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Diversity of Planktonic Rotifers from Enamakkal Lake, Kerala, India

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Abstract: Zooplankton occupy the central ecological position in the aquatic food web. They are known as staple food item of fishes especially the larvae of fishes. Rotifers are among the major groups of zooplankton. The present investigation was carried out in Enamakkal lake (Lat. 10.5059°N and Long. 76.0848° E) at Thrissur District, Kerala, India. The planktonic rotifers diversity was studied for a period of one year from October-2018 to September-2019. During the present study, 10 genera of planktonic rotifers were recorded. Out of the 10 genera, *Brachionus* was recorded from all months and it formed the dominant rotifer in all seasons. In monsoon the diversity of Rotifers was greater than that of pre-monsoon and post-monsoon. Among the various species encountered during the present study, the maximum diversity and abundance were seen in the *Brachionus* sp., represented by 11 different species in monsoon. In pre-monsoon only *Brachionus* sp. was present. In pre-monsoon and post-monsoon *B. rotundiformis* and *B. plicatilis* were the abundant species.

Keywords: Zooplankton, Rotifera, Brachionidae, Biodiversity, Enamakkal lake, *Brachionus*

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Introduction

Zooplankton plays a pivotal role in the aquatic food chain. They graze on phytoplankton and in turn form the food for higher trophic organisms. The zooplankton production assessment can give the approximation of the fish population (Tiwari and Nair, 1991). Rotifers are among the major groups of zooplankton. They are considered as bioindicators of water quality since they are sensitive to environmental parameters (Gannon and Stemberger, 1978). The production and temporal variation in rotifer population is influenced by intricate interaction of various physical, chemical, biological, geographical and ecological parameters (Hulyal and Kaliwal, 2008). They occur in all types of fresh and saline water habitats. Estuarine rotifer fauna forms a major portion of zooplankton during certain seasons (Nair *et al*., 1984). *Brachionus plicatilis* species

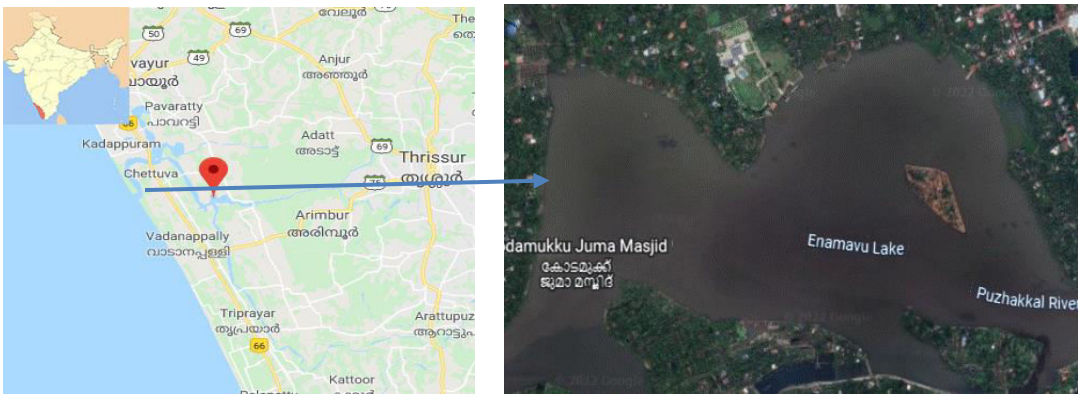

Fig. 1: Map of study area with sampling locations (source: google map).

complex is the widely known brackish water rotifer and play a crucial role in the form of primary live food 6for shrimp larvae and marketable fish production (Lubzens *et al*., 2001). Nayar and Nair (1969) reported 15 species of rotifers of the family Brachionidae, collected from different areas in Kerala, India. Cleetus *et al.* (2015) observed 26 species of the rotifers belonging to 10 families, with maximum abundance of *Brachionus* sp. (60%) in Vembanad estuary, Kerala, India. Asha *et al*. (2020) have studied different zooplankton groups from southern part of Vembanad estuary of which rotifers constituted 14%. Anitha and Rani (2016) reported 42 species of rotifers belonging to 16 genera from two low- saline back waters of Kerala and the family Brachionidae was the predominant one in their investigation. A total of 40 species of rotifers belonging to 15 genera and 10 families were recorded by Fathibi *et al*. (2020) from Thrisssur Kole wetland and these are dominated by the family Brachionidae. In this context, the present study describes diversity, periodic occurrence of planktonic rotifers from Enamakkal area of Thrissur district, Kerala, India.

Materials and Methods

Enamakkal lake is a backwater lake situated at Enamakkal of Thrissur district in Kerala and it lies in line with Thrissur kole wetlands. The lake covers about 25 km^2. It lies at a Latitude 10.5059^0 North and Longitude 76.0848^0 East (Fig. 1).

The study was carried out on a monthly basis from October 2018 to September 2019. Rotifer collections were made after sunset from surface of the water column at different sites by filtering 100 L of water through conical plankton net of bolting silk having a mesh size of 50 µm. It is then preserved in 4% formaldehyde and identified using standard key and literature (Ward and Whipple, 1958; Sharma, 1983; Battish , 1992). The density of rotifers was determined following the Sedgwick-Rafter cell method under a light microscope with 40x – 100x magnification and count of organisms were expressed in Ind./m^3 (Welch, 1948).

Individuals/cubic meter, D = n x Vs x S/Na x V

Where, n = no. of organisms counted; Vs = volume of the sub sample concentrate (ml); S = Split factor; Na = volume of the aliquot enumerated (ml); V = volume of water filtered (m^3).

Month wise data for a period of 1 year were grouped for this study from October, 2018 to September, 2019. For seasonal studies, October-January was treated as post-monsoon, Feb-May as pre-monsoon and June–September as monsoon. The rotifers of all the eight sampling sites for individual months were clubbed and month-wise distribution and contribution of rotifers was carried out. Month wise diversity indices were calculated using the PAST software and mean of October-January was taken as post-monsoon,

February-May as pre-monsoon and June–September as monsoon.

Bray Curtis similarity coefficients were calculated for studying the month wise species composition similarity. The similarity is taken as 1 when the two samples are totally similar and as 0 when the samples are totally dissimilar. In Cluster analysis, Paired group (UPGMA) clustering and Bray Curtis similarity index was used to construct the map. All the univariate and multivariate analysis for the diversity profile were done using Past 4.12b.

Results and Discussion

Quantitative distribution:

Seasonal diversity variation of rotifers is given in Tables 1 to 3. Average density of rotifers from the study area during the post-monsoon period was 41.13±15 numbers per m^3. Density of rotifers was maximum at site 2 (59.5±57.2 per m^3) followed by site 1 (55.5±63.2 per m^3). But it was the least at site 5 (20.75±23.5 per m^3) (Fig. 2). In monsoon season the average density of rotifers was 137±33 numbers per m^3. In the majority of stations, rotifer density was higher during monsoon. Density of rotifers was maximum at site 2 (182.5±59 per m^3) followed by site 1 (178.25±121.38 per m^3). But it was the least at site 5 (97.75±25 per m^3). In pre-monsoon season the average density of rotifers was 71.9±25 per m^3. Site 4 showed maximum density of 127.5±153.3 numbers per m^3 and site 5 recorded least density (39.5±29.15 per m^3). From the season wise analysis, monsoon was observed highest density of rotifers than post-monsoon and pre-monsoon. Nandan (1991), Harikrishnan (1993) and Anuradha (1996) documented the presence and density of rotifers in various brackish water locations of southern Kerala while, studying the plankton communities in these areas. The distribution and abundance of the rotifer population in a particular aquatic ecosystem are significantly influenced by environmental factors.

Qualitative distribution:

During the present study, 10 genera of planktonic rotifers were recorded from the eight sampling sites (Table 4). They were *Asplanchna*, *Brachionus*, *Keratella*, *Platyias*, *Trichocerca*, *Filinia*, *Mytilina*, *Euchlanis*, *Lecane* and *Polyarthra*. Out of the 10 genera, *Brachionus* was recorded from all months and it was maximum in June (216 No/m^3) (Fig. 3). Month wise contribution of rotifers is given in Figure 3. Keratella recorded from July to October and October showed the maximum abundance of 37 individuals per m^3 (Fig. 3). Lecane sp. and Filinia sp. also showed maximum density in October with 32 and 21 individuals per m^3 (Fig. 3). The *Brachionus* species formed the dominant rotifer in all seasons. Among the various species encountered during the present study, the maximum diversity and abundance were seen in the *Brachionus* sp., represented by 11 different species in monsoon. In pre-monsoon only *Brachionus* sp. was present as stated by Sharma (1983, 1987) that in warmer parts of peninsular India and tropical regions *Brachionus* sp. constitutes the dominant rotifers in total rotifers. *Brachionus* is also considered as an indicator of eutrophication (Bahura *et al*., 1993). Rise in rotifer density shows progressing eutrophication (Gannon and Stemberger, 1978).

To study and compare the rotifer diversity during the study period, the data was subjected to diversity analysis. The diversity of zooplankton was assessed using Shannon-Wiener index [H], Simpson index [1-D], Margalef index and Pielou's evenness index (Tables 1-3). The Shannon-Weiner's diversity index which is the commonly used diversity measure marked the highest value of 2.13±1.16 at site 1 (monsoon) and the lowest value of 0.5±0.05 in site 3 (pre-monsoon). ANOVA of Shannon diversity exhibited significant difference ($p<0.01$). Dhuru *et al*. (2015) observed maximum diversity during the post-monsoon, whereas minimum diversity in winter. Similar to Shannon diversity species richness was high in monsoon at site 1 with a total of 15±8.8 species. The Margalef's richness Index which incorporates the number of individuals and species number, showed a higher value 2.94±1.86 at site 1 (monsoon) and a lower value of 0.3±0.13 at site 6

Table 1: Diversity indices of rotifers in monsoon

Diversity indices	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**
Species number (mean± SD)	15±8.83	12±7.26	7±4.08	9±5.72	10±6.16	10.75±7.2	9.5±6.14	8.5±4.65
Abundance (mean± SD)	178±121.4	182.5±59	126.7±99	164±144	97.75±25	124.5±52	114±66.2	108.7±76
Simpson_1-D (mean± SD)	0.74±0.33	0.65±0.37	0.67±0.26	0.64±0.26	0.73±0.26	0.71±0.24	0.72±0.28	0.69±0.26
Shannon H (mean± SD)	2.13±1.16	1.7±1.06	1.52±0.77	1.51±0.79	1.82±0.9	1.75±0.89	1.76±0.91	1.64±0.78
Evenness e^H/S (mean± SD)	0.79±0.16	0.62±0.16	0.78±0.07	0.66±0.17	0.79±0.04	0.71±0.1	0.78±0.04	0.75±0.13
Margalef (mean± SD)	2.94±1.86	2.16±1.44	1.44±1.1	1.89±1.38	2.01±1.4	2.13±1.59	1.93±1.41	1.77±1.13

Table 2: Diversity indices of rotifers in post-monsoon

Diversity indices	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**
Species number (mean± SD)	9±10.1	6.75±5.7	4.5±4.4	4.25±4.5	3.75±2.9	4.25±3.9	5±5.5	5.25±4.7
Abundance (mean± SD)	55.5±63.2	59.5±57.2	47±62	53.3±82.5	20.7±23.5	29±36.8	24±38.1	40±34.7
Simpson_1-D (mean± SD)	0.65±0.2	0.6±0.17	0.58±0.17	0.59±0.12	0.62±0.12	0.55±0.15	0.49±0.35	0.45±0.26
Shannon H (mean± SD)	1.48±0.94	1.25±0.68	1.07±0.65	1.01±0.57	1.08±0.52	1.01±0.52	1.03±0.92	0.99±0.74
Evenness e^H/S (mean± SD)	0.76±0.14	0.68±0.18	0.87±0.13	0.92±0.22	0.94±0.12	0.85±0.21	0.89±0.15	0.69±0.12
Margalef (mean± SD)	1.88±1.87	1.37±1.05	0.87±0.79	0.78±0.76	0.88±0.59	0.95±0.76	1.22±1.16	1.13±1.03

Table 3: Diversity indices of rotifers in pre-monsoon

Diversity indices	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Species number (mean± SD)	2	2	2	2	2	2	2	2
Abundance (mean± SD)	60.7±91.6	72.5±99.1	63.5±75.5	127±153	39.5±29.1	67.5±62.1	79.25±90	64.5±72.6
Simpson_1-D (mean± SD)	0.47±0.15	0.39±0.22	0.31±0.03	0.39±0.13	0.44±0.05	0.46±0.06	0.41±0.14	0.37±0.12
Shannon H (mean± SD)	0.65±0.15	0.55±0.26	0.5±0.05	0.57±0.15	0.63±0.05	0.66±0.06	0.59±0.15	0.56±0.12
Evenness e^H/S (mean± SD)	0.97±0.14	0.89±0.2	0.82±0.04	0.89±0.13	0.94±0.05	0.96±0.05	0.91±0.14	0.88±0.11
Margalef (mean± SD)	0.38±0.17	0.43±0.26	0.39±0.2	0.45±0.31	0.37±0.23	0.3±0.13	0.31±0.12	0.35±0.17

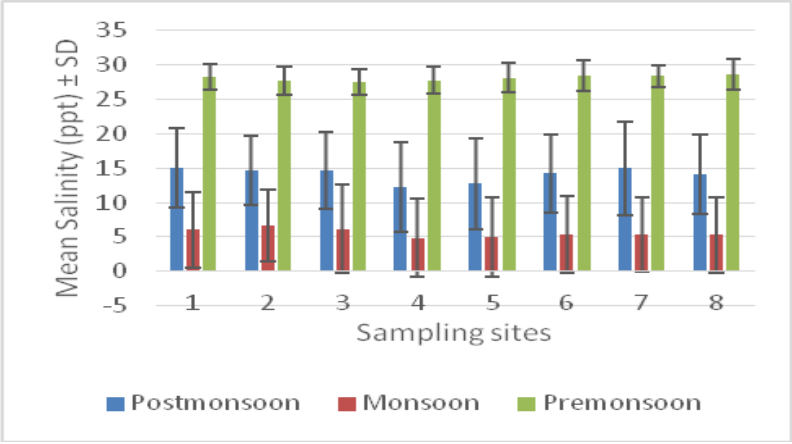

Fig. 2: Season wise salinity profile of sampling sites.

(pre-monsoon). The Pielou's evenness Index which gives the evenness distribution among the different groups gives a value of 0.97±0.14 for site 1 (pre-monsoon) and 0.96±0.05 for site 6 (pre-monsoon). Simpson Index also marked highest value at site 1 (0.74±0.33). Site 1 also showed next highest value of Simpson Index (0.65±0.2) in post-monsoon.

From the season wise analysis of diversity (Fig. 4), abundance (Fig. 5) and salinity profile for the three seasons (Fig. 2), it is clear that the salinity plays a key role in the distribution of rotifers which has also been described by earlier workers (Nair and Tranter, 1971; Varghese and Krishnan, 2009; Paturej and Gutkowska, 2015; Vineetha et al., 2015). An increase in salinity resulted in a decrease of rotifer species richness and diversity (Irena Bielanska Grajner and Cudak,

Table 4: Species checklist of rotifers recorded from Enamakkal lake during 2018-2019

Order	Family	Genus	Species
Ploimida	Asplanchnidae	*Asplanchna*	*Asplanchna brightwelli* *Asplanchna priodonta* *Asplanchna herricki*
Ploimida	Brachionidae	*Brachionus*	*B. plicatilis* *B. falcatus* *B. forficula* *B. quadridentatus* *B. caudatus* *B. rotundiformis* *B. angularis* *B. diversicornis* *B. donneri* *B. dichotomous* *B. calyciflorus*
Ploimida	Brachionidae	*Keratella*	*K. cochlearis* *K. tropica*
Ploimida	Brachionidae	*Platiyas*	*P. patulus* *P. quadricornis*
Ploimida	Trichocercidae	*Trichocerca*	*T. cylindrica* *T. pusilla* *T. bicristata* *T. longiseta* *T. similis*
Floscullariacea	Filiniidae	*Filinia*	*F. opoliensis* *F. camasecla*
Ploimida	Mytilinidae	*Mytilina*	*M. bisulcata* *M. ventralis*
Ploimida	Euchlanidae	*Euchlanis*	*E. dilatata*
Ploimida	Lecanidae	*Lecane*	*L. quadridentata* *L. luna* *L. leontina* *L. bulla* *L. blachei* *L. closterocerca*
Ploimida	Synchaetidae	*Polyarthra*	*Polyarthra* sp.

2014). Rotifer communities is changed to salinity tolerant species during months of high salinity (Manickam *et al*., 2015). Yuan *et al*. (2020) also observed the number and diversity (richness, evenness, Shannon index, and Simpson's index) of the zooplankton species which decreased as salinity increased.

The species composition similarity as derived from Bray-Curtis similarity matrix indicated a maximum similarity of 0.9444 between November and December and the most dissimilar months with respect to species distribution was February and June with a similarity of only 0.06278 (Table 3). A dendrogram (Fig. 6) was constructed which

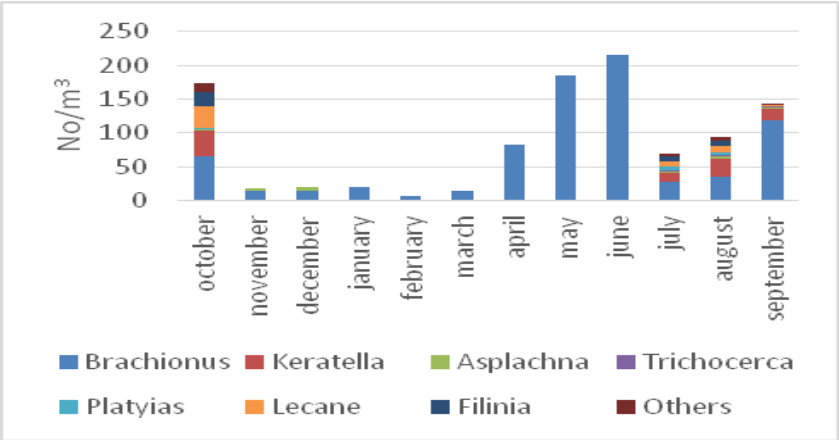

Fig. 3: Month wise contribution of rotifers.

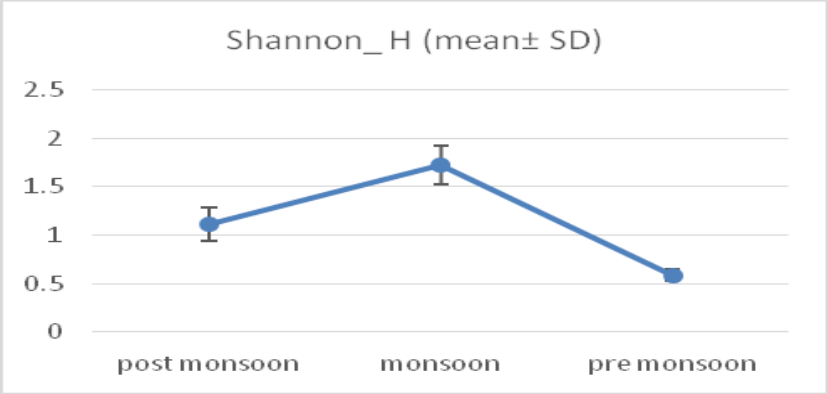

Fig. 4: Shannon diversity in different seasons.

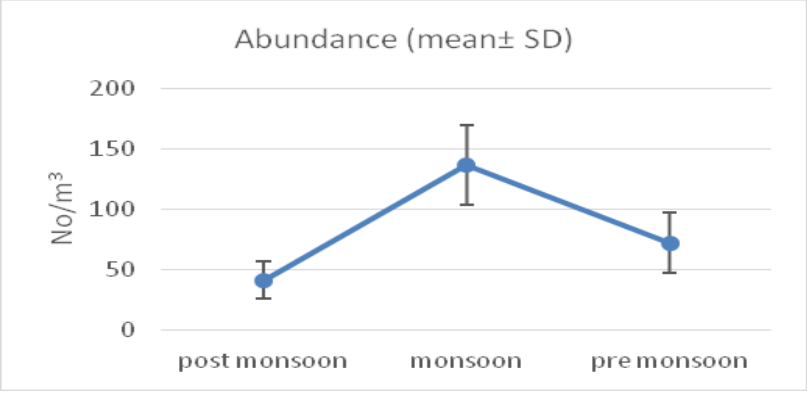

Fig. 5: Abundance in different seasons.

Table 5: Bray Curtis similarity index of months

	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19
Oct-18	1											
Nov-18	0.1466	1										
Dec-18	0.1555	0.9444	1									
Jan-19	0.2063	0.7027	0.7179	1								
Feb-19	0.0774	0.5833	0.5384	0.5185	1							
Mar-19	0.149	0.8387	0.8484	0.8235	0.6666	1						
Apr-19	0.5148	0.26	0.2745	0.3883	0.1555	0.2886	1					
May-19	0.3685	0.1287	0.1372	0.1951	0.0729	0.1407	0.6194	1				
Jun-19	0.3392	0.1115	0.1191	0.1694	0.0627	0.1217	0.5551	0.9226	1			
Jul-19	0.519	0.3639	0.3783	0.45	0.1845	0.3378	0.3456	0.2067	0.1842	1		
Aug-19	0.6629	0.2901	0.3025	0.3485	0.1375	0.2574	0.384	0.244	0.2196	0.8238	1	
Sep-19	0.5615	0.1791	0.1893	0.2471	0.094	0.1796	0.7382	0.7269	0.6639	0.4402	0.4834	1

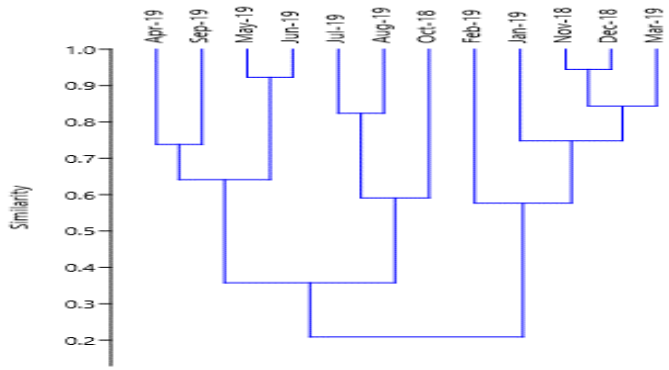

Fig. 6: Hierarchical cluster analysis- month wise.

revealed separate grouping based on similarity in species composition and abundance. In the month wise cluster analysis, mainly three clusters were obtained. From the cluster it can be easily understood that the month of November and December shows the maximum similarity of species compared to all the other months.

Studies related to the diversity and ecology of rotifers of this lake are not conducted. More studies on long term basis have to be conducted, including the hydrographical parameters possibly help us to derive a reliable conclusion about the distribution and abundance of planktonic rotifers.

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