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Ecology of rotifers in Cochin backwaters, Kerala, India

MOLLY VARGHESE AND L. KRISHNAN
Central Marine Fisheries Research Institute, P. B. No.1603, Kochi - 682 018, Kerala, India
e-mail: mollykandathil@hotmail.com

ABSTRACT

Water and rotifer samples were analysed simultaneously from nine different habitats along Cochin backwaters during the period from August 2000 to July 2002. The correlation coefficients were worked out between rotifers and thirteen environmental characteristics with respect to each station separately as well as in the study area as a whole. Rotifers showed significant positive correlations with nitrite, chlorophyll *a*, total suspended solids, phosphate and biochemical oxygen demand, in the study area. Station-wise results on correlation along with the levels of significance are presented and discussed.

Keywords: Cochin backwaters, Ecology, Rotifers

Introduction

Ecological characteristics play an important role in the quantitative and qualitative assemblage of rotifers in an ecosystem. Some of the minor changes may not affect the rotifer community as they are capable of acclimatization or modifying their position in the water column. But, certain other changes can affect the rotifer assemblages in the ecosystem. In adverse conditions, rotifers may produce resting eggs and, when environmental features become favourable, they can hatch, producing amictic females capable of multiplying parthenogenetically. As rotifers form as an excellent live feed organism, it is pertinent to understand their availability and relationships with different environmental characteristics in nature. Realising these facts the ecology of rotifers in different ecosystems have been studied (Shiel,1979; Holland *et al.,* 1983; Rao and Mohan, 1984; Sharma, 1992; Gopakumar and Jayaprakas, 2003). Even though the distribution and ecology of rotifer fauna have been studied in different parts of the world, the studies in India are limited and are mostly related to the ecosystems of northern parts of the country. The limited studies carried out in southern parts of India were mostly on freshwater habitats. Gopakumar (1998) studied the brackishwater rotifers of Kerala with special reference to *Brachionus plicatilis* as live feed for aquaculture. Anitha (2003) carried out studies on certain selected live feed organisms used in aquaculture, with special reference to rotifers of the family Brachionidae. These two studies gave more emphasis on culture aspects than on distribution and ecology. The ecology of rotifers in many of the brackishwater habitats in Kerala is not well documented and there is no information on the ecology of rotifers from the brackishwater ecosystems in central part of Kerala. This is the pioneering work in this direction dealing with ecology and its influence on rotifers in nine different habitats along the Cochin backwater system.

Materials and methods

The Cochin backwater and certain canals adjoining the system extending to about 50 km were selected for the study during August 2000 -July 2002. Monthly collections were made for rotifers and water samples from nine stations, station I to IX *viz*., Vypeen, Puthuvypu, Narakkal, Cherai, Eloor, Fisheries Harbour, Ernakulam market canal, Mangalavanam and Poothotta respectively. These stations were selected based on their uniqueness and difference in environmental characteristics (Molly and Krishnan, 2009).

The rotifer samples were collected from each station by filtering 500 l of water through a conical net made of bolting silk of 40 µ mesh size. The rotifers were enumerated and grouped into total rotifers, family Brachionidae and genus *Brachionus;* as the family Brachionidae and genus *Brachionus* constitute major shares in total rotifers (Table 1). Water samples collected simultaneously from the surf zones of each station were analysed for water temperature, pH, dissolved oxygen, salinity, H_2S, Biochemical Oxygen Demand (BOD), alkalinity, micronutrients like phosphates and nitrites using standard methods (APHA, 1998); chlorophyll *a* was estimated following the method by Strickland and Parsons (1968), Total Suspended Solids (TSS) by Boyd and Tucker (1992) and ammonia by the method adopted by Zolorzano (1969). To extract reliable information, the data on environmental parameters and that of rotifers collected for 24 months were pooled together and the resulted average data of 12 months were considered for further analyses and interpretation.

Correlation coefficients were calculated between rotifers and environmental characteristics prevailing in each station, as well as in the study area as a whole, using Microsoft Excel and t-test was carried out to assess the levels of significance.

Results

The correlation between hydrography and rotifers were worked out using month-wise data, to understand the extent of influence of various environmental characteristics on the abundance of rotifers. In order to indicate the share of family Brachionidae and genus *Brachionus* in total rotifers, station-wise contribution is given in Table 1.

Table 1. Percentage composition of family Brachionidae and genus *Brachionus* in total rotifers in the study area

Stations	% of Brachionidae out of total rotifers	% of *Brachionus* out of total rotifers	% of *Brachionus* out of Brachionidae
1	87.54	83.96	95.91
2	93.99	93.91	99.92
3	98.61	98.61	99.99
4	88.46	88.16	99.66
5	31.82	29.23	91.85
6	43.18	31.40	72.73
7	25.83	22.57	87.37
8	93.45	93.37	99.91
9	44.15	37.30	84.48

It is very clear that family Brachionidae and genus *Brachionus* contribute major shares in total rotifers and genus *Brachionus* constitute a major portion in family Brachionidae in most of the stations studied. Hence, the different environmental characteristics along with their correlations with the numerical abundance of total rotifers, family Brachionidae and genus *Brachionus* in all the nine stations are presented separately. Further, in order to have an overall understanding about the study area, the data collected from all the nine stations were pooled together and correlation between rotifers and environmental characteristics were computed and described.

Hydrography, rotifers and their interrelationships in each station

Month-wise variations in rainfall, water temperature, pH, dissolved oxygen, salinity, alkalinity, phosphate-phosphorus, nitrite-nitrogen, ammonia, biochemical oxygen demand, hydrogen sulphide, chlorophyll *a* and total suspended solids in the study area is depicted in Fig. 1

Monthwise numerical abundance of total rotifers, family Brachionidae and genus *Brachionus* pertaining to each station are given in Fig. 2.

The results of correlation analysis between the 13 environmental characteristics and numerical abundance of total rotifers, family Brachionidae and genus *Brachionus* in all the nine stations carried out separately are presented. The numerical abundance of total rotifers, family Brachionidae and genus *Brachionus* showed significant positive correlation ($p<0.05$) with dissolved oxygen at station I, while, they revealed highly significant positive correlations ($p<0.01$) with dissolved oxygen, biochemical oxygen demand, total suspended solids and chlorophyll *a* and significant positive correlation ($p<0.05$) with water temperature at station II. At station III, highly significant positive correlation was noticed between BOD and the distribution of rotifers, family Brachionidae and genus *Brachionus,* but at station IV, these three groups of rotifers showed significant correlation to BOD ($p<0.01$), chlorophyll *a* ($p<0.01$) and nitrite ($p<0.05$).

At station V, the interrelations of family Brachionidae and the genus *Brachionus* with salinity, alkalinity and nitrite were highly significant ($p<0.01$), while, the distribution of rotifers was positively correlated ($p<0.05$) with salinity, alkalinity, ammonia and BOD. The numerical abundance of family Brachionidae showed positive correlation with rainfall at station VI ($p<0.05$).

At station VII, the distribution of rotifers was found to be positively correlated with dissolved oxygen and rainfall, significant at 5% levels and showed negative relations with alkalinity ($p<0.01$) and H_2S ($p<0.05$). Here, the family Brachionidae showed significant positive correlations ($p<0.05$) with temperature, highly significant correlation ($p<0.01$) with chlorophyll *a* and significant negative correlations with phosphate and ammonia. At this station, the distribution of the genus *Brachionus* was also positively correlated to temperature ($p<0.05$), chlorophyll *a* ($p<0.01$) and negatively correlated to ammonia ($p<0.05$).

At station VIII, the relationships of the numerical abundance of rotifers, family Brachionidae and genus *Brachionus* with concentrations of nitrite and phosphate were highly significant, and with TSS and alkalinity, the relations were significant. At station IX, the concentration of nitrite showed positive correlation with total rotifers ($p<0.01$), family Brachionidae ($p<0.05$) and genus *Brachionus* ($p<0.05$).

Overall correlation in the study area

The data collected from nine stations were pooled together and correlation coefficients between rotifers and environmental parameters were calculated to study the ecological implications in the study area *in toto*. Month-wise numerical abundance of rotifers, family Brachionidae and genus *Brachionus* are given in Table 2 and the pooled data on the different environmental characteristics in the study area are given in Table 3.

Fig. 1. Month-wise distribution of environmental characteristics in the study area

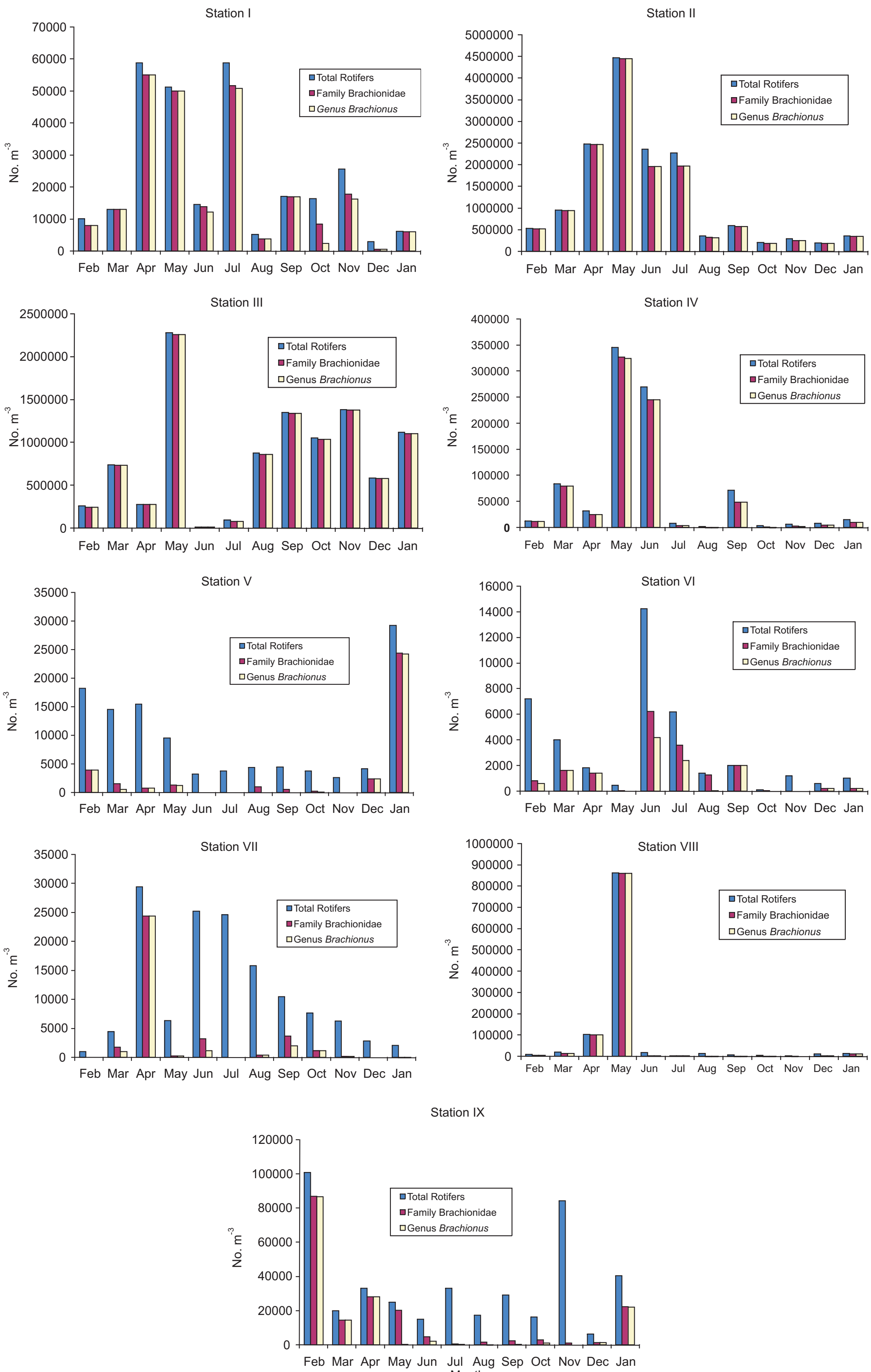

Fig. 2. Month-wise distribution (no. m^{-3}) of total rotifers, family Brachionidae and genus *Brachionus* in different stations

Table 2. Month-wise distribution (no. m^{-3}) of Rotifers, family Brachionidae and genus *Brachionus* in the study area irrespective of stations.

Months	Rotifers	Family Brachionidae	Genus *Brachionus*
Feb	105650.39	97365.17	97320.72
Mar	205724.61	199503.89	199215.00
Apr	336766.67	331182.22	331182.22
May	894056.67	884412.22	881952.22
Jun	303282.11	250060.00	249144.44
Jul	278671.11	234157.78	233933.33
Aug	143847.22	131977.78	130970.00
Sep	231899.06	220255.11	219782.89
Oct	146314.44	136923.33	135800.56
Nov	200385.17	183325.17	182474.06
Dec	89975.56	86261.50	86261.50
Jan	175613.89	169543.33	169521.11

In the study area, the correlations of the genus *Brachionus,* family Brachionidae and total rotifers with environmental parameters were similar showing highly significant correlations ($p<0.01$) with nitrite, chlorophyll *a* and TSS, significant correlations ($p<0.05$) with phosphate and BOD.

Discussion

Environmental parameters influence the distribution and abundance of rotifer community of any particular aquatic habitat as evidenced by the present study. In the study area, irrespective of stations, rotifers showed highly significant positive correlation with chlorophyll *a*. The chlorophyll *a* concentration is a direct measure of primary productivity of a water body. Of all the stations studied, chlorophyll *a* concentration was the highest at station II in almost all the months indicating the highly productive nature of this station. It was interesting to note that the rotifer density also was the maximum at station II among all the stations studied. In general, station II (Puthuvypu) is considered as a good nursery ground for finfishes and shellfishes which can be due to the high primary productivity as well as secondary productivity which are evidenced by the high chlorophyll content and high rotifer density. A positive correlation between the population density of rotifers and chlorophyll *a* was also reported by van Dijk and van Zanten (1995) in the river Rhine. In river Thames, May and Bass (1998) also reported that in general, an increase in rotifer abundance seemed to parallel a similar increase in chlorophyll *a* concentration in the river water.

Significant positive correlations were observed between BOD and rotifers at stations II, III, IV and V. Compared to all the other stations, BOD values were higher at station VII (3.8–30.3 mg l^{-1}), in almost all the months which is located nearer to the Ernakulam market where the wastes and decayed materials are discharged to the canal, resulting in organic pollution. A negative correlation between rotifers and BOD was observed at this station. Probably, high BOD resulting from high organic pollution may not be favourable for the growth and multiplication of rotifers. The above observations point out that even though BOD is positively correlated to the abundance of rotifers, very high values of BOD may not be favourable for rotifer production.

The abundance of rotifers showed highly significant positive correlations with TSS at stations II and VIII, of which the correlations were highly significant at station II. The TSS at station II varied between 35 and 80.7 mg l^{-1}, while at station VIII, range of TSS was from 15 to 58.5 mg l^{-1}. Konnur and Azariah (1987) also found a correlation

Table 3. Month-wise distribution of environmental characteristics in the study area irrespective of stations

Months	Water temp. (^oC)	pH	D. O. ml l^{-1}	Salinity ppt	Alkalinity ml l^{-1} as $CaCO_3$	PO_4-P µg at l^{-1}	NO_2-N µg at l^{-1}	NH_3-N µg at l^{-1}	BOD ml l^{-1}	H_2S ml l^{-1}	Chlorophyll *a* mg m^{-3}	TSS ml l^{-1}	Rainfall mm
Feb	30.71	7.21	2.13	19.50	71.07	2.73	0.38	20.64	4.86	0.23	1.88	39.97	25.00
Mar	31.43	7.32	2.28	18.78	68.77	3.15	0.15	20.94	4.40	0.08	2.70	44.42	5.50
Apr	32.11	7.16	2.99	17.14	63.35	1.32	0.05	6.46	3.09	0.00	3.25	40.30	142.50
May	30.60	7.20	3.06	9.11	73.90	8.72	3.36	49.23	7.94	0.00	4.54	62.77	436.00
Jun	29.04	7.17	2.74	2.75	52.84	5.30	0.83	35.50	3.96	0.00	2.86	40.84	702.50
Jul	28.68	7.36	2.81	3.22	62.06	6.65	0.37	40.88	5.85	0.01	2.61	30.51	452.50
Aug	28.31	7.30	2.90	2.97	62.10	5.62	0.39	49.16	2.78	0.00	2.43	19.75	382.50
Sep	29.73	7.28	3.09	8.00	48.84	3.32	0.56	27.91	5.48	0.10	4.01	27.81	208.50
Oct	29.07	7.31	2.42	4.22	65.72	5.28	0.35	35.42	5.16	0.00	2.10	25.77	344.50
Nov	29.22	7.24	2.14	11.00	65.34	3.67	0.50	29.47	5.19	0.17	0.97	24.56	139.00
Dec	28.21	7.05	2.84	18.56	70.93	1.42	0.30	15.47	3.92	0.09	0.99	32.80	10.00
Jan	28.58	7.16	2.62	21.72	75.91	1.50	0.31	15.12	4.37	0.23	1.25	44.50	23.50

between the biomass of rotifer and the total suspended particulate matter in the estuarine region of Adyar River. But, they observed that very high and very low suspended particulate matter cause a reduction in the biomass of rotifers. In other words, when the particulate matter amounted less than 200 mg l^{-1} and above 450 mg l^{-1}, a suppression of rotifer population, was noticed by the authors. The range of TSS in the present study is not in agreement with the ranges observed by Konnur and Azariah (1987) in Adyar River. Holland *et al*. (1983) stated that variations in suspended solids, often significantly associated with variations in rotifer numbers in Atchafalaya River basin, Louisiana; which is in agreement with the present study.

Phosphate content showed significant positive relationship with the abundance of rotifers in the present study area. Compared to other stations, phosphate concentration was higher at station VIII, with a peak in May. In station VIII (Mangalavanam), which is located in a mangrove forest with a bird sanctuary, the decayed mangrove leaves and guano add a lot of nutrients, especially phosphate . It is interesting to note a highly significant positive correlation between the abundance of rotifers and phosphate content at this station. This is in agreement with Kobayashi *et al.* (1998) who noticed a positive correlation between total phosphorus and zooplankton density in Hawkesbury Nepean river in Australia where, 64% of total zooplankton taxa was composed of rotifers.

The nitrite concentration showed high significant positive correlation with rotifers at stations VIII, IX and IV. Compared to other stations, nitrite showed higher values at stations VII and VIII. At station VIII, the high nitrite content may be due to the decayed mangrove vegetation and the guano. As indicated earlier, the proximity of station VII to the local market would have increased nitrite content at this station. In spite of the higher values of nitrite at stations VII and VIII, significant positive correlation with rotifer abundance was observed only at station VIII and not so at station VII. This can be due to some negative impacts of other factors like high H_2S, low dissolved oxygen content and very high BOD levels on the abundance of rotifers at station VII.

Nandan and Azis (1994) mentioned that *Brachionus* sp. along with *Acartia tropica,* copepod nauplii, *Chironomus calligaster* and *Pentaneura* sp. were indicators of sulphide pollution in the coir retting zones of the Kadinamkulam estuary, Kerala. However, in the present study area, a negative correlation between H_2S and total rotifers was recorded at station 7, where H_2S was significantly high. In some other stations, H_2S was present only in negligible quantities and in others, H_2S was absent. During the study period, *Brachionus* spp. as well as other rotifers weres recorded, not only from the stations where H_2S was present, but also from stations where H_2S was not observed.

The different sampling stations have their own physico-chemical characteristics and act as different ecosystems. Moreover, at the same station, some of the environmental parameters are found to be favourable while others are unfavourable for the growth and multiplication of rotifers. This phenomenon is very clear at station VII and station V. At station VII, phosphates, nitrites and certain levels of BOD are favourable for rotifer population, but, other parameters like high H_2S, high ammonia and low dissolved oxygen, showed negative impact on rotifer population. At station V, as it is affected by industrial pollution, it is characterized by very low pH, as low as 5 in certain months, due to the discharges from factories situated in nearby areas, which can be harmful for the abundance of rotifers. But, due to mixing of water from small rivulets, the dissolved oxygen content is high in this station, which can favour rotifer population. The rotifer assemblages as well as the interrelationships or combined interactions of environmental characteristics on the distribution and abundance of rotifers can be varied for different ecosystems. Absence of correlations of certain parameters with rotifer community was observed in certain stations, which can be due to the combined interactions of different variables acting on the distribution and abundance of rotifers, rather than the influence of a single variable, on rotifer population. Such a view is also expressed by Gopakumar (1998) and Anitha (2003), while studying the impact of environmental parameters on the distribution of rotifers in brackishwater habitats of southern Kerala.

The present study reveals the preference of rotifers to specific environments. Such information can advantageously be applied not only to select a particular strain/species of rotifer, but also to understand the interactions of various environmental factors on the culture conditions of rotifers in the hatchery. Since rotifers are considered to be an excellent and indispensable live feed organism in aquaculture practices, long term and species-wise investigations in this line is necessary to arrive at more reliable conclusions.

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