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Zooplankton Diversity Indices and Seasonal Variations in Kadwai Reservoir, Ratnagiri District, Maharashtra, India

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Abstract: *Zooplankton diversity and its seasonal variations were studied in Kadwai reservoir of Ratnagiri district, Maharashtra. The sampling was conducted during the monsoon and post monsoon seasons from 1st June to 1st November, 2015 to know the zooplankton population in the reservoir. Qualitative estimation was done by using light microscope up to the genus level, and quantitative estimation of zooplankton by using Sedgewick-Rafter cell (S-R cell). The results showed that, the zooplankton density being 770 nos/ml in the reservoir with a composition of rotifers (117), cladocerans (401), copepods (150) and protozoa (102). The species diversity of zooplankton was determined by using diversity indices like Shannon-wiener, Simpson diversity index, and species evenness, and the maximum values of 2.28 to 2.29, 0.79 to 0.87, and 0.98, were recorded respectively in October and November month of post monsoon. The minimum values of 2.19 to 2.20, 0.77 to 0.80, and 0.77 were recorded respectively in June, July and August month of monsoon season. The season-wise and month-wise zooplankton analysis showed an average abundance of species lower in monsoon due to inflow of water and less photosynthetic activity by primary producers and the maximum occurrence indicating that Kadwai reservoir contains more zooplankton during post monsoon season. On the contrary, the zooplankton showed a maximum occurrence in post monsoon indicating availability for stocking fish seed during that season.*

Keyword: *Plankton, Zooplankton, diversity indices, Simpson's diversity index, Shannon-Weaver index, Taxon Evenness, Kadwai reservoir.*

INTRODUCTION

The term "Plankton" was first time used in 1887 by Victor Hansen [1]. To designate the heterogenic assemblage of minute microscopic single cell organism and the detritus in water [2]. Guy stated that productivity of any aquatic water bodies depends on amount of plankton present in the water body [3].

The plankton occurs usually in all the natural water bodies as well as in man-made impoundment like ponds tanks, reservoir, and irrigation channels etc. The primary production of organic matter is in the form of phytoplankton's which are more intense in reservoir, lake than in rivers [4]. The composition and biomass of phytoplankton and zooplankton species in reservoirs depends on a complex combination of factors, such as temperature, light, and availability of nutrient [5]. Zooplankton are microscopic free swimming diverse group of minute floating animal forms found in aquatic ecosystems, are represented as Protozoa, Rotifera, Cladocera, Crustaceans and Copepoda. The study of zooplankton community is important as its provides way of predicting productivity of water bodies and it is one of the principle links in the food chain [6]. Due to the prolonged monsoon in Konkan region, almost all the reservoirs are full of water. The water bodies are not utilized for fish production. The fish production of these reservoirs are very low, due to

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the availability of natural food like phytoplankton and zooplankton. There is no scientific data on plankton diversity are available. Therefore, the present study of zooplankton communities and analysis of zooplanktons by using diversity indices like Shannon-Weaver index, Simpson's diversity index and Taxon evenness structure and composition of total zooplankton to predict the water quality and aquatic health for sustainable management of Kadwai reservoir ecosystem of Ratnagiri district were conducted from June 2015 to November 2015.

MATERIAL AND METHODS

Study Area

Kadwai reservoir, located about 3 km away from the Kadwai village, Tal. Sangameshwar, Dist. Ratnagiri. It is formed by constructing a stonework dam across the Kadwai basin in the year 1982 at the Latitude 17° 16′ 55.4" N and Longitude 73° 33′ 52.4" E. The total area of Kadwai reservoir is 14 hectors and water spread area is 22 ha and average water depth is about 11.75 m (Fig. 1).

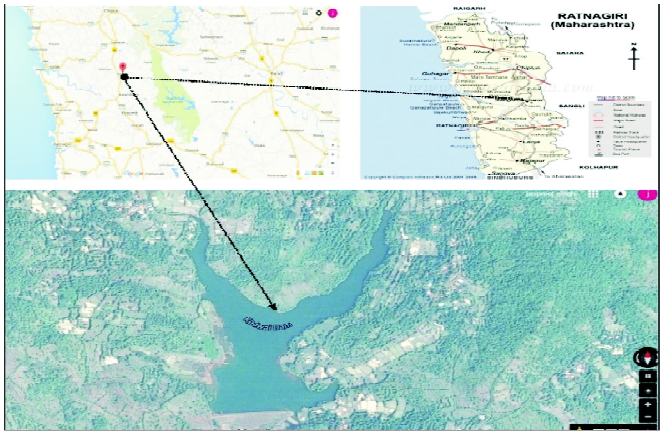

Figure 1: Kadwai reservoir, Sangmeshwar, Ratnagiri, Maharashtra

Plankton Sampling and Analysis

The study of plankton diversity indices, samples was collected on monthly basis; the present study was carried out from 1st June 2015 to 1st November 2015 for 180 days period to analyze the planktons of Kadwai reservoir. The surface water of the reservoir are collected during early hour of day by filtering 50L of water through bolting silk net (No. 25) and preserved in 5% formalin and concentrated to 10 ml [7]. The samples were analyzed qualitatively under the microscope for different types of zooplanktons and the quantitative assessment was done by using Sedgewick-Rafter Cell of (50 x 20 x 1 mm) to hold a plankton sample of 1 ml and expressed as numbers per liter [8]. Standard identification keys were used for identification of zooplankton [9, 10, 11].

Diversity of zooplankton was studied by Lackey's drop count method [12] and species observed under light microscope and photographs were taken on Motic BA210. The total number of zooplanktons present in a litre of water sample calculated by using following formula:

$$\mathbf{N = n \times v / V}$$

Where,

N = Total no. of organisms/ lit of water filtered,

n = Number of organisms counted in 1 ml plankton of sample,

v = Volume of concentrate plankton sample (ml),

V= Volume of total water filtered through (L)

The species diversity of zooplankton was determined by using diversity indices like Shannon-Weaver index, Simpson's diversity index and Taxon evenness [13, 14].

Simpson's diversity index

The Simpson's diversity index (D) is calculated using the following equation:

$$D = \frac{\Sigma_{i=1}^{s} ni(ni-1)}{n(n-1)}$$

Where, ni = proportion of the i^{th} taxon in the community.

s = number of taxa.

n = number of species

Shannon-Weaver index

This is widely used method of calculating biotic diversity in aquatic and terrestrial ecosystems and is expressed as:

$$H = -\sum_{i}^{s}(pi)(\log 2\, pi)$$

Where, H = index of species diversity

s = number of species

pi = proportion of total sample belonging to the i^{th} species.

Taxon Evenness

This is relative distribution of individuals among taxonomic groups within a community and is expressed as:

$$E = \frac{H}{In(D)}$$

Where, E = Taxon Evenness,

D = Taxon Dominance defined as total no. of distinct taxa in a population.

H = index of species diversity

RESULT AND DISCUSSION

In this study of zooplankton were represented by four groups of phylum viz. Rotifera, Cladocera, Copepoda and Protozoa. Among all cladocera, copepoda, and rotifera were dominant as compared to other group of zooplanktons protozoa throughout the study period (Fig. 2).

The total numbers of species recorded were 770 of which Rotifers (117), Cladocera (401), Copepods (150), and Protozoa (102). It was noticed that cladocerans contributes a major part of zooplankton populations. Values of zooplankton species in Kadwai reservoir were showing in Table 1.

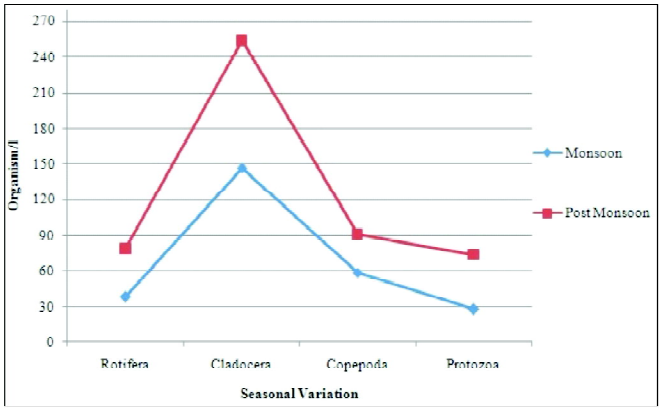

Figure 2: Seasonal Variation in zooplankton groups from 1st June 2015 to 1st Nov 2015

Table 1
Values of Zooplankton Species Diversity Indices

Month-wise Diversity indices	*June*	*July*	*Aug*	*Sept*	*Oct*	*Nov*
Shannon-Wiener Index	2.20	2.19	2.23	2.27	2.29	2.28
Simpson Index	0.77	0.77	0.78	0.79	0.86	0.87
Species Evenness	0.95	0.94	0.96	0.98	0.98	0.98

The Shannon-wiener index, Simpson index and Species evenness maximum values of 2.28 to 2.29, 0.79 to 0.87, and 0.98 was recorded during October and November in post monsoon season and minimum values of 2.19 to 2.20, 0.77 to 0.80, and 0.77 respectively, in June, July, and August in monsoon season (Fig. 3).

Protozoa: These are the very diverse group of unicellular eukaryotic organisms any of which are motile [15]. In present study protozoa was represented by vorticella species (Fig. 4 and Fig. 5, a). The abundance of protozoas was higher in post monsoon season and rarely found in monsoon season. The average abundance of protozoas ranged from 10-22 org/l.

Rotifera: These organisms considered as the most important soft body invertebrates and a second dominant group of zooplankton in respect to average abundance from 11-32 org/l. Rotifera was most abundance in post monsoon and least in monsoon season (Fig. 2). The brachionus species was dominant throughout the study period (Fig. 4 and Fig. 5, b). Bhowmic observed that increased in zooplankton population in post monsoon season due to increased in photosynthetic activity in water bodies [16]. According to Adoni stated that increased in rotifer diversity due effect of eutrophication [17]. Similar trend of diversity in zooplankton population observed in Ramgarh lake Gorakhpur [18].

Cladocera: Singh et al. reported that abundance in density and biomass of cladocera was determined by food supply [19]. In present work similar observation was observed due to maximum

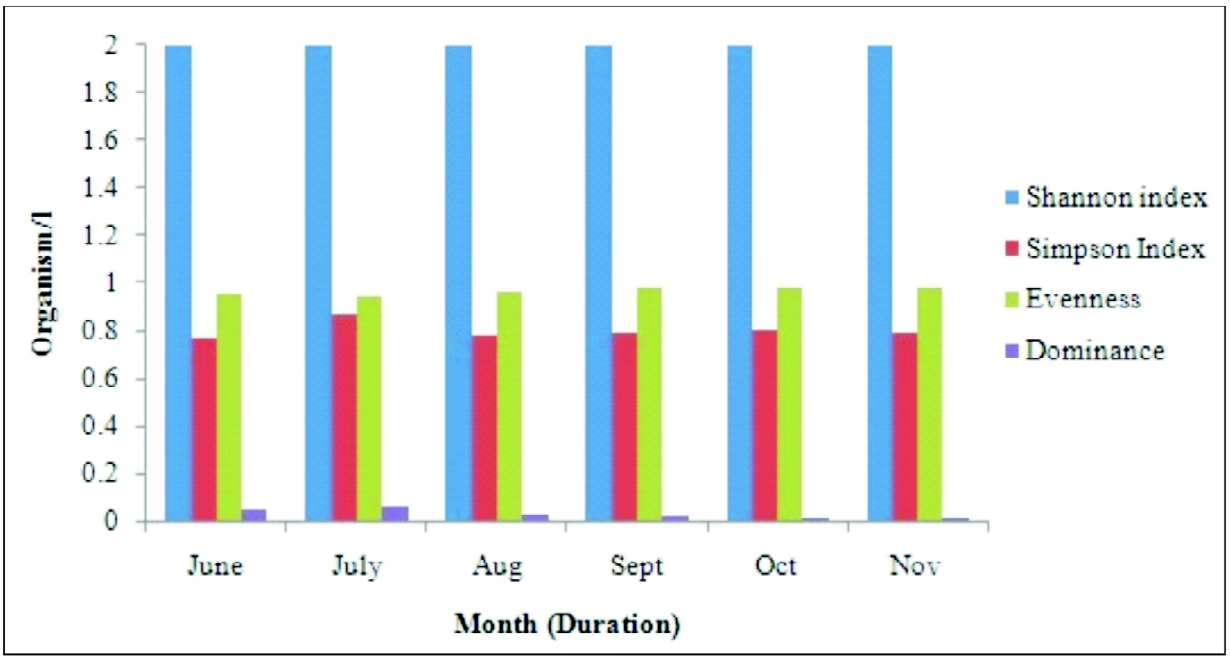

Figure 3: Zooplankton species diversity

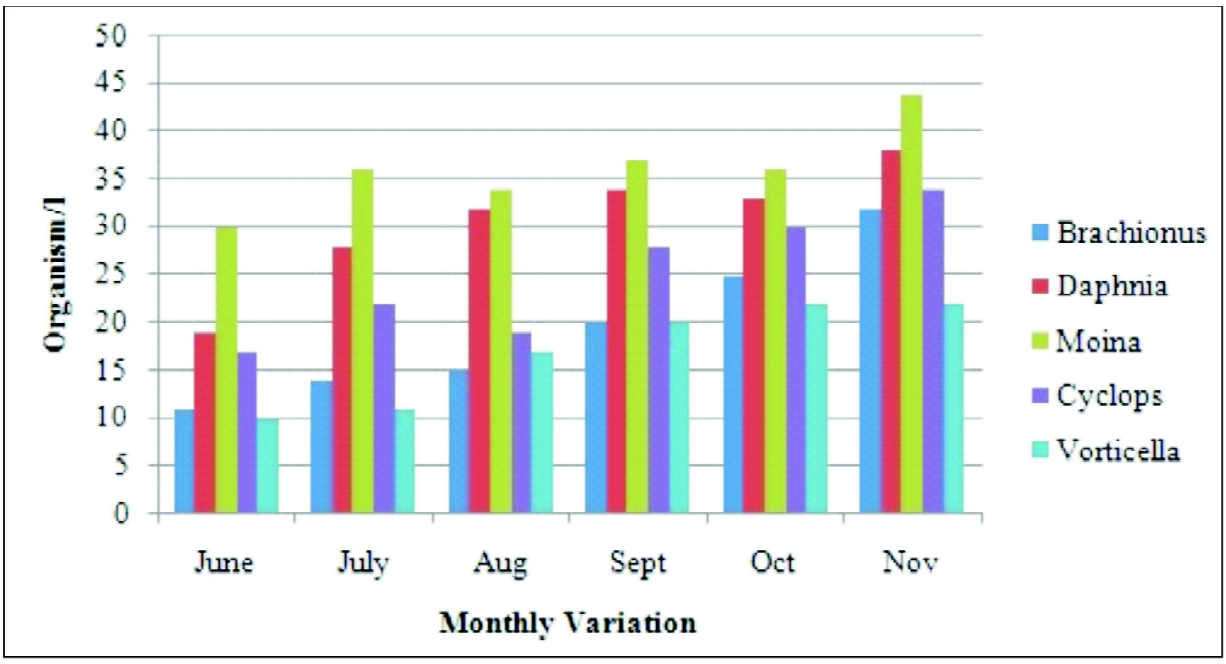

Figure 4: Variation in Zooplankton species from 1st June 2015 to 1st Nov 2015

abundance in food supply (phytoplankton) in post monsoon season. Cladocera ranged from 19-44 org/ l higher as compared to other group of zooplanktons (Fig. 2). Under cladocera, moina and daphnia species was dominant throughout the study period (Fig. 5, c and d). During post monsoon season maximum abundance observed in cladocera population and whereas, minimum in monsoon season. Qadri and Yousuf observed that during summer the cladocera population was moderate due to dense growth of rotifers and it is found that the temperature is the primary factor affecting the occurrence and distribution of cladocera [20]. In present study, it has been observed that population of rotifera and cladocera was maximum throughout the study period.

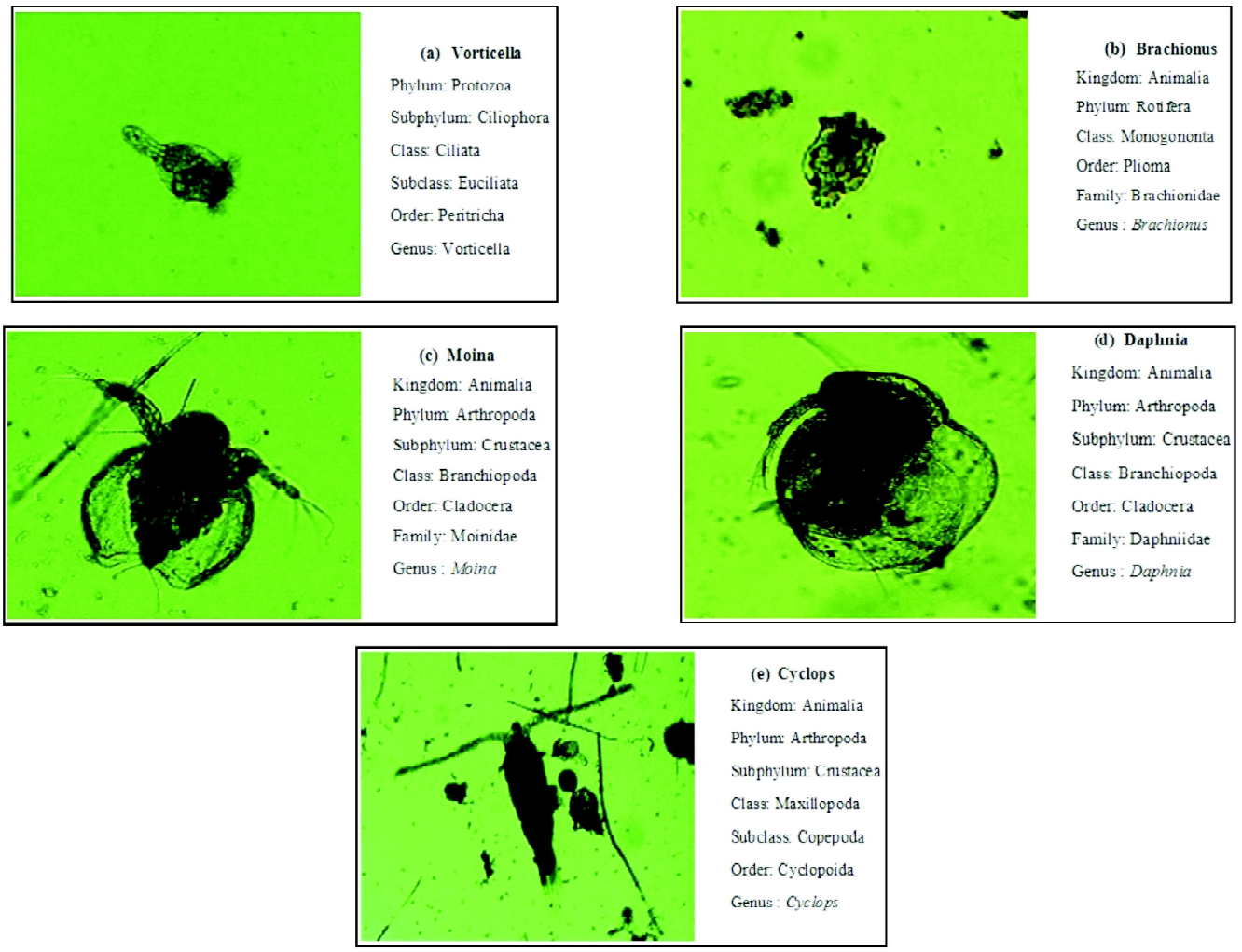

Figure 5: Zooplankton species as seen under light microscope and photography by Motic BA210: a: Vorticella, b: Brachionus, c: Moina, d: Daphnia, e: Cyclops

Copepoda: The copepods are most dominant group of zooplankton population. In present study, copepods were abundant throughout the study period. The abundance of copepod more or less higher in post monsoon and minimum in monsoon season (Fig. 2). Cyclops was dominants during study (Fig. 5, e). It was ranged from 17-34 org/l. This group of zooplankton population constitutes a major zooplankton communities occurring in almost all the water bodies, which serve food for many fish and play vital role in ecological pyramids [21].

Therefore, in this particular study the diversity of zooplankton showed distinct seasonal variation and all group of zooplankton population have shown their own maximum and minimum abundance or peaks during a particular season.

CONCLUSION

In present work overall view reveals that the fluctuation of zooplankton occurs distinctly in the study area and normally in monsoon there is less population due to dilution factors in reservoir and its effects leads to less photosynthetic activity by primary producers. The population raises bit higher level during post monsoon due to favourable environmental conditions and presence of excess food supply in the form of bacteria and suspended detritus. In post monsoon where inflow is less to compare with other seasons resulted in stability of water body and availability of food is more due to decomposition of organic matter and the density of zooplanktons were high due to less predators, which serves as food for many fishes and suitable

for stocking fish seed in the post monsoon for development of culture-based capture fishery in this reservoir.

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