-0.767	1

Fig 5: Karl Pearson coefficient Analysis of environmental factor and different taxa of Zooplankton at station B during year 2020-2021.

Conclusion

The understanding of the plankton distribution and its corelation with environmental factors in the lakhota lake, Jamnagar has greatly benefited from this work. As a case study, the effects of long-term environmental changes on lakhota lake, Jamnagar plankton assemblage were investigated. This knowledge should support the sustainable management of the lake by assisting in the integration of plankton ecology into environmental management techniques. In case of Zooplankton both the station showed Rotifera member has the dominant group, which implies the water quality is bad and eutrophication nature of water Rotifera has the dominant group which if followed by Cladocera and Copepoda and Protozoa. 13 different physicochemical parameter showed different mean value during different season during 2020-2021. These factors act as nutrient for the plankton growth that's why study of correlation between abiotic and biotic factors is very important for the lake.

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