Limnology of Rankala Lake, Kolhapur.

V. B. Berde[1]* and C. V. Berde[2]

1. Arts, Commerce and Science College, Lanja. Maharashtra.
2. Gogate Jogalekar College, Ratnagiri. Maharashtra.

Abstract- The present study was carried out at Rankala, Kolhapur, Maharashtra. Water was analysed for physico-chemical parameters as well as the zooplankton composition. This study was carried out every month for 2 years. A correlation between the physico-chemical parameters and the plankton abundance was established. Rotifer community exhibited a strong correlation with temperature. Copepoda were the second most abundant zooplankton group in the lake. Biomass was high during winter as compared to other seasons.

Index terms – Zooplankton, physico-chemical, limnology, lake

I. INTRODUCTION

The study of temporal and spatial distribution of zooplankton in relation to various physico-chemical factors forms an important aspect of the freshwater ecology aimed at understanding life in water. Lakes, water reservoirs and streams, which are the most valuable sources of drinking water for the world's population, are vulnerable to pollution and degradation of water quality, particularly to eutrophication. The inland water bodies are closed ecosystems in which zooplanktons hold a key position in the metabolism of water bodies, trophic levels, food chains and energy flow.

For Correspondance:

Dr. Vikrant B. Berde
Assistant Professor,
Department of Zoology, Arts, Commerce and Science College,
Lanja. Maharashtra.

Dr. Chanda V. Berde
Assistant Professor,
Department of Biotechnology, Gogate Jogalekar College,
Ratnagiri. Maharashtra.

Planktons, both producers and consumers, play an important role in the transformation of energy from one trophic level to the next higher trophic level ultimately leading to fish production which is the final product of the aquatic environment. From ecological point of view, rotifers, cladocerans and copepods are considered to be the most important components, which play a vital role in energy transformation. The occurrence and abundance of zooplankton in freshwater ecosystem depends on its productivity, which in turn is influenced by physico-chemical parameters and level of nutrients. Further, the diversity and density of zooplankton populations occur in succession depending upon interspecific and intraspecific nteractions and predation potential (Fernando, 1980a).

II. MATERIALS AND METHODS

Study area: For physico-chemical analysis of the water bodies, water from three pre-designated sites from the water bodies under study was collected. Collections were made by using plastic containers of two litre capacity. The plastic containers were rinsed thoroughly before use. The collected samples were analysed by following standard methods (APHA, 1989) and by using water testing kits manufactured by C. P. R. Foundation, Chennai, India. Water temperature at each sampling point was recorded on the day of collection using a centigrade thermometer. The hydrogen ion concentration (pH) was measured at three sampling stations using a grip pH meter (Systronics). The alkalinity, hardness, calcium, chlorides, iron, magnesium, phosphates and sulphates were estimated using water testing kits generated by C. P. R. Foundation, Chennai, India.

Zooplankton samples were collected by means of a plankton hand net of bolting nylon cloth (mesh size 45 µm). The net was prepared according to the design given by

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Welch (1952). Samples were collected by filtering 50 litres of water through net, from each water body in early morning hours (between 8 to 11 a.m.), once a month for a period of two years *i.e*. February 2011 to December 2013.

The procedures for collection, storage and analysis of samples were followed as described in standard methods (APHA, 1989). Inorder to collect the zooplankton species adhering to the weeds, weeds were taken into a bucket and rinsed vigorously. The water from the bucket was seived through the bolting nylon cloth. The zooplankton samples were preserved in 4% neutral formalin solution. The samples were tagged for biomass, taxonomical and numerical studies. The individual species of zooplankton were sorted out and their whole mounts were stained with borax carmine, Lugol's iodine or methylene blue, according to the requirements.

Some species were dissected for taxonomically important body parts and were processed in a similar manner. Pointed entomological forceps and needles were used for handling and dissecting the zooplankton. Camera lucida drawings of the entire body or body parts were made under suitable magnifications for detailed studies. At the same time, some species were subjected for microscopic photography under suitable magnifications of stereoscopic microscope, inverted and trinacular microscope.

For the numerical estimation, the organisms were observed under light microscope using "Sedgwick Rafter Cell" as per the procedure given in the standard methods (APHA, 1989). Average of 5 to 10 counts for each sample were taken into account and results are expressed as number of organisms per litre by using the formula:

$$n = \underline{(a \times 1000)\ c}$$

Where, n = number of planktons per litre of water

a = average number of planktons in 1 ml of subsample

L = volume of original water sample in litre

c = ml of plankton concentrate

The biomass of zooplankton was determined by displacement method (APHA, 1989) and results are expressed in terms of ml of biomass per 100 ml of water filtered.

Zooplankton was identified upto species level, using standard literature (Pennak, 1953; Dumont and Tundisi, 1984; Michael and Sharma, 1988; Battish, 1992; Edmondson, 1992; Dhanapathi, 2000).

III. RESULTS AND DISCUSSION

The study of physico-chemical parameters and their effects on the biological parameters are important in understanding the trophic state of a water body. Each factor plays its role in regulating the ecosystem of the water body. The concentration of the various constituents along with factors such as rainfall, agricultural runoffs are also of equal importance. The changes in one factor is directly or indirectly related to the other factors.

Fig.1. shows the physico-chemical parameters recorded for Rankala lake during 2011 - 2013. A pH range of 6.5 and 7.6 was noted in November '11 and May '11, respectively, while temperature was maximum at 35.5 ^{o}C in May '11 and minimum at 20.4 ^{o}C in December '12. Alkalinity ranged from 88 ppm recorded in July '12 to 240 ppm in May '11, while hardness was in the range of 92 ppm in November '11 and 185 ppm in August '12. Calcium was present maximally at 118 ppm concentration as calculated in the month of August '12 and was minimum at 48 ppm in the month of August '11.

Lowest concentration of chlorides was 39 ppm in the month of August '11, while highest concentration was 108 ppm in October '11. Iron showed its maximum presence at 0.7 ppm in October '11, November '11, July '12 and October '12, while a minimum of 0.3 ppm was present during March '12 and September '12. Maximum phosphates were found at 0.7 ppm concentration in November '11, December '11 and August '12 whereas, minimum concentration of 0.3 ppm of the same was noted in February '11, May '11, February '12 and April '12. Magnesium and sulphate ranged between 19 ppm in June '12 to 100 ppm in June '11 and 109 ppm in January '12 to 190 ppm in June '12, respectively.

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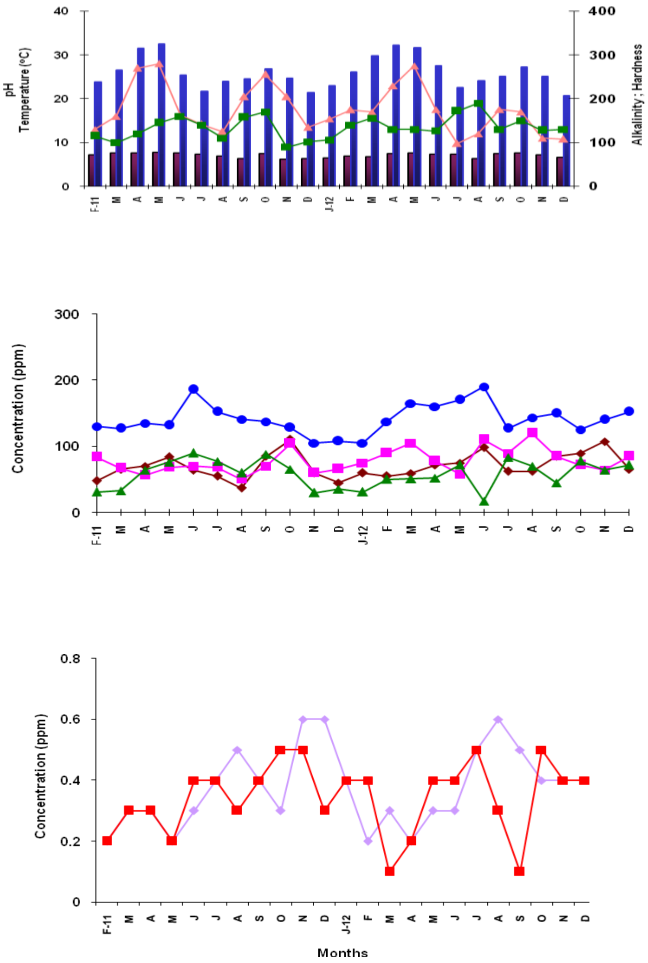

Key: , Temperature; , pH; , Alkalinity; , Hardness; , Sulphate; , Chlorides; , Calcium; , Magnesium; , Phosphate; , Iron

Fig. 1. Physico-chemical parameters of Rankala lake during 2011 - 2013

Natural waters rich in dissolved organic matter, tend to have low pH values. Humic and fulvic acids released from dead and decaying organic matter contribute to the acidic nature of water during summer, along with reduced water volume due to evaporation (Philips, 1964). Studies have shown that organic acids can alter the acidity as well as modify the changes due to strong acid inputs, thus offering a large buffering capacity (Lydersen, 1998). Aquatic life is favoured by a pH range between 6.1 to 6.63 (Trivedi and Raj, 1992). At lower pH values between 5.0 and 5.5, though growth rates were higher, reproductive parameters such as fecundity, frequency of reproduction, brood size, size at maturity, *etc*., were reduced as compared to the same at neutral to alkaline pH (Chandini, 1987). Rasool *et.al*. (2003) have also recorded alkaline pH of the water of Rankala lake.

The pH of tropical water bodies is influenced by its surroundings and hence differs from one water body to another. W.H.O has recommended water of pH range of 6.5 - 8.5 suitable for drinking purposes. Whereas, higher pH values above 9.5 are reported to cause zooplankton mortality (O'Brien and de Noyelles, 1972). Freshwater has weaker buffering capacity as compared to saline water. The pH of water body is dependent or is regulated by carbon dioxide - bicarbonate - carbonate system (Zafar, 1966). Water tends to be alkaline when these ions are present in high quantities. Hazarika and Dutta (1994) have reported the probable reason for alkaline pH to be calcium carbonate concentration.

High values of chlorides, phosphates and sulphates in the Rankala lake have been also reported recently by Rasool *et.al*. (2003). Water inflow along with organic matter, so also, decomposition of aquatic plants and organisms contribute to the chloride content. Biological oxidation, detergents, fertilizers, leaching into the water results in increased amount of phosphates in this water body.

The data on Rankala lake revealed a sudden increase in the biomass in August and September of '11, which peaked in the month of December '11 at 2 ml/111 ml of filtrate (Fig. 2). The population density of zooplankton was also the highest in this month (5200 individuals/L), contributed by rotifer population of 1550 individuals/L, cyclopoida population of 1110 individuals/L and copepoda larvae population of 1650 individuals /L. A similar pattern was observed for '12, where the biomass showed a peak in November at 1.8 ml/111 ml of filtrate and the dominant fauna were rotifers. However, the zooplankton density was highest with 4730 individuals/L in December and the groups contributing to this density were rotifer population of 1635 individuals/L and cyclopoida population of 1240 individuals/L. Lowest zooplankton count was found during July '11 and October '01 with 1747 and 1800 individuals/L, respectively.

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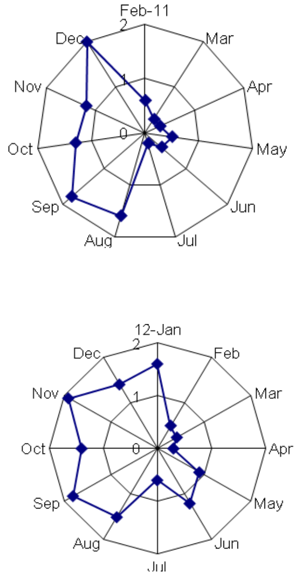
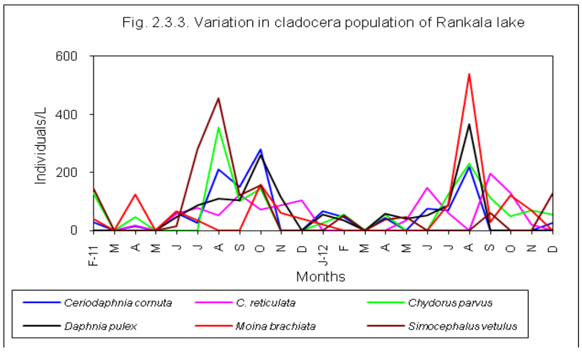
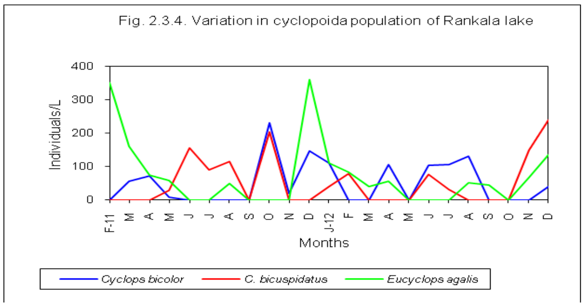


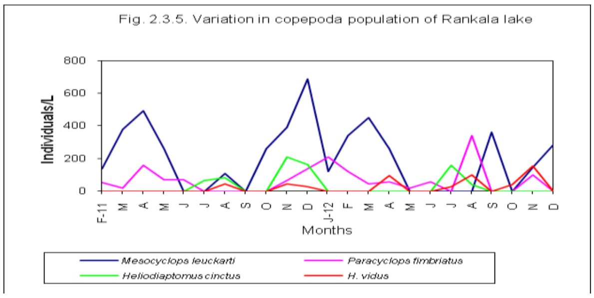
Fig. 2 Zooplankton biomass of the Rankala lake during 2011 - 2013

The highest density in the lake was of rotifers, while calanoids were least dense. The percentage of abundance of zooplankton was found in the following descending order: rotifera (45.99 %) > copepoda larvae (18.04 %) > cyclopoida (15.11 %) > cladocera (15.01 %) > others (below 10 %).

Rankala lake had 20 species of cladocerans. The species encountered in Rankala lake were *Alona costata*, *Alonella excisa*, *Chydorus ovalis*, *Alona gutttata*, *Ceriodaphnia cornuta*, *C. pulchella*, *C. reticulata*, *Chydorus parvus*, *Daphnia pulex*, *Diaphanosoma senegal*, *Indialona ganapati*, *Leydigia acanthocercoides*, *Macrothrix spinosa*, *Pleuroxus aduncus*, *Bosminopsis deitersi*, *Polyphemus pediculus*, *Pseudochydorus globulus*, *Pseudosida bidentata*, *Simocephalus acutirostratus* and *S. vetulus*. In Rankala lake, cladocera species were at peak counts in August of both years with the most populous species being *Simocephalus vetulus* (455 individuals/L) during 2011 and *Moina branchiata* (540 individuals/L) during 2012, as shown in Fig. 2.3.3. Composition of copepoda species in Rankala lake are graphically presented in Figs. 2.3.4 and 2.3.5. A total of 12 species were detected from this lake. The most populous species of calanoida and cyclopoida detected during the study period were *Heliodiaptomus cinctus*, *Heliodiaptomus viduus* and *Mesocyclops leuckarti*.







Pearson's bivariate correlation was analysed for physico-chemical parameters and zooplankton abundance in the Rankala lake and the results are given in Table 1. A strong correlation was observed between temperature and cladocerans, while weak correlation was seen with harpacticoids and *Heliodiaptomus cinctus*. Water pH showed statistically significant correlation with rotifers and weak correlation with *Anuroeopsis fissa*, *B. patulus* and *Heliodiaptomus cinctus*. Alkalinity showed a weak correlation with cyclopoids. Strong correlation was seen for hardness with *K. tropica* and *Moina branchiata*, whereas the correlation was weak with rotifers, *B. patalus*, *Ceriodaphnia cornuta*, *Daphnia pulex*, *Eucyclops agalis* and *Mesocyclops leuckarti*. Calcium exhibit only weak correlation with *Daphnia pulex*, *Moina branchiata* and *Cyclops bicolor*, while chlorides had weak correlation with calanoids, *Eucyclops agalis* and *Heliodiaptomus cinctus*. No correlation was noted between iron and zooplankton fauna. Magnesium demonstrated strong correlation with rotifers, *B.*

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angularis, B. patulus and *K. tropica*, apart from having a weak correlation with *Eucyclops agalis* and *Mesocyclops leuckarti.* Cladocerans, calanoids, ostracods and *Heliodiaptomus cinctus* demonstrated strong correlation with phosphates, while *D. negrensis* was weakly correlated with the same. Suphate content showed low correlation with harpacticoids and *Heliodiaptomus cinctus.*

In conclusion, the density of rotifers were recorded more than any other group of zooplankton followed by larval stages of copepod and then adult copepods and cladocerans. The harpacticoids and ostracods were the least recorded groups and were not present in all seasons. Statistical analysis shows that there is positive as well as negative correlation between zooplankton species and physico-chemical parameters, confirming intricate interaction between and among these parameters.

Table 1: Pearson's bivariate correlation for physico-chemical factors and zooplankton abundance in Rankala lake

	Temp (^{0}C)	pH	Alkalinity	Hardness	Ca^{+2}	Cl^{-1}	Fe^{+3}	Mg^{+2}	PO_4	SO_4
Average values	25.8	7.14	175.3	137.2	79.0	69.6	0.34	59.6	0.368	142
Rotifera	-0.383	-0.707**	-0.341	-0.478*	0.130	-0.106	0.010	-0.635**	0.304	-0.196
Cladocera	-0.540**	-0.312	-0.390	0.333	0.171	-0.180	0.330	0.238	0.599**	-0.107
Cyclopoida	-0.285	-0.112	-0.416*	-0.322	0.062	-0.003	-0.225	-0.410	0.082	-0.151
Calanoida	-0.395	-0.375	-0.375	-0.184	-0.281	-0.424*	0.198	0.001	0.668**	-0.275
Copepod larva	0.057	-0.169	0.213	-0.140	-0.161	0.113	0.361	0.046	0.144	-0.035
Harpacticoida	0.474*	0.108	0.304	0.234	0.129	-0.057	-0.255	0.132	-0.159	0.422*
Ostracoda	-0.188	-0.228	0.002	0.179	-0.040	0.156	0.070	0.196	0.627**	-0.144
Anuroeopsis fissa	-0.178	-0.454*	-0.163	-0.129	0.105	-0.05	-0.067	-0.206	0.012	-0.010
K. tropica	-0.167	-0.056	-0.287	-0.572**	-0.042	0.175	-0.142	-0.623**	0.089	-0.059
Brachionus angularis	0.000	-0.26	0.086	-0.38	-0.003	-0.237	-0.227	-0.527**	-0.193	-0.404
B. patulus	-0.275	-0.513*	-0.265	-0.502*	0.023	-0.313	0.047	-0.569**	0.219	-0.167
Ceriodaphnia cornuta	-0.187	-0.205	-0.034	0.469*	0.377	0.102	0.234	0.209	0.173	-0.001
Daphnia pulex	-0.176	-0.316	-0.022	0.522*	0.466*	0.069	0.281	0.187	0.369	-0.065
Moina branchiate	-0.124	-0.206	-0.155	0.541**	0.461*	0.061	0.115	0.218	0.412	-0.108
Cyclops bicolor	-0.077	-0.129	0.073	0.166	0.441*	0.187	0.211	-0.209	0.164	-0.236
Eucyclops agalis	-0.312	-0.236	-0.311	-0.472*	-0.083	-0.452*	-0.358	-0.476*	-0.008	-0.388
Mesocyclops leuckarti	0.107	-0.178	0.172	-0.465*	-0.125	-0.21	-0.408	-0.448*	0.047	-0.369
Heliodiaptomus cinctus	-0.441*	-0.462*	-0.282	-0.237	-0.211	-0.444*	0.296	-0.128	0.709**	-0.461*

Key: * $P < 0.05$, ** $P < 0.01$ Except for temperature and pH, all parameters are in ppm

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