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STUDIES ON DIVERSITY, SEASONAL VARIATION AND ZOOPLANKTON COMMUNITY OF FRESHWATER, RAMADESHWAR LAKE (HIRWA TALAV) OF TEHSIL –RAMTEK, DISTRICT- NAGPUR, MAHARASHTRA, INDIA

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ABSTRACT

Seasonal study on Zooplankton Dynamics as indicator of water quality was carried out on Ramadeshwar Lake (Hirwa Talav) in Tehsil Ramtek, Nagpur District in Maharashtra. The lake is situated near Tai Golwalkar Mahavidyalaya, Ramtek and enhances scenic beauty to the college premises, but may cause problems if not maintained regularly owing to its rapid eutrophication due to human settlement. Hence a study was carried out during January 2021 to December 2021 to investigate the Zooplankton diversity. Four representative sampling stations were selected on Ramadeshwar Lake. Zooplankton net (62 µ) was used to collect the water samples and Sedgwick Rafter Cell was used to enumerate the Zooplankton. Water sampling was done monthly. Results showed around 26 species were found belonging to Rotifera, Cladocera & Copepoda inhabit all four sampling stations. Rotifera included 13 species and dominated in all the months with average composition of 39.52 % in Summer, 41.27% in Monsoon & 44.16 % in Winter. Cladocera included 8 species with average composition of 24.15% in Summer, 25.2 % in Monsoon & 23.69 % in Winter. Whereas, Copepoda comprised 5 species with average composition 36.27% in Summer, 33.45% in Monsoon & 32.53 % in Winter with an intermediate range of population. The values of Shannon Wiener Diversity Index (SWDI) (1.42 in Summer, 1.65 during Monsoon and 2.2 in Winter) for the four sampling locations, indicate a Mesotropic to Eutrophic status of water body, that is detrimental for swimming, anthropogenic activities and irrigation of crops due to microbial contamination. The study reveals that the Lake water is highly productive as the Zooplankton count is moderate. Hence, such water bodies should be monitored at proper intervals, pollution may be controlled by promoting fish culture activities must be acclaimed by the Government authorities which will control anthropogenic sources of pollution to the Lake. Such restored lakes will be highly beneficial for sustainable water source for future generations to come.

KEYWORDS: 'Hirwa Talav', Rotifera, Cladocera, Copepoda, Zooplankton.

INTRODUCTION

Sited at a distance of 50 km. from Nagpur, tehsil Ramtek is a city and Municipal council in Nagpur District located at 21.4°N 79.33°E. It is famous for its ancient temples viz., Rama temple & Jain temple main attraction for tourists. Ramadeshwar Lake also called as 'Hirva Talav' a lentic water body situated near Tai Golwalkar Mahavidyalaya, Ramtek. Ancient Ramaleshwar Temple, situated at the banks of the 'Hirva talav' also occupies visitors for its scenic beauty. Initially the lake served as a freshwater reservoir for the water cascading from the hills of the Tekdi Mandir, Ramtek. But since few years it is being utilized by the inhabitants for anthropogenic activities, swimming & irrigation purposes.

Freshwater Zooplankton is one of the bio-indicator used for assessment in ecological health monitoring of water bodies by most of the research workers (Ismail and Adnan, 2016; Jakhar 2013, Rahkola-Sorsa 2008, Santos-Wisniewski *et al*., 2006). Water has an immense power to restore its impurities and maintain a balanced ecosystem. This is mainly achieved by the role played by the biotic components in achieving the oligotrophic or clean water status of the surface water bodies. Zooplankton is an important component in aquatic food web connecting primary producers with higher secondary producers (Santos-Wisniewski *et al*., 2006). Thus, Zooplankton diversity and density changes with change in water quality i.e. oligotrophic to eutrophic water quality. Zooplankton as heterotrophic micro-invertebrates, play a vital role in the aquatic food web.

Zooplankton help to regulate the aquatic productivity. During recent years, the diversity, abundance and tolerance of Zooplankton have been used to indicate the deterioration in water quality caused by pollution and eutrophication induced largely by human activity (Mekong River Commission, 2015). The present paper deals with the dynamics of Zooplankton throughout the year and application of Shannon Wiener Diversity Index to assess the water pollution status.

Figure 1: Four (R_1, R_2, R_3 & R_4) Sampling stations located at Ramadeshwar Lake (Hirwa talav), Tehsil- Ramtek, District- Nagpur.

MATERIALS AND METHODS

The locations of sampling stations were selected as per the accessibility. Four sampling stations (R_1, R_2, R_3 & R_4) were selected for collecting water samples for Zooplankton analysis (**Figure 1**). Monthly water samples were collected during morning hours (between 7:00 am & 8:00 am) for analysis of Zooplankton population during January 2021 to December 2021 period. An amount of 50 litres water was filtered through plankton net of mesh size 62 µ to concentrate the Zooplankton in the filtrate collected in the bottle attached to the plankton net. The filtrate containing Zooplankton was preserved by adding 4 ml commercial Formalin to 96 ml filtrate to make the final concentration of 4% Formalin in filtrate. The monthly collected samples were tagged as R_1, R_2, R_3 & R_4 and conserve samples at room temperature. Sedgwick Rafter counting chamber was used for Zooplankton analysis. The qualitative and quantitative analysis of Zooplankton were done following standard methods (APHA, 1976). Zooplankton were identified by using standard keys (Ward & Whipple, 1959 and Needham, 1972). Species diversity index of Zooplankton was determined using Shannon and Wiener Diversity Index (SWDI) method (Shannon, 1948).

RESULTS AND DISCUSSION

Diversity of Zooplankton Species

Around 26 Zooplankton species belonging to Rotifera, Cladocera and Copepoda were recorded from all the sampling stations during the study period (**Table 1**). Physical characteristics of different Zooplankton groups are described by Ferdous and Muktadir (2009). Rotifera is soft bodied Zooplankton having short life cycle among the Zooplankton and grow rapidly under favorable conditions. Cladocerans are characteristics nutrient group of Zooplankton and preferred food for higher fishes in the food chain. Copepods have toughest exoskeleton and have long and tough appendages. They can swim faster than other Zooplankton. A community structure of Zooplankton species at Ramadeshwar Lake during the study period (January to December 2021) in all the four location represented in Figure 1, clearly displays that all the sampling locations show higher number of Rotifera species (13), followed by Cladocera species (8) and Copepoda species (5). There was diversity and variation in the four sampling location therefore, not all four location had all 26 Zooplankton species recorded during analysis. Sampling location R_1 had seven species each of group Rotifera & Cladocera while four species of Copepodan were found. Sampling location R_2 had nine Rotifera species, seven Cladocera species and five Copepoda species. Sampling locations R_3 & R_4 had eleven species of Rotifera and five species of Cladocera each. They differed in their Copepodan species with four and three species respectively as listed below in **Table 1**.

Table 1: Presence of Zooplankton Community Structure during the Study Period.

Sr. No.	Name of species	Sampling location			
		R_1	R_2	R_3	R_4
Group I- Rotifera					
1	*Brachionus caudatus*	+	+	-	+
2	*Brachionus calyciflorus*	-	+	+	+
3	*Brachionus rubens*	+	-	+	+
4	*Brachionus bidenta*	+	+	+	+
5	*Brachionus havanensis*	-	+	-	+
6	*Brachionus dimidiatus*	-	+	+	+
7	*Keratella tropicana*	+	-	+	+
8	*Asplanchna brightwelli*	+	+	+	+
9	*Polyarthra remata*	-	+	+	-
10	*Filinia longiseta*	+	+	+	+
11	*Pompholyx sulcata*	-	-	+	+
12	*Anuraeopsis navicula*	-	-	+	-
13	*Epiphanes brachionus*	+	+	+	+
Group II- Cladocera					
1	*Moina macrocopa*	+	+	+	+
2	*Moina micrura*	+	+	+	+
3	*Diaphanosoma brevireme*	+	+	-	+
4	*Ceriodaphnia cornuta*	+	-	-	-
5	*Macrothrix elegans*	+	+	+	+
6	*Macrothrix squamosa*	-	+	+	-
7	*Graptobleberis occidentalis*	+	+	+	+
8	*Sida crystalline*	+	+	-	-
Group III- Copepoda					
1	*Nauplius* sp.	+	+	+	+
2	*Cyclops sp.*	+	+	+	+
3	*Mesocyclops leuckarti*	+	+	-	-
4	*Heliodiaptomus viduus*	-	+	+	-
5	*Thermocyclops hyalinus*	+	+	+	+
	TOTAL	18	21	20	19

Phylum Rotifera: Diversity of Rotiferan species were thirteen in number belonging to six families. **Table 2** below shows the diversity of Rotifera occurred in Ramadeshwar Lake. The species that were found viz: *Brachionus caudatus, B.calyciflorus, B.rubens, B.bidenta B.havanensis, B.dimidiatus Keratella tropicana, Asplanchna brightwelli, Polyarthra remata, Pompholyx sulcata, Anuraeopsis navicula, Epiphanes brachionus and Filinia longiseta*. (**Plate 1**)

Table 2: Diversity of Zooplankton of Phylum Rotifera.

Phylum	Family	Genus species
Rotifera (Cuvier, 1798)	Brachionidae (Ehrenberg, 1838)	*Brachionus caudatus* (Barrois and Daday, 1894)
		B.calyciflorus (Pallas, 1766)
		B.rubens (Ehrenberg, 1838)
		B.bidenta (Anderson, 1889)
		B.havanensis (Rousselet, 1911)
		B.dimidiatus (Bryce, 1931)
		Anuraeopsis navicula (Rousselet, 1911)
		Keratella tropicana (Apstein,1907)
	Asplanchnidae (Eckstein, 1883)	*Asplanchna brightwelli* (Gosse, 1850)
	Synchaetidae (Hudson & Gosse, 1886)	*Polyarthra remata* (Ruttner-Kolisko, 1959)
	Testudinellidae (Harring, 1913)	*Pompholyx sulcata* (Hudson, 1885)
	Epiphanidae (Harring, 1913)	*Epiphanes brachionus* (Ehrenberg, 1837)
	Fillinidae (Harring & Myers, 1926)	*Filinia longiseta* (Ehrenberg, 1834)

These species have been reported to be the best indicators of water pollution. Rotifer is popularly used as indicator by other workers (Sladecek 1983). Species of *Brachionus*, especially is a better indicator of water pollution as it is least affected by the algal blooms in eutrophic water (Ceirans, 2007; Dadhich *et al*., 1999). Attayde & Bozelli (1998) reported that *Asplanchna* sp., *Brachionus* sp., and *Filinia* sp. were superior indicators of eutrophic waters and probably *Brachinus* sp. alone can determine the eutrophic status of water body. Rotifera are most significant group in the Zooplankton community (Saler 2004, Barrabin 2000, Aboul-Ezz *et al*. 1996). Rotifers are reported as the faster growth in eutrophic water bodies (Cajander, 1983). Rotifers especially *Brachionus* sp. were recorded at higher density in two eutrophic lakes (Ismail and Adnan, 2016). They opinioned that in eutrophic waters rotifer are not visible to predatory fishes due to turbid and low transparency water and small size of Rotifers. Similar results were also observed by Barrabin (2000) and Saler (2004).

Cladocera, an Order belonging to the Subphylum Crustacea are of greater significance in the aquatic food chain, as they are considered food for young as well as adult fishes (Pannak, 1978). Ramadeshwar Lake showed presence of 8 species of Cladoceran belonging to five families, as per **Table 3**. Moinidae (*Moina macrocopa & M. micrura), Macrothricidae (Macrothrix elegans & Macrothrix squamosal),* Chydoridae (*Graptobleberis occidentalis), Sididae (Sida crystalline* & *Diaphanosoma brevireme)* and Daphnidae (*Ceriodaphnia cornuta).* (**Plate 2**)

Table 3: Diversity of Zooplankton of Order Cladocera.

Phylum	Arthropoda	**Genus species**
Subphylum	Crustacea	
Class	Branchiopoda	
Order	Cladocera (Latreille 1829)	
Family	Moinidae, (Goulden, 1968)	*Moina macrocopa* (Straus, 1820)
		M. micrura (Kutrz, 1874)
	Macrothricidae (Norman & Brady, 1867)	*Macrothrix elegans* (Sars, 1901)
		Macrothrix squamosa (Sars, 1901)
	Chydoridae (Stebbing , 1902)	*Graptoleberis occidentalis* (Sars,1901)
	Sididae (Baird,1850)	*Sida crystalline* (O.F. Muller1776)
		Diaphanosoma brevireme (Sars,1901)
	Daphnidae (Straus,1820)	*Ceriodaphnia cornuta* (Sars, 1885)

Cladoceran also known as 'water fleas' are transparent and larger than Rotiferans. They have high nutritional value and existing food for secondary consumers. These are found plenty in ponds and lakes than Rivers (Ward & Wipple 1959). Specifically species belonging to families Chydoridae and Macrothricidae inhabit the shallow and weedy waters , others like *Moina* sp. prefer the muddy pools, whereas , *Diaphanosoma* sp. reside in the limnetic zone , while some like *Sida crystalline* found between the weeds and paddles in open waters, highly sensitive taxon to polluted lakes as reported by Cattaneo *et. al*. in 1998. Although others prefer deep waters, according to Uttangi (2001) Cladocerans play a vital role in energy transformation.

Water analysis at Ramadeshwer Lake indicated species from Subclass **Copepoda**, consists of five species from two orders Cyclopoid (*Nauplius* sp., *Cyclops* sp, *Thermocyclops hyalinus*) and Calanoid (*Heliodiaptomus viduus*) (**Plate 3).** Copepodan's are important member of the Zooplankton for their role in the trophic dynamics and in energy transfer in the aquatic ecosystem, provide food for fishes in fresh water ponds, lakes and play a major role in fish production (Kamble and Meshram, 2005; Pawar *et al.*, 2003).

Hence, Copepoda organisms constitute an essential link in aquatic food chain and form an intermediate trophic level between bacteria, algae and protozoan on the one hand and small and large plankton eaters, mainly fish, on the other (Sehgal, 1983).They also help us to detect pollution in the lakes consequently being indicators of water pollution (Dzyuban and Kuznetsova (1978), Carter (1971), Patalas (1972), Ringler and Langford (1967). Another study done by Kurasava (1975), Radhakrishna & Rangareddy (1976) presented an account on Copepods for their indicator value in water pollution. Whereas, seven and eight species of Copepoda have been identified by George, (1966), Baruah *et al*., (1993) as indicators of polluted water.

Table 4: Diversity of Zooplankton of Subclass Copepoda.

Phylum - Arthropoda				
Subphylum-Crustacea				
Subclass- Copepoda				
Order - Cyclopoida				
Family	Cyclopoidae (Dana, 1853)	*Nauplius sp.*, *Cyclops sp.*,	*Thermocyclops hyalinus* (Rehberg, 1880)	*Mesocyclops leuckarti* (Claus, 1857)
Order - Calanoida				
Family	Diaptomidae (Baird, 1850)	*Heliodiaptomus viduus* (Gurney, 1960)		

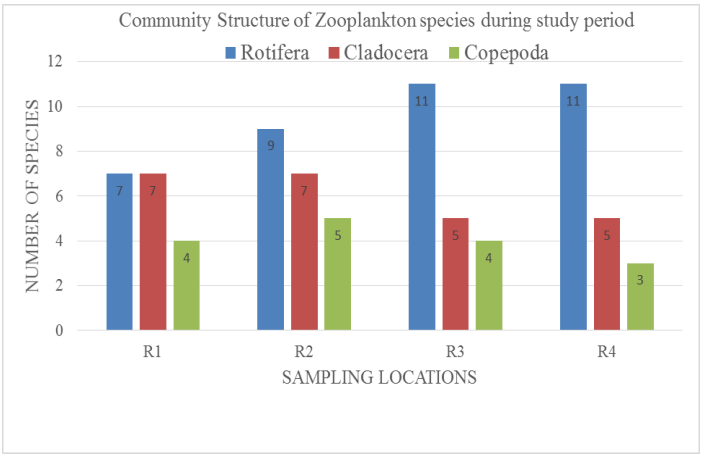

Figure 2: Community Structure of Zooplankton species at Ramadeshwar Lake during study period January to December 2021.

Diversity of Cladoceran group is nearly equivalent to diversity of Rotifer, however, the diversity of Copepoda is lesser than diversity of Rotifer. At the same time, the Zooplankton community structure **(Figure 2)** show the dominance of Rotifera followed by Cladocera and Copepoda. Thus, community structure of zooplankton community is good indicator of water quality. Dominance of Rotifera in eutrophic water is also explained by the fact that the species of Cladocera and Copepoda have larger size than species of Rotifera which are smaller than 250 µm (Shiel, 1995) and larger size species are easily consumed by predator fishes (Karus, 2014).

Community structure: The community structure based on species diversity is shown in **Figure 2,** indicating dominance of Rotifer species at all the sampling locations at Ramadeshwar Lake. Above discussion indicates that rotifer grow fast in eutrophic waters while Cladocerans and Copepodans are preferentially consumed by predator fishes resulting in dominance of Rotifers and sub dominance of Cladocerans and Copepodans. This shows that the Ramadeshwar Lake is Mesotrophic to Eutrophic in nature. Rotifera are important group in the community structure and indicate the water quality.

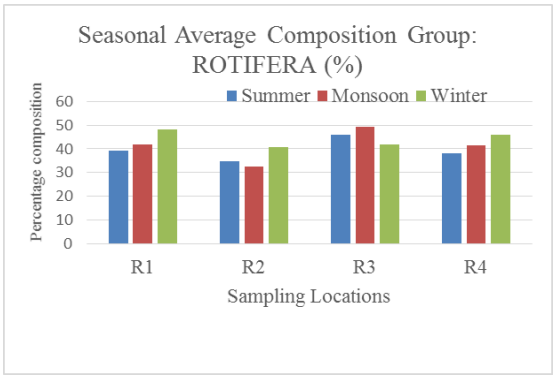

Figure 3: Seasonal Variation in Density of Zooplankton group Rotifera at Ramadeshwar Lake (Jan.- Dec.2021).

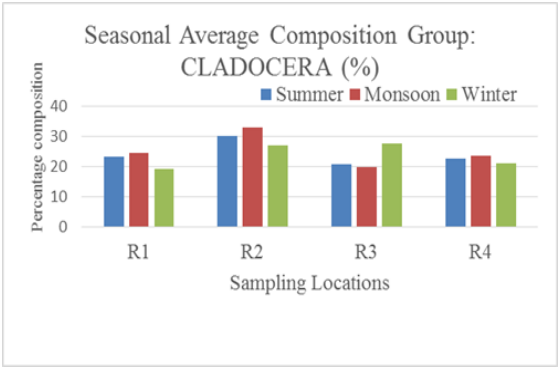

Figure 4: Seasonal Variation in Density of Zooplankton group Cladocera at Ramadeshwar Lake (Jan.-Dec.2021).

Density and Seasonal Dynamics of Zooplankton Groups

Based on quantitative data on counting of Zooplankton species, Rotifera group (Fig. 3), dominated in all the seasons, but was found maximum during monsoon with average composition of 49.1% at location R_3 in Monsoon. Density of Rotiferan was also found high during winter with average composition of 48.35 % at R_1 sampling location. Whereas, it was 45.9 % at R_3 location during summer.

Figure 4, shows the seasonal variations of Cladoceran group which shows moderate number of species occurring at sampling stations R_1, R_3 & R_4 in all the three seasons. But sampling station R_2 shows more number of Cladoceran in Monsoon 32.8%, Summer 30.05% & 26.95% during Winter. The percentage Cladoceran population is reasonably low when compared to Rotifera. This may be due to the presence of fishes in the lake which feed on these transparent water fleas.

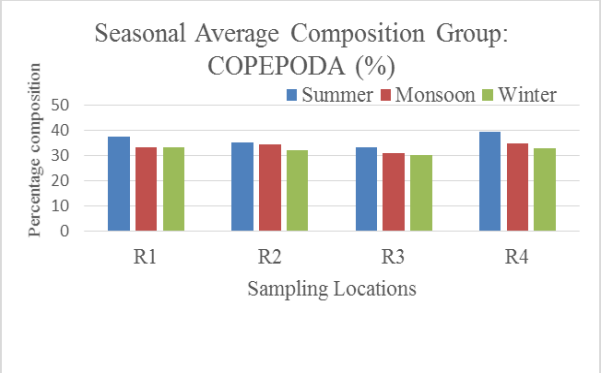

Figure 5: Seasonal Variation in Density of Zooplankton group Copepoda at Ramadeshwar Lake (Jan.-Dec.2021).

Copepodan density was reasonably high in number in especially in summer. Pradhan (2014) found similar results while investigating Zooplankton diversity of Wunna Lake. *Cyclops* & *Nauplius* are sensitive to pollution and tend to increase with the amount of nutrients as observed by Verma *et al* (1984) and Unni (1996). At Ramadeshwar Lake the sampling location R_4 showed maximum number of individuals 39.3% in summer, 34.5 % & 34.8 % at R_2 & R_4 respectively in Monsoon, 33% in summer at R_1 location. During winter season location R3 showed the lowest 30.45% of Copepoda individuals. Even sampling location R_1 (33.49%), R_2 (32.36%) & R_3 (33.13%) showed lower number of individuals during winter (Figure 5). This probably must be related to food availability in the lake and lower temperatures.

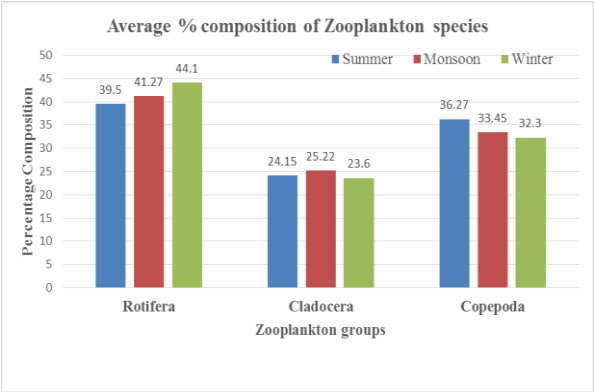

Figure 6: Average Seasonal Variation of Zooplankton group at four sampling locations in three seasons in Ramadeshwar Lake (Jan.-Dec.2021).

Average Seasonal variation: Average seasonal variation of Zooplankton group at four sampling locations in three seasons in Ramadeshwar Lake showed in Figure 6.

Rotifera: group dominated in all the three seasons but were maximum during winter season with 44.1 % composition of Rotifera. Whereas, Monsoon average composition was 41.27 % and lowest was Summer 39.5%.

Cladocera: They maximum during the Monsoon season with 25.22% composition. While summer (24.15%) and winter (23.6%) ranged mediocre.

Copepoda: During summer Copepoda were maximum 36.27 % composition which decreased in Monsoon (33.45%) and Winter (32.3%).

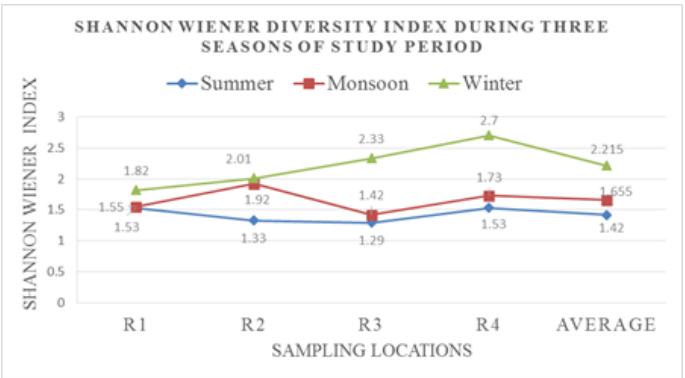

Figure 7: Average SWDI of Zooplankton group at four sampling locations in three seasons in Ramadeshwar Lake (Jan.-Dec.2021).

Shannon Wiener Diversity Index (SWDI): The values of Shannon Weaver Index (SWI) (Shannon & Weaver 1949) for the four locations R_1, R_2, R_3 & R_4 during summer season was observed to be 1.53, 1.33, 1.29 & 1.42 respectively (Figure 7). During monsoon season, SWI increased to 1.55, 1.92, 1.73 & 1.65, R_1 to R_4 respectively. While in winter, SWI was found in increasing level showing highest productivity stage 1.82, 2.01, 2.33 & 2.7, R_1 to R_4 respectively. The range of average of all the four locations showed high productivity during Winter (SWI 2.21), then Monsoon (SWI 1.65) and lower during Summer (SWI 1.42). The Zooplankton diversity is bimodal showing two peaks in monsoon season and winter season. SWI range indicated Mesotrophic to Eutrophic status of Ramadeshwar Lake.

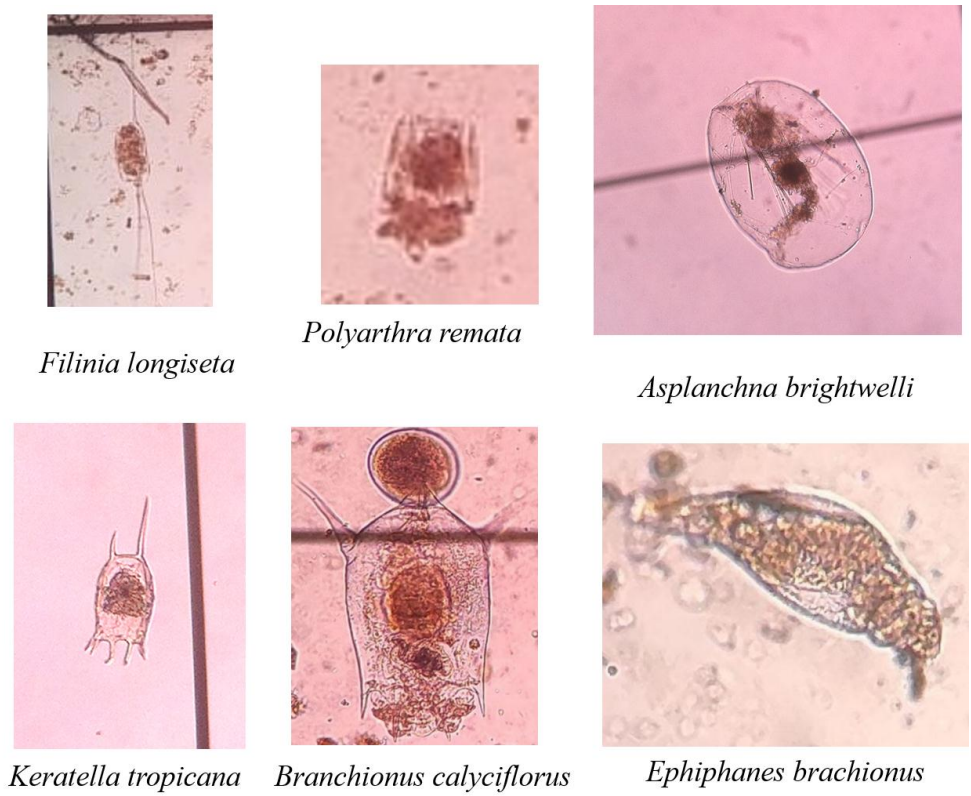

Plate 1: Some of the ROTIFERA species found in Ramadeshwar Lake, Ramtek.

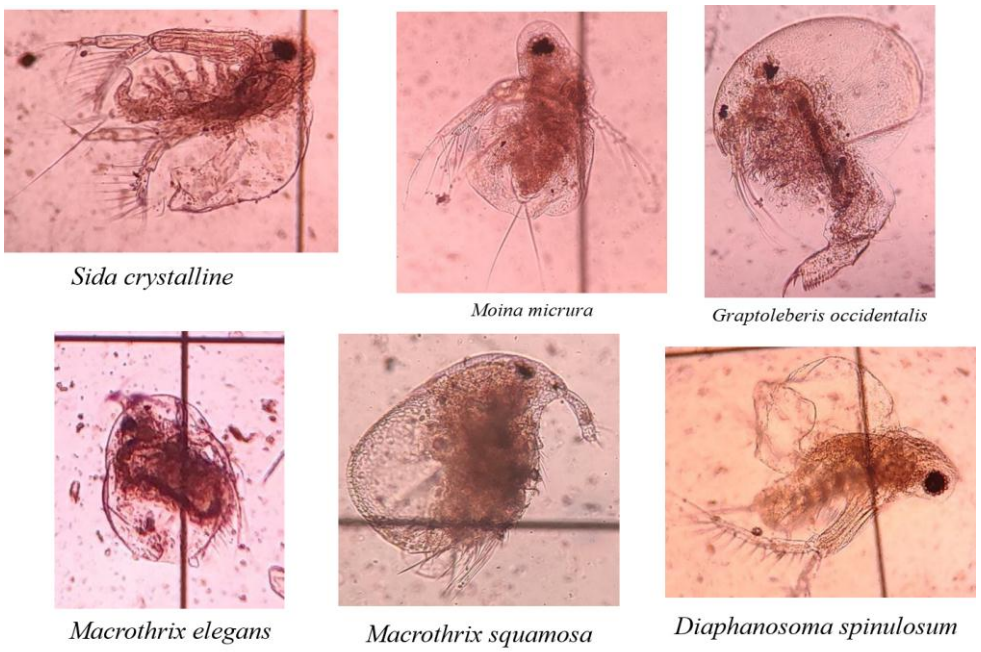

Plate 2: Some of the CLADOCERA species found in Ramadeshwar Lake, Ramtek.

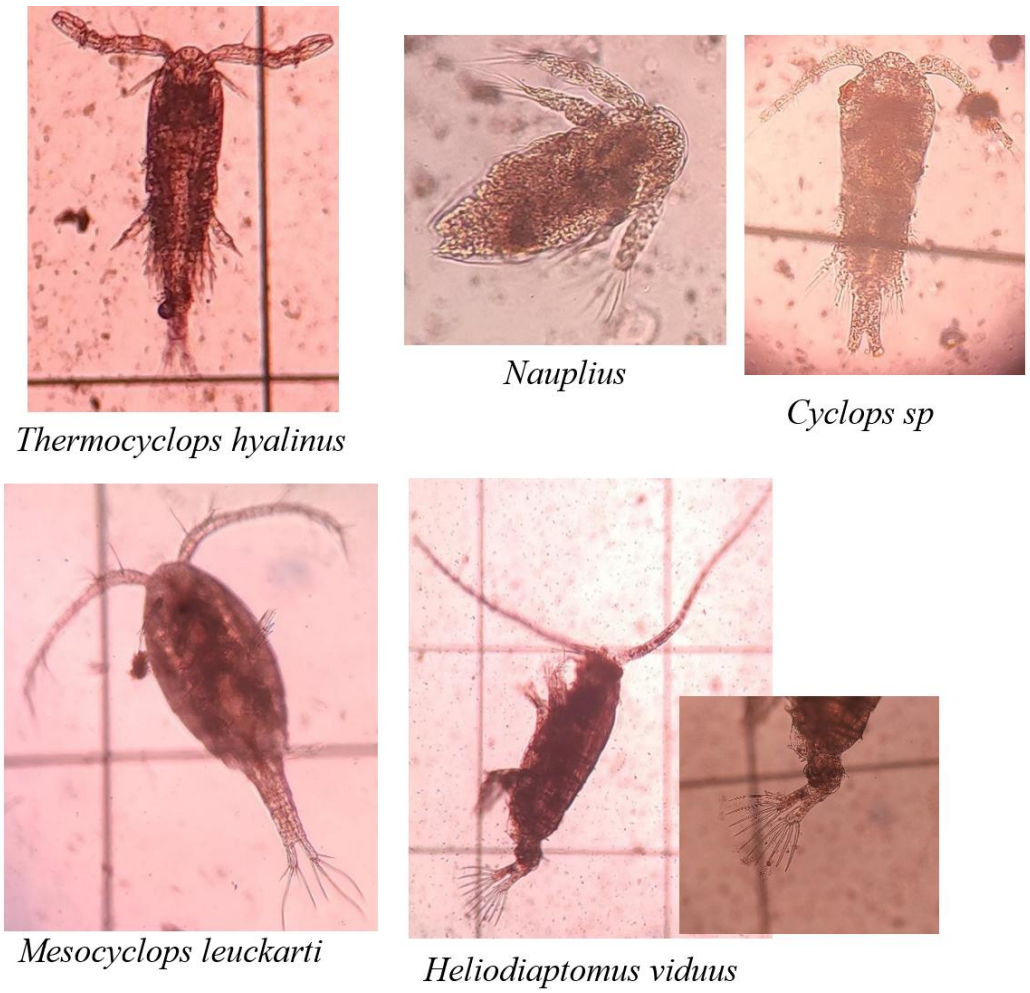

Plate 3: Some of the COPEPODA species found in Ramadeshwar Lake, Ramtek.

CONCLUSION

It is concluded that Rotifera group is the best indicator of the eutrophic status of the Ramadeshwar Lake water. Among Rotiferans, *Brachionus* sp. is the better indicator of water pollution in water body and may be used to track the trophic status of any eutrophic water body. Rotifera was observed as the dominant group in all the seasons, followed by Copepoda and Cladocera groups.

Therefore, Ramadeshwar Lake is presently Mesotrophic and may change to Eutrophic condition if timely pollution control measures are not undertaken. And such Eutrophic Ramadeshwar Lake water will hamper its use for irrigation due to fear of microbial contamination of crops and recreational activity due to deterioration of water quality. The eutrophication rate may be reduced by controlling the nutrient and pollution sources to the Lake as well as by promoting fish culture activity in the Lake to graze on Zooplankton of the Lake.

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REFERENCES

1. Aboul-Ezz SM, Salem SA, Samaan AA, Latif AFA, Soliman AA, Distribution of rotifers in the Rosetta Nile branch (Egypt) Journal of Egyptian and German Social Zoology, 1996; 20(D): 85–123. [Google Scholar]
2. APHA Standard methods for the examination of water and waste water. 4th edition, American Public Health Association, Washington, 1976; 1-1193.
3. Attayde JL, Bozelli RL, Assessing the indicator properties of zooplankton assemblages to disturbance gradients by canonical correspondence analysis. Canadian Journal of Fisheries and Aquatic Sciences, 1998; 55(8): 1789–1797. http://dx.doi.org/10.1139/f98-033. [Google Scholar]
4. Barrabin JM. The rotifers of Spanish reservoirs: Ecological, systematical and zoogeographical remarks. Limnetica, 2000; 19: 91–144. [Google Scholar]

5. Baruah, A, Sinha AK and Sharma UP, Plankton variability of a tropical wetland, Kawar (Begusarai) Bihar, J. Freshwater biol., 1993; 5: 27-32.
6. Cajander V, Production of planktonic Rotatoria in Ormajarvi, an eutrophicated lake in southern Finland. Hydrobiologia, 1983; 104(1): 329–333. http://dx.doi.org/10.1007/BF00045986. [Google Scholar]
7. Carter KCH, Distribution and abundance of planktonic crustacea in ponds near Georgian Bay (Ontario, Canada) in relation to hydrography and water chemistry. Arch Hydrobiol, 1971; 68: 204-231.
8. Ceirans A, Zooplankton indicators of trophy in Latvian lakes. Acta Universitatis Latviensis, 2007; 723: 61–69. [Google Scholar]
9. Dadhich N, Saxena MM. Zooplankton as indicators of trophical status of some desert aters near Bikaner. Journal Environment and Pollution, 1999; 6(4): 251–254. [Google Scholar]
10. Dzyuban NA & Kuznetsova SP, Zooplankton as an indicator of reservoir pollution. Gidrobiol, 1978; 14(6): 42-47.
11. Ferdous Zannatul and Muktadir AKM, A Review: Potentiality of Zooplankton as Bioindicator. American Journal of Applied Sciences, 2009; 6(10): 1815-1819.
12. George MG, Comparative plankton ecology of five fish tanks in Delhi. Hydrobiologia, 1966; 27: 81-108.
13. Ismail AH and Adnan AAM, Zooplankton composition and abundance as indicators of eutrophication in two small man-made lakes. Trop. Life Sciu. Res., 2016; 27 (supp1): 31-38. doi: 10.21315/tlsr2016.27.3.5
14. Jakhar P. Role of phytoplankton and zooplankton as health indicators of aquatic ecosystem: A review. International Journal of Innovation Research Study, 2013; 2(12): 489–500. [Google Scholar]
15. Kamble, BB & Meshram CB, A preliminary study on zooplankton diversity of Khatijapur tank, near Achalpur, Dist. Amravati, Maharashtra. J. Aqua. Biol., 2005; 20(2): 45-47.
16. Karus K, Paaverb T, Agasilda H, Zingela P. The effects of predation by planktivorous juvenile fish on the microbial food web. European Journal of Protistology, 2014; 50(2): 109-121. http://dx.doi.org/10.1016 /j.ejop.2014.01.006. [PubMed] [Google Scholar]
17. Kurasawa H, Productivity of communities in Japanese inland waters. Part 9. Zooplankton. In: JIBP Synthesis Vol.10 (Eds) Mori S. & Yomamoto G. Tokyo University Press Tokyo, 1975; 436.
18. Mekong River Commission technical report Identification of Freshwater Zooplankton of the Mekong River and its Tributaries, Cambodia, Lao PDR, Thailand & VietNam. MRC technical paper, April 2015; 45. ISSN: 1683-1489; 1-197.
19. Needham J.G. and Needham P.R. A Guide to the Study of Freshwater Biology. 5th edition. Holden-Day Inc., California, 1972; 108.
20. Pradhan VP, Zooplankton diversity in fresh water Wunna lake. International Journal of Life Sciences, 2014; 2(3): 268-272.
21. Pawar, SK, Madlapure VR and Pulle JS, Study of zooplanktonic community of Sirur dam water near Mukhed in Nanded District, (MS), India. J. Aqua. Biol., 2003; 18(2): 37-40.
22. Patalas K, Crustacean plankton and the eutrophication of St. Lawrence great lakes. J. Fish Res Bd Can, 1972; 29: 1451-1462.
23. Radhakrishna Y and Rangareddy Y. Habitat preferences in some common freshwater calaonid species in the lower deltaic region of the river Krishna. Memoir 1. Society of Zoologists, Guntur, India, 1976; 66-69.
24. Rahkola-Sorsa M, University of Joensuu, The structure of zooplankton community in large boreal lakes and assessment of zooplankton methodology. PhD diss., 2008. [Google Scholar]
25. Ringler FH and Langford RR, Congeneric occurrence of species of *Diaptomus* in Southern Ontario lakes. Can J. Zool, 1967; 45: 81-90.
26. Saler S, Observation on the seasonal variation of rotifer fauna of Keban Dam Lake (Cemisgezek Region) Science and Engineering Journal of Firat University, 2004; 16(4): 695–701. [Google Scholar]
27. Santos-Wisniewski M, Rocha O, Guntzel A, Matsumura-Tundisi T. Aspects of the life cycle of *Chydorus pubescens* Sars, 1901 (Cladocera, Chydoridae) Acta Limnologica Brasiliensia, 2006; 18(3): 305–310. [Google Scholar]
28. Shannon CE, A mathematical theory of communication. The Bell System Technical Journal, 1948, 27: 379–423 and 623–656.
29. Sehgal KL, Planktonic copepods of freshwater ecosystems. Interprint, New Delhi, 1983; 169.
30. Shiel RJ, Cooperative Research Centre for Freshwater Ecology Identification Guide no. 3. Albury: Murray Darling Freshwater Research Centre; A guide to identification of rotifers, cladocerans and copepods from Australian Inland Waters, 1995. [Google Scholar]
31. Sladecek V, Rotifers as indicators of water quality. Hydrobiologia, 1983; 100(1): 169–201. http://dx.doi.org/10.1007/BF00027429. [Google Scholar]
32. Unni KS, Ecology of River Narmada. APH Publishing Co-operation, 5, Ansari Road, Daryagang, New Delhi, 1996; 371.
33. Verma SR, Sharma P, Tyagi AK, Rani S, Gupta AK, *et. al.*,. Pollution and saprobic status of Eastern Kalinade. Limnologica (Berlin), 1984; 15(1): 69-133.
34. Ward HB and Whipple GC Fresh water Biology, 2nd Edition, John Wiley and Sons, New York, 1959.