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GLIMPSES OF AQUATIC BIODIVERSITY

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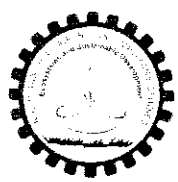

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BIODIVERSITY OF ROTIFERS IN SELECTED CENTRES OF COCHIN BACKWATER SYSTEM, KERALA

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Rotifers are considered to be an excellent and indispensable live feed for larvae of many finfishes and crustaceans. It(1960) was the first to culture the rotifer, *Brachionus plicatilis* for feeding marine fish larvae, and now it is being extensively used as live feed in hatcheries all over the world. Their slow swimming habits, ability to tolerate a wide range of salinities, parthenogenetic mode of reproduction and ability to get enriched easily, make rotifers an ideal live feed organism. As aquaculture sector is fast growing and is gaining more importance as the fish landings and supply are getting irregular, the role of rotifers is all the more important.

Realising the importance of rotifers, many workers have studied the rotifer fauna, their distribution and biodiversity in different ecosystems all over the world. Some of the works in this line are those by Anderson (1889), Edmondson and Hutchinson (1934), Pasha (1961), Nayar (1968), Nayar and Nair (1969), Vasisht and Battish (1971a - d; 1972), Pejler(1977), Koste (1978), De Ridder S(1985, 1987), Sharma (1987), Sarma (1988), Koste and Shiel (1987; 1989; 1990), Govindasamy and Kannan (1991), Shiel and Green (1996), Unni and Fole (1997), Gopakumar (1998), Sharma and Sharma (2001) and Anitha (2003). The majority of these works were pertaining to freshwater habitats and only a few studies were carried out in brackishwater ecosystems, not only in India but in other countries also. Hence, an attempt is made here to study the biodiversity of rotifers in nine different ecosystems along the Cochin backwater system.

Methodology

The Cochin backwater and certain canals adjoining the system extending to about 50 kms. was selected for the study. Monthly collections of rotifers were made from nine stations *viz.* Vypeen, Puthuvypu, Narakkal, Cherai, Eloor, Fisheries Harbour, Ernakulam Market canal, Mangalavanam and Poothotta, during the period from August 2000 to July 2002. The map showing the collection sites is given in Fig.1.

These stations were so selected that each of them showed a unique and different environment. The first station, Vypeen is located near Cochin barmouth, a very dynamic environment with maximum influence of tide and the wind action. The second station, Puthuvypu is considered as a good nursery area with plenty of finfish and shellfish seeds. The third station, Narakkal is a well known site for aquaculture where the traditional aquaculture methods are being practiced and the collection site gets a good inflow of water from culture ponds. The fourth station, Cherai is located about 5 kms away from the sea, where plenty of Chinese dipnets are operated and wastes from small fish and shellfish processing plants were discharged into this region. The fifth station, Eloor is a well known hot spot of industrial pollution with an almost freshwater environment. The sixth station Fisheries Harbour is with the turmoil of a fish landing centre, a busy water way with a deeper shipping channel and the added oil pollution. The seventh station, Ernakulam Market canal is near to the Ernakulam market and all the wastes from the market were being discharged to this

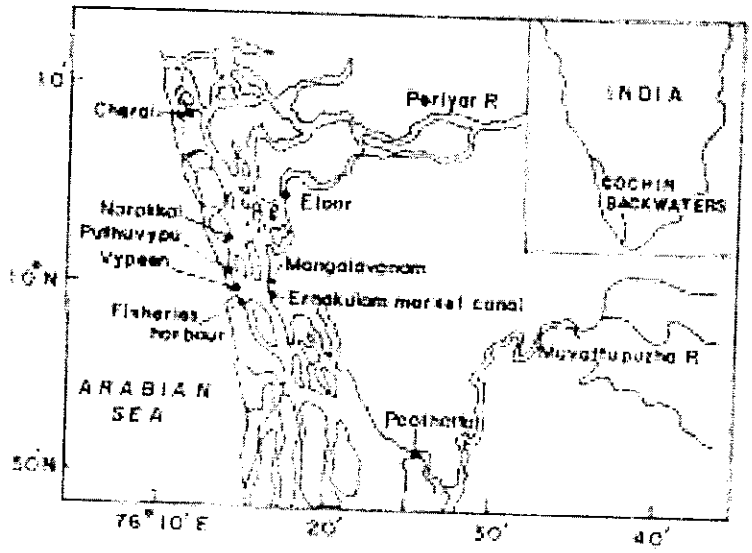

Fig.1: *Map showing the location of collection stations*

canal. The eighth station, Mangalavanam is a small mangrove forest which is a bird sanctuary as well as a mangrove reserve. The nineth station, Poothotta is about 25 kms away from Ernakulam and was an almost freshwater ecosystem.

The rotifer samples were taken from each station by filtering 500 litres of water through a conical plankton net made of bolting silk having a mesh size of 40 μ, and preserved using 4% formaldehyde. The sample was made upto 100 ml, an aliquote of 1 ml was taken in a counting chamber, observed under a binocular microscope and the different genera of rotifers were identified and counted. From this, the count of organisms present in 1000 litres(m^3) of water was estimated. For seasonal studies, February-May was treated as premonsoon, June-September as monsoon and October-January as postmonsoon season. Analyses were performed to calculate species richness, evenness and diversity indices of rotifers for each station, both monthwise and seasonwise, using the PRIMER 5 (Plymouth Routines In Multivariate Ecological Research) software package developed at the Plymouth Marine Laboratory, UK(Clarke and Warwick 2001). These indices were statistically analysed using SPSS 12.00 software. ANOVA tests were carried out between months and between stations. Charts were prepared representing the seasonwise mean values and standard deviations.

Results

The distribution of rotifer fauna in the study area are presented, both qualitative and quantitative studies were made. The rotifers were studied upto generic level. The biodiversity indices of rotifers are dealt with separately.

A. Qualitative distribution: 20 genera of rotifers belonging to 13 families were recorded from the different stations during the present study. They were *Brachionus, Keratella, Platyias, Anuraeopsis, Mytilina, Euchlanis, Dipleuchlanis, Epiphanes, Microcodides, Lepadella, Lecane, Monostyla, Cephalodella, Scaridium, Trichocerca, Polyarthra, Encentrum, Hexarthra, Filinia* and *Testudinella*. The qualitative distribution of rotifers in different stations are given in Table 1.

Out of the 20 genera of rotifers recorded during the study period, the maximum of 19 genera were recorded from station IX ie.Poothotta(Table.1). The lowest number of genera, 13 were observed from stations III, VI and VIII ie. Narakkal, Harbour and Mangalavanam. Among the 20

Table 1: *Families and Genera of Rotifers in different localities in the study areas.*

Families	Genera	Station1	Station2	Station3	Station4	Station5	Station6	Station7	Station8	Station9
Brachionidae	*Brachionus*	+	+	+	+	+	+	+	+	+
"	*Keratella*	+	+		+	+	+	+		+
"	*Platyias*	+				+				+
"	*Anuraeopsis*	+	+	+	+	+	+	+	+	+
Mytilinidae	*Mytilina*					+		+		+
Euchlanidae	*Euchlanis*	+		+	+	+	+	+	+	+
"	*Dipleuchlanis*					+		+	+	+
Epiphanidae	*Epiphanes*	+	+	+	+	+	+	+		+
"	*Microcodides*							+		
Colurellidae	*Lepadella*	+	+	+	+	+		+	+	+
Lecanidae	*Lecane*	+	+	+	+	+	+	+	+	+
"	*Monostyla*	+	+	+	+	+	+	+	+	+
Notommatidae	*Cephalodella*	+	+		+	+	+	+	+	+
"	*Scaridium*				+					+
Trichocercidae	*Trichocerca*	+	+	+	+	+	+	+	+	+
Synchaetidae	*Polyarthra*	+	+	+	+	+	+	+	+	+
Dicranophoridae	*Encentrum*	+	+	+	+	+	+	+	+	+
Hexarthridae	*Hexarthra*		+	+		+	+			+
Filiniidae	*Filinia*	+	+	+	+	+			+	+
Testudinellidae	*Testudinella*	+	+	+	+	+	+	+	+	+

genera recorded, *Brachionus, Anuraeopsis, Lecane, Monostyla, Trichocerca, Polyarthra, Encentrum* and *Testudinella* were noticed from all the nine stations studied.

B.Quantitative distribution: In order to have an understanding of the general distribution pattern of rotifers in the study area, the numerical abundance of rotifers was studied for all the nine stations separately. The rotifers were represented by 13 families. Among the 13 families of rotifers observed in the present collections, the family Brachionidae dominated the majority of stations, studied. Also, the genus *Brachionus,* formed the major component of the family Brachionidae in all the nine stations. Hence, along with the rotifers, the numerical abundance of family Brachionidae and the genus *Brachionus* was also taken for the study to have a better understanding of the distribution pattern of rotifers in the study area.

The quantitative distribution of rotifers, family Brachionidae and the genus *Brachionus,* in all the 9 stations is given in Fig 2.

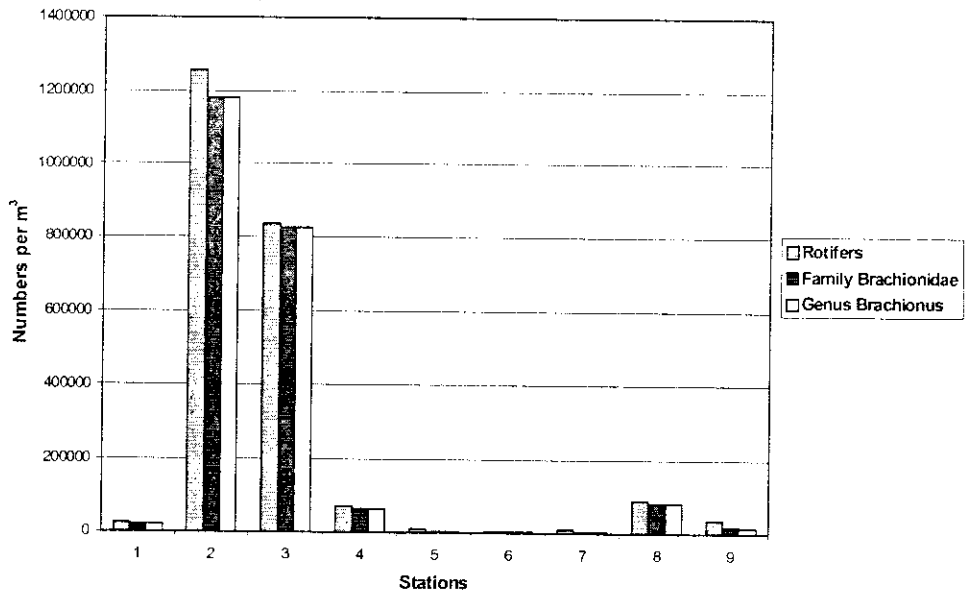

Fig. 2: *Stationwise distribution of Rotifers, family Brachiondae and genus Brachionus during the study period*

Of the rotifers recorded from the study area, the stationwise distribution showed that rotifers were maximum at station II followed by station III with 54% and 36% respectively, and the minimum of 0.14% was recorded at station VI.

To have an in depth knowledge of the faunal composition of the study area, the distribution of each genus of rotifers among different stations are presented (Fig.3)

The abundance of *Brachionus* extended to 54% at station II, and this stood as the highest percentage recorded among all the nine stations studied. Next in abundance was 38% at station III. The minimum of 0.05% was noticed at station VI. The genus, *Keratella* was maximum at station IX with 57% of the total recorded from the study area. But, there was no occurrence of *Keratella* at stations III & VIII.

The genus, *Platyias* was recorded in stations I,V and IX and was absent in other stations. A maximum of 48% was noticed at station I, 34% at station IX and 18% at station V. The genus, *Anuraeopsis* was observed in all the nine stations studied. Of the total *Anuraeopsis* recorded from all the stations, a minimum of 1.3% was noticed at station VI and a maximum of 41% was recorded in station II.

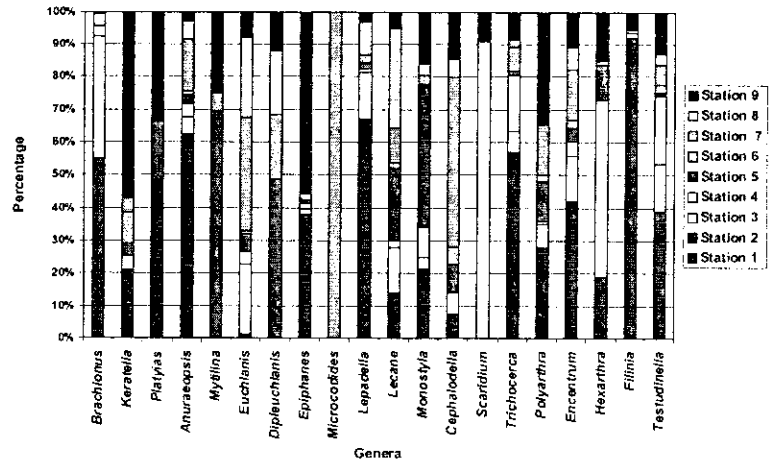

Fig. 3: *Percentage composition of Rotifer genera in the study area*

The genus, *Mytilina* was recorded in stations V, VII and IX and was absent in other stations. A maximum of 69% was noticed at station V, followed by 25% at station IX. The genus, *Euchlanis* was not observed at station II. The abundance of *Euchlanis* was maximum at station VII with 35% of the total recorded, from the entire study area. The genus, *Dipleuchlanis* was observed from stations V, VII, VIII and IX and was absent in other stations. This genus was maximum at station V(49%).

The genus, *Epiphanes* was absent at station VIII and was available in all the other stations. A maximum of 56% was noticed at station IX. Next in abundance was noticed at station II with 37% of the total *Epiphanes* recorded from the study area. The genus, *Microcodides* was available only at station VII and that was a single occurrence noticed from the study area.

The genus, *Lepadella* showed a maximum of 64% at station II. It was not recorded from station VI. The genus, *Lecane* was available in all the nine stations studied, and a minimum of 0.87% was noticed at station I. A maximum of 30% was recorded at station VIII, followed by 22% at station V. The genus, *Monostyla* was present in all the stations studied, a minimum of 0.6% was noticed at station VI and a maximum of 43% at station V.

The genus, *Cephalodella* was not observed at station III. A maximum of 51% was noticed at station VII. The genus, *Scaridium* was available at stations IV and IX. It was absent in other stations. Of the total recorded from the study area, 91% was observed at station IV and the rest, 9%, at station IX.

The genus, *Trichocerca* was observed in all the stations studied. Out of the total, a minimum of 0.3% was noticed from station VIII and a maximum of 54% at station II. The genus, *Polyarthra* was observed in all the stations studied. A minimum of 0.04% was observed at station VIII, the maximum was noticed at station IX, where 35% of the total *Polyarthra* from the study area were recorded. The genus, *Encentrum* was noticed in all the stations studied with a minimum of 2.86% at station VI and a maximum of 39% at station II.

The genus, *Hexarthra* was not available in stations I, IV, VII and VIII and was present in other stations. Of these, a maximum of 54% was noticed from station III. The genus, *Filinia* was maximum at station II, contributing to 92% of the total *Filinia* recorded from the study area. It was not available in stations VII and VIII. The genus, *Testudinella* was available in all the nine stations in considerable numbers. Taken together, a minimum of 0.74% was noticed in station V and a maximum of 35% was observed from station II.

C. Biodiversity of rotifers: To understand the distribution of rotifers in the biodiversity point of view, the Richness index, Evenness index, Shannon index and Simpson index were calculated for rotifers and presented. These are mathematical expressions to measure the variability of distribution of different genera in different stations. Monthwise as well as seasonwise indices were computed for each station. The ANOVA test was conducted to study the variations of these indices between stations as well as between months.

The abundance of rotifers in each station and different diversity indices are given in Table 2.

Table 2: *Stationwise diversity indices and abundance of rotifers*

Stations	Abundance Nos. per m^3	Richness index	Evenness index	Shannon index	Simpson index
1	23335	0.3672	0.4074	0.6274	0.2895
2	1255465	0.3863	0.1630	0.3186	0.1316
3	835604	0.3169	0.1039	0.1709	0.0658
4	71594	0.4941	0.5141	0.9010	0.4399
5	9450	0.6797	0.7486	1.4336	0.6778
6	3354	0.3600	0.7000	0.9037	0.4945
7	11340	0.5145	0.7103	1.2047	0.6085
8	88915	0.4394	0.4713	0.8109	0.4206
9	35083	0.7719	0.5575	1.2082	0.5364

The richness index showed maximum at station 9 followed by station 5. The evenness of distribution was maximum at station 5. The Shannon index of diversity was the highest at station 5 followed by station 9. The Simpson index also was maximum at station 5.

The seasonwise values of richness index, evenness index, Shannon index and Simpson index with Standard Deviations for all the stations are depicted in Figs. 4 to 7. ANOVA tests were carried out to understand the variations of different indices between stations as well as between months, and are given in Tables 3 and 4.

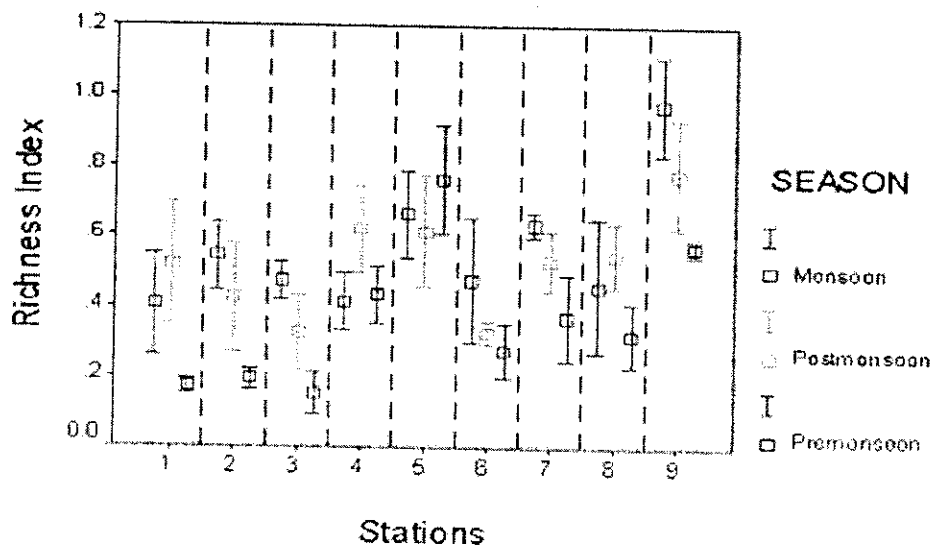

Fig. 4: *Seasonwise distribution along with SD of Richness Index of Rotifers in the study area*

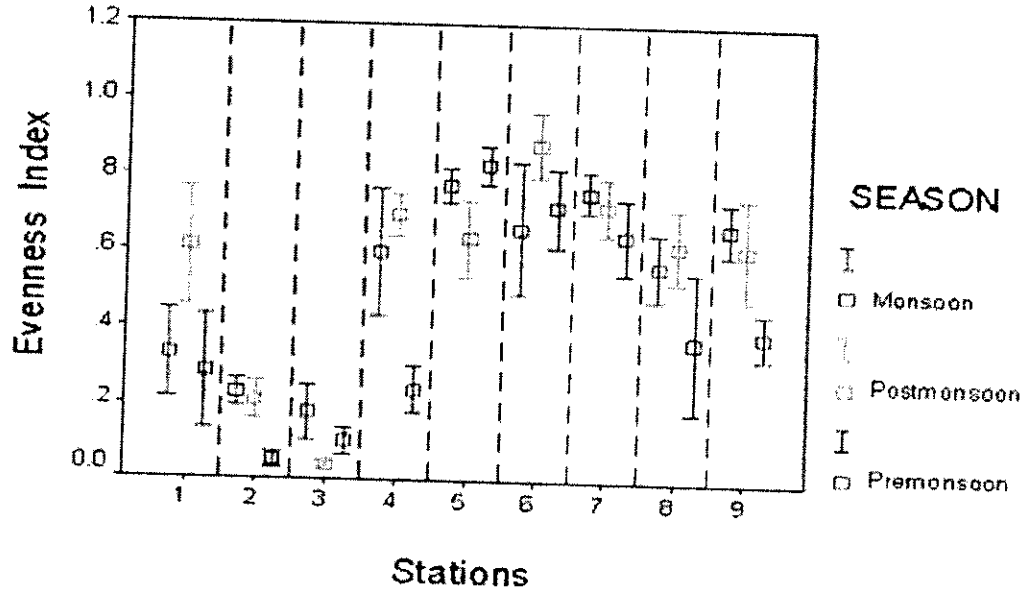

Fig. 5: *Seasonwise distribution along with SD of Evenness Index of Rotifers in the study area*

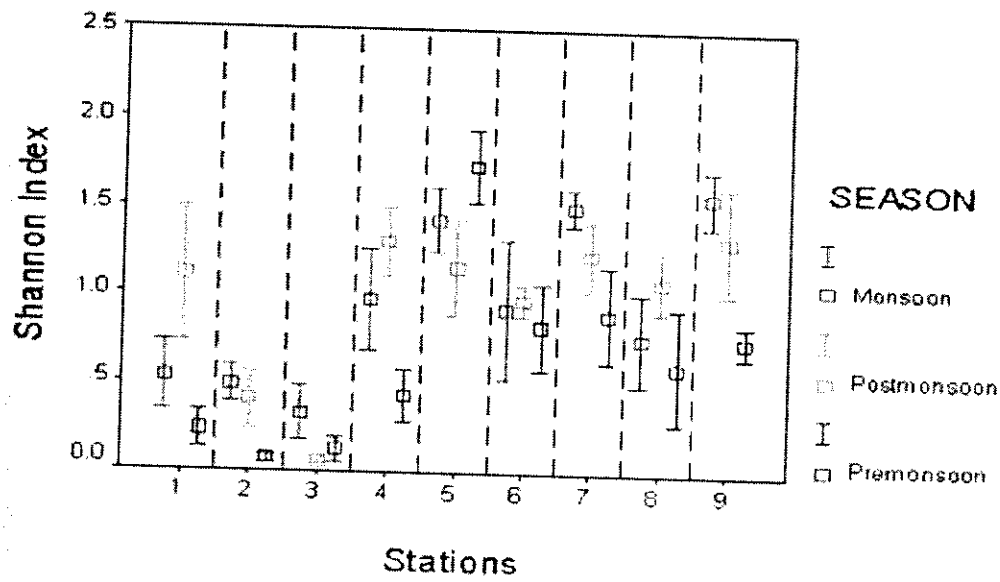

Fig. 6: *Seasonwise distribution along with SD of Shannon Index of Rotifers in the study area*

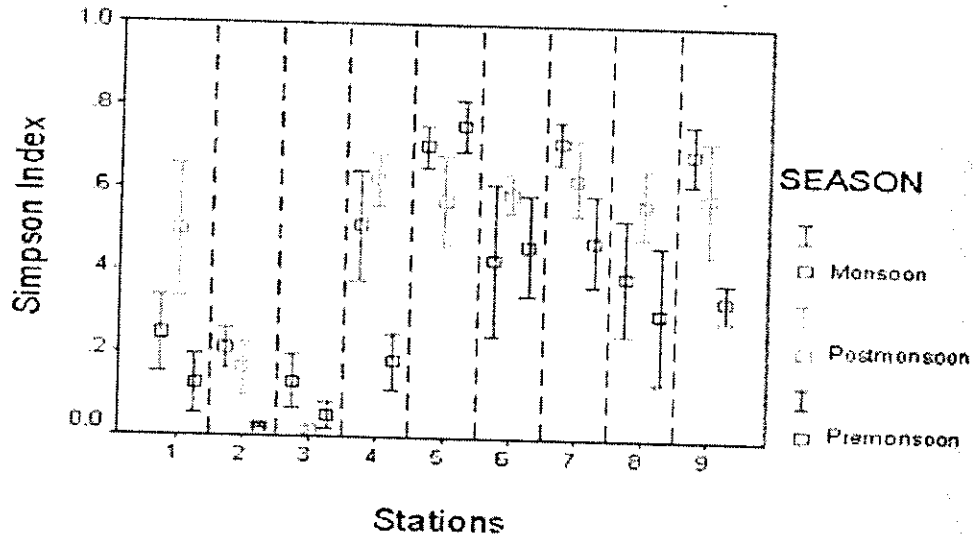

Fig. 7: *Seasonwise distribution along with SD of Simpson Index of Rotifers in the study area*

Table 3: *Results of ANOVA of different diversity indices of rotifers between stations*

	Sum of Squares	df	Mean Square	F	P
Evenness Index	5.42711836	8	0.678389796	15.47090	0.0000**
Richness Index	2.28744768	8	0.285930961	4.85867	0.0000**
Shannon Index	16.73291637	8	2.091614546	9.60335	0.0000**
Simpson Index	4.14822782	8	0.518528477	11.40853	0.0000**

** Highly Significant (P< 0.01)

Table 4: *Results of ANOVA of different diversity indices of rotifers between months*

	Sum of Squares	df	Mean Square	F	P
Richness Index	2.678871852	11	0.243533805	4.301855	0.0000**
Evenness Index	1.190154566	11	0.108195870	1.197878	0.2993
Shannon Index	6.445290818	11	0.585935529	1.766093	0.0707
Simpson Index	1.329468892	11	0.120860808	1.585406	0.1153

** Highly Significant (P< 0.01)

The seasonal studies on richness(Fig.4) was maximum during monsoon season at stations II, III, VI, VII and IX. At stations I, IV, and VIII, it was the highest during postmonsoon season. And only at station V, the richness index showed maximum during the premonsoon season.

The evenness of distribution(Fig.5) was the highest at stations II, III, VII and IX during monsoon season. It was maximum at stations I, IV, VI and VIII during the postmonsoon season. At station V alone, the maximum evenness observed during the premonsoon season.

The Shannon diversity index(Fig.6) showed maximum during monsoon season at stations II, III, VII and IX. At stations, I, IV, VI and VIII the index was maximum during the postmonsoon season. At station V alone, the index was maximum during the premonsoon season.

The seasonal studies on Simpson index of diversity(Fig.7) showed maximum during monsoon season at stations II, III, VII and IX. The diversity was the highest during postmonsoon season at stations I, IV, VI and VIII. Here also, at station V alone, the index was maximum during the premonsoon season.

The results of ANOVA(Tables 3&4) revealed that the variations between stations was significant with respect to all the four indices($P< 0.01$). But, between months, only the Richness index showed significant values($P<0.01$) and in other cases the variations were not significant.

Discussion

The results indicated the availability of 20 genera of rotifers distributed along the nine different habitats along Cochin backwater system. These 20 genera belonged to 13 families, whereas Sharma(1991) in an extensive work on rotifers has recorded 60 genera belonging to 24 families from India. As early as in 1971, Nair & Nayar reported 18 species of rotifers from freshwater habitats in Irijalakuda, Kerala. Later, Gopakumar (1998) reported 30 species of rotifers under 16 genera, belonging to 13 families from three brackishwater habitats of southern part of Kerala with varying salinity regimes. In a similar study, Anitha(2003) recorded 44 species of rotifers belonging to 16 genera under 12 families from two estuaries located in southern part of Kerala. The maximum numbers of genera recorded from brackishwater habitats of Kerala so far recorded was during the present study. Out of the 20 genera, a minimum of 13 and a maximum of 19 numbers of genera were distributed in varying numbers in different stations, in the present study.

The quantitative abundance of rotifers, family Brachionidae and genus *Brachionus* varied between stations significantly, except that of stations II and III. It is worthwhile to mention that maximum average density of 1255465 numbers per m^3 was noticed from Station II ie. Puthuvypu, which is a typical nursery area for finfishes and shellfishes. Station III stood second in rotifer abundance with an average density of 835604 numbers per m^3. The higher density of rotifers in these two ecosystems is associated with highly productive waters , which support fish and shrimp culture in these areas. Again, the minimum population density of just 3354 numbers per m^3 was noticed in station VI, which is a fisheries harbour site where several boats are being operated, everyday by fishermen, resulting in some extent of oil pollution, and, also repair work of boat/ship are carried out, including chipping of the hull. A small canal with polluted water having high content of organic matter also joins the area adjascent to station VI, which can also influence the rotifer fauna adversely.

The variability in the distribution of rotifers in different stations can also be explained in terms of diversity indices. In the present study, the indices of richness, evenness and diversity are found to follow a similar pattern, eventhough the magnitude is different. While studying the diversity of rotifer communities in lakes of southern Chile, Schmid-Araya s(1993) also observed that diversity

was significantly related to richness and evenness in all the stations studied. In the present study, although the changing trend in different seasons are same, the values differed considerably from station to station. The results of ANOVA also indicated that all the four indices (Richness, Evenness, Shannon and Simpson) show significant variations between stations. Thus the assemblages of rotifers in different stations are not identical. The maximum species richness of rotifers was noticed at station IX, where 19 genera of rotifers were recorded out of 20 reported from the study area. The evenness of distribution was maximum at station V. Since, the diversity is a function of both richness and evenness combined together, maximum diversity index was noticed at station V. Eventhough station V is influenced by the industrial pollutants from factories, the higher dissolved oxygen content and perhaps the weeds floating in a portion of the collection site might have been the reason for higher rotifer diversity at this station. It is worthwhile to mention here that Duggan *et al.*(1998) found high diversity of rotifers with respect to macrophyte distribution - with emergent and submerged vegetation.

Among the 13 families reported in the present account, the family Brachionidae formed the major portion and constituted 94% of total rotifers in the study area with a range of 25.83 - 98.61 % in different stations. Gopakumar (1998) and Anitha (2003) also noticed maximum number of species under the family Brachionidae among the total number of rotifer species; from the brackishwater habitats of southern coast of Kerala. This shows that the family Brachionidae is highly resistant and is well adapted to live in varying ecological biotopes.

Among the different diversity indices, the Shannon-Weiner index of diversity is more useful in comparing different sites(Hosetti, 2002). Here the Shannon index of diversity was maximum at station V followed by station IX. It is to be mentioned here that among the nine stations studied, the lowest salinity was recorded at station V with next higher salinity at station IX and almost freshwater condition prevailed in these two stations throughout the study period(unpublished information). Ruttner-Kolisko (1974) states that "rotifers are at home in freshwater, and it is there that they have developed their variety". Thus the present finding fully agrees with this statement. Station V, Eloor is a well known site for industrial pollution and at the same time maximum diversity of rotifers is also noticed from this site. So, higher diversity might have been observed from this site if it was not polluted. Thus, there is an indication of biodiversity loss in the case of rotifers here eventhough the magnitude of loss cannot be measured at this stage as this is the first report of its kind from this area. Hence, further studies in this line are necessitated to understand the rotifers and their sustainable development in these ecosystems.

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