



CORRELATION STUDY OF ZOOPLANKTON DIVERSITY, SPECIES RICHNESS AND PHYSICO-CHEMICAL PARAMETERS OF GHODAZARI LAKE (MAHARASHTRA)

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Abstract

Zooplankton diversity and species richness can be affected by physico-chemical characteristics, morphology of lake and human activity in the catchment area of the lake. Zooplankton diversity and the physico-chemical characteristics of the lake is an important criterion for evaluating the trophic status of the lake and suitability of water for domestic purposes. Thus study was undertaken to evaluate the zooplankton community structure diversity, seasonal variation in the population and its correlation with physico-chemical parameters in Ghodazari Lake. The present study was undertaken for a period of 6 months from January 2016 to June 2016. Water samples were collected on monthly basis from selected sampling site for analyzing the physico-chemical parameters and population dynamics of the zooplanktons in the reservoir. A total of 26 zooplankton taxa were recorded: 11 rotifers, 5 copepods, 7 cladocerans and 3 ostracods. Zooplanktons were present in the following order of dominance; Rotifera > Cladocera > Copepoda > Ostracoda. The physico-chemical parameters considered in the present study were: water temperature, pH, transparency, electrical conductivity, dissolved oxygen, total hardness, biological oxygen demand and chemical oxygen demand. Correlation coefficients (R) were determined using correlation matrix to identify the correlation between zooplankton diversity and physico-chemical parameters. Shanon-Weiner Index was in the range of 4.51 to 4.61 indicating lake preserves rich plankton diversity. Presence of pollution tolerant taxa like *Brachionus*, *Keratella* and *Lecane* spp. indicate semipolluted water of the reservoir. The trophic status of the lake evaluated from the zooplankton analysis and physico-chemical parameters indicates that the lake is mesotrophic nature.

Keywords: zooplankton diversity, Ghodazari Lake, rotifera, correlation matrix, physico-chemical parameters

Introduction

Ghodazari lake is a freshwater natural lake situated at 20° 32' 29. 25"N longitude, 79° 37' 44.33" E latitude at the elevation of 245Mts. in Chandrapur district, Maharashtra. This Lake serves as a source of domestic water for near about villages. It is therefore very important to keep the quality of water good for domestic purposes. Zooplanktons plays important role in food web by linking the primary producers with consumers of higher trophic levels of the lake ecosystem. Many species of the zooplanktons have high potentiality as a bioindicator to monitor quality of water and their density can be correlated with biotic and abiotic factors of the water bodies (Ferdous and Mukhtadir, 2009). Zooplanktons are sensitive to the changes in environmental conditions, thus are good indicators of changes in water quality parameters (Schindler, 1987). Thus present investigation is an attempt to assess the water quality parameters, zooplankton community structure, dominance, abundance and density in Ghodazari Lake.

Materials and Methods

Sample collection was carried out monthly from January 2016 to June 2016. Zooplankton samples were collected by filtering 50 liters of the lake water through standard plankton nylon net with mesh size 55µm.

The concentrated samples were preserved in 4% formalin soon after the collection. Identification was carried out by using standard literature. The recorded species were identified following Ward and Whipple, 1959; Edmondson, 1959; Mizuno, 1964; Dussart, 1969; Harding and Smith, 1974; Kolisko, 1974; Koste, 1978; Victor and Fernando, 1979; Mizuno and Takahashi, 1991; Battish, 1992; Reddy, 1994; Michel and Sharma, 1998 and Dhanapathi, 2003. Quantitative analysis and evaluations were carried out according to Edmondson (1959) and Telesh (1986).

Six indices were used to estimate zooplankton diversity and species richness. Species diversity index was calculated based on Simpson (1949) and Shannon-Weiner (1949); richness index was adopted by Margalef (1951) and Menhinic (1964) and equitability Index by Magurran (1988). Dominance index or Simpson's index of diversity was calculated using formula 1- Simpson index. The percentage relative abundance of the specimens was estimated by direct count.

The collection and analysis of various physico-chemical parameters of water samples were carried out by following the standard methods (APHA, 2005; Saxena, 1994; Manivasakam, 1982; Trivedy and Goel, 1986). Triplicates of each analysis were performed and mean values were used for calculation.

Statistical Analysis

The correlation coefficient matrix between each pair of parameters was estimated to identify the highly correlated and interrelated water quality parameters. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS 10.0).

Results and Discussion

Lakes are important wetlands which plays their role as a source of water for drinking and domestic purposes. Lakes improves the water table of the near about areas and forms its own ecosystem and supports flora and fauna of that region. However exponential growth of the population and urbanization has created tremendous pressure on the lakes thereby leading to the problems like eutrophication and influencing the trophic status of the lakes. Thus regular assessment of water quality parameters and zooplankton diversity is essential to evaluate the trophic status of the lake.

In present investigation 11 species of Rotifera including 2 families and 5 genera, 7 species of cladocera including 5 families and 6 genera, 5 species of Copepoda including 3 families and 5 genera and 3 species belonging to Ostracoda were noted. Overall 26 species of zooplankton were reported (Table 1). The most abundant taxonomic group recorded during the study was the rotifers. Zooplankton were present in the following order of dominance; Cladocera > Rotifera > Copepoda > Ostracoda. The community structure of zooplankton showed a mixed composition of mesotrophic to eutrophic species. *Brachionus* species are indicator of eutrophic conditions (Baloch and Soomro, 2004). Presence of pollution tolerant taxa like *Brachionus*, *Keratella* and *Lecane* spp. indicate semipolluted waters of the reservoir (Patrick, 1950). Abundance of mesotrophic species like *Keratella vulga*, *Keratella tropica* indicates the mesotrophic nature of the reservoir. *M. micrura* and *Diaphanosoma* and *Alona* were the main dominant cladocerans in Ghodazari reservoir, while other species remain rare. The cladoceran populations are rich in density but poor in species diversity.

Zooplankton density and relative abundance is shown in graph. (Fig.1 and Fig. 2).

Composition of zooplankton community is strongly dependant on the season. In the current study the density of rotifers was maximum during winter in February (31.08%) and minimum at the summer in May (20.21%). Cladoceran density was maximum during winter (45.83%) and minimum during the premonsoon

in June (31.63%). Copepods showed their maximum density during summer (26.95%) and minimum density (16.66%) during winter. However ostracods showed their maximum density during summer (14.90%) and minimum density during winter (7.5%).

The values for biodiversity indices that is Simpson index, Dominance index, Shannon-weiner index, Menhinik index and Equalitability index are represented in the Table. 2. Shannon-weiner index values are in the range of 4.51 to 4.61 and Margalef richness index values are in the range of 4.25 to 4.62 confirms the mesotrophic status of this reservoir. Simpson index values as low as 0.040 and maximum 0.045 while Dominance index is high as 0.95 are good indicators of rich diversity of species in this reservoir. From the equitability index (0.95 to 0.98) it is evident that distribution of zooplankton species during the study was even and follows the Lorenz graph. Evenness, is therefore, best used as a baseline value to which future studies can be compared. No major fluctuation was found in the equitability index during entire study period.

Physico-chemical parameters of water

The physico-chemical parameters of water at Ghodazari lake is represented in the Table 3.

Water temperature

Temperature of Reservoir water ranged from 19.4°C to 30.3°C during entire study period. Seasonal fluctuations were observed during the investigation.

pH

During present study water pH values were ranged from 7.6 to 8.4. Alkaline nature of the reservoir was noted during the entire investigation period. pH range of 7.5 to 8.5 is desirable concentration as per guidelines of WHO (2004). pH range from 5 to 8.5 is best for plankton growth (Umavathi *et al.*, 2007).

Transparency

In the present investigation transparency was ranged from 19.0 cm to 30.2 cm.

Higher transparency occurred, during winter and summer due to less suspended particles and absence of influx of silt.

Electrical conductivity

Present investigation revealed that, conductivity fluctuated between 300 $\mu\text{mho}/\text{cm}$ to 614 $\mu\text{mhos}/\text{cm}$. Total amount of ionisable salts in water were positively correlated with electrical conductivity (Bobori, 1996).

Dissolved oxygen

In the present investigation the dissolved oxygen was in the range of 5.0 mg/L to 8.0 mg/L. Dissolved oxygen concentration more than 5mg/L favors good growth of flora and fauna.

Total Hardness

In the present investigation total hardness was in the range of 110 to 177 mg/L. Many workers has noted a positive correlation between temperature and hardness (Jhingran, 1982; Singh, 1986). The observed values of hardness are in the permissible limit of drinking water (WHO, 2004).

Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

During present investigation minimum BOD and COD values ranged from 2.1 to 4.0 mg/L and 8.0 to 12.4 mg/L respectively. Significant correlation ($r=0.9$) in between BOD and COD was observed during the investigation.

Correlation among the Physico-chemical parameters and Zooplanktons:

Correlation matrix of the physico-chemical variables is shown in Table 4.

A positive correlation between water temperature and pH, hardness, BOD, COD, copepoda and plankton density was observed in the present study. However negative correlation exists with cladocera (Table.4).

The pH of the Ghodazari reservoir water showed significant positive relationship with hardness, BOD and COD. However inverse relationship was noted with transparency and cladocera.

In the present investigation transparency showed negative correlation with dissolved oxygen.

Conductivity showed a positive correlation with hardness, BOD and ostracoda and negative relationship with DO.

Dissolved oxygen (DO) showed a significant correlation with COD.

Hardness in the present study showed significant positive relationship with BOD, COD, copepoda and density of zooplankton and negative significant correlation with cladocera.

BOD and COD showed positive significant correlation with copepoda and zooplankton density and significant negative correlation with cladocera.

Among zooplanktons rotifera population showed significant positive correlation with dissolved oxygen. Cladocera showed negative significant correlation with temp, pH, hardness, BOD and COD. Copepoda showed significant positive correlation with temp, hardness and BOD. However Ostracoda showed significant positive correlation with conductivity.

Zooplankton density showed positive correlation with temp, pH, hardness and BOD.

Conclusion

The results obtained from the present investigation revealed that, all values the physical and chemical properties of Ghodazari reservoir water were within desirable limits as per the guidelines of the WHO (2004). Thus water of Ghodazari reservoir is suitable for irrigation, pisciculture and drinking purpose.

Table 1: Zooplankton species identified in Ghodazari Reservoir.

Rotifera	Cladocera	Copepoda	Ostracoda
Family: Brachionidae	Family: Sididae	Family: Diaptomidae	<i>Cypris subglobosa</i>
<i>Brachionus bidentata</i>	<i>Diphanosoma</i>	<i>Diaptomus</i>	<i>Stenocypris</i>
<i>B. falcatus</i>	Family: Daphnidae	<i>Heliodiaptomus viddus</i>	<i>Eucypris</i>
<i>B. ureceolaris</i>	<i>Ceriodaphnia reticulata</i>	Family: Cyclopidae	
<i>B. forficula</i>	Family: Moinidae	<i>Cyclops leuckartii</i>	
<i>B. calyciflorus</i>	<i>Moina micrura</i>	<i>Mesocyclops hyalinus</i>	
<i>B. quadidentatus</i>	Family: Bosminidae	Family: Canthocamptidae	
<i>Keratella tropica</i> (Apstein)	<i>Bosmina longirostris</i>	<i>Nauplii</i>	
<i>Keratella vulga</i>	<i>Bosmina coregoni</i>		
<i>Lecane arcuata</i>	Family: Chydoridae		
<i>Filinia longiseta</i>	<i>Chydorus globosus</i>		
Family: Asplanchnidae	<i>Alona rectangula</i>		
<i>Asplanchna priodonta</i>			

Table 2 : Zooplankton community structure and α - biodiversity indices of Ghodazari reservoir.

Month	Simpson Index	Dominance index	Shanon-Weiner index	Margalef Richness index	Menhinic index	Equitability Index
Jan	0.044	0.95	4.51	4.56	1.67	0.96
Feb	0.041	0.95	4.57	4.62	1.74	0.97
Mar	0.043	0.95	4.55	4.40	1.52	0.96
Apr	0.043	0.95	4.55	4.37	1.49	0.96
May	0.045	0.95	4.49	4.43	1.54	0.95
Jun	0.040	0.95	4.61	4.25	1.38	0.98

Table 3. Range of variation, Mean \pm standard error of the physico-chemical characteristics of water of Ghodazari lake during January, 2016 to June, 2016

S. No.	Parameter	Unit	Range of Variation		Mean \pm Std. Error
			Min	Max	
1.	pH	--	7.6	8.4	7.72 \pm 0.4
2.	Water Temp.	$^{\circ}\text{C}$	19.4	30.3	23.9 \pm 1.66
3.	Transparency	Cm.	19.0	30.2	26.6 \pm 1.07
4.	Electrical Conductivity	$\mu\text{mho Cm}^{-1}$	300	614	477 \pm 47.4
5.	Dissolved Oxygen	mgL^{-1}	5.0	8.0	6.6 \pm 0.52
6.	Total Hardness	mgL^{-1}	110	177	143.83 \pm 10.4
7.	B.O.D.	mgL^{-1}	2.1	4.0	2.56 \pm 0.31
8.	C.O.D.	mgL^{-1}	8.9	12.4	10.08 \pm 0.53

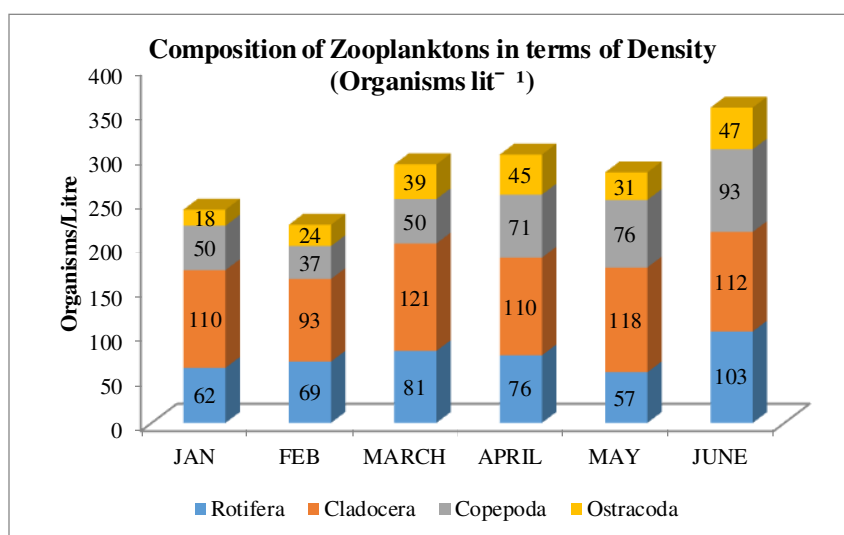
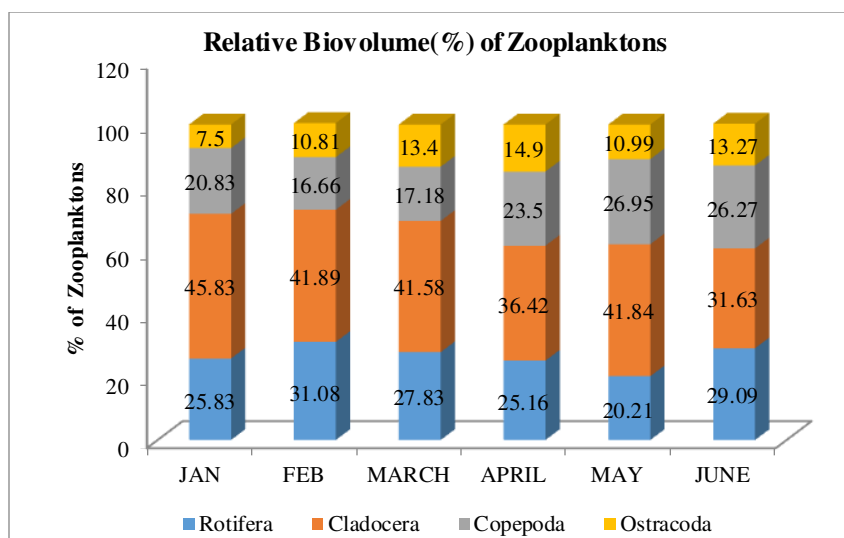
**Fig,1.** Composition of Zooplanktons in terms of density.**Fig, 2.** Relative biovolume (%) of Zooplanktons

Table 4. Correlation matrix of the physico-chemical variables of Ghodazari reservoir . (method = Pearson)

r	Temp	pH	Trans	Cond	DO	Hardness	BOD	COD	Rotifera	Cladocera	Copepoda	Ostracoda	Density of Org.
Temp	1												
pH	0.905	1											
Transparency	-0.498	-0.728	1										
Conductivity	0.626	0.343	0.335	1									
DO	-0.099	0.272	-0.723	-0.733	1								
Hardness	0.963	0.814	-0.306	0.793	-0.283	1							
BOD	0.915	0.753	-0.423	0.655	-0.258	0.937	1						
COD	0.873	0.888	-0.625	0.48	0.087	0.873	0.902	1					
Rotifera	-0.209	0.172	-0.419	-0.484	0.821	-0.255	-0.306	0.125	1				
Cladocera	-0.826	-0.867	0.523	-0.539	-0.078	-0.859	-0.828	-0.975	-0.228	1			
Copepoda	0.805	0.614	-0.287	0.566	-0.428	0.774	0.834	0.62	-0.624	-0.509	1		
Ostracoda	0.527	0.406	0.06	0.754	-0.263	0.7	0.6	0.651	0.105	-0.748	0.164	1	
Density of Org.	0.882	0.771	-0.53	0.544	-0.039	0.891	0.948	0.925	-0.085	-0.863	0.638	0.685	1

*The values (r) ranging from 0.576 and above , 0.708 and above are significant at $P \leq 0.05$ (2-tailed) and $P \leq 0.01$ (2-tailed), respectively.

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