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Note

Brachionus species distribution in relation to environmental characteristics in Cochin backwaters, Kerala, South India

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ABSTRACT

The interrelations between the species distribution of rotifers and environmental characteristics in Cochin backwaters were investigated by analysing rotifer as well as water samples collected simultaneously from nine different stations during the period from August 2000 to July 2002. Thirteen species of *Brachionus viz*., *B. plicatilis, B. rotundiformis, B. angularis, B. urceolaris, B. rubens, B. forficula, B. caudatus, B. calyciflorus, B. bidentata, B. quadridentatus, B. patulus, B. falcatus* and *B. mirabilis* were enumerated and quantified from the rotifer samples. Water samples were analysed for different parameters like water temperature, pH, dissolved oxygen, salinity, hydrogen sulphide, biochemical oxygen demand, alkalinity, phosphate, nitrite, chlorophyll *a*, total suspended solids and ammonia. The correlation coefficients were worked out between different species of *Brachionus* and the environmental characteristics with respect to each station separately as well as in the study area as a whole. In the study area, *Brachionus rotundiformis* dominated and contributed 85.76% among the thirteen species of *Brachionus* and showed significant positive correlations with nitrite, biochemical oxygen demand, chlorophyll *a* and total suspended solids. *B. plicatilis* was found to show significant positive relation with phosphate. *B. plicatilis*, *B. angularis*, *B. rubens* and *B. patulus* exhibited significant negative relation with salinity while they showed significant positive correlations with rainfall. Also, salinity showed significant negative correlation with *B. urceolaris* while *B. falcatus* exhibited significant positive relation with rainfall.

Keywords: *Brachionus,* Cochin backwaters, Ecology, Environmental parameters, Species distribution

Introduction

Rotifers form an important link in the food chain of most finfish/shellfish species in the aquatic ecosystem. These organisms are exposed to a variety of changes in the physical, chemical and biological characteristics of the environment in which they live. Since rotifers play an important role in the ecosystem, the ecological investigations on them gain importance. Several researchers have studied the ecology of rotifers from diverse ecosystems (Arora, 1966; Vasisht and Sharma, 1977; Shiel, 1979; Holland *et al*. 1983; Laal, 1984; Sampathkumar, 1991; Sharma, 1992; Kumar,1994; Gopakumar, 1998; Anitha, 2003). Most of the studies were carried out in freshwater habitats and the ecology of *Brachionus* species from many of the brackishwater habitats in India is not well documented. Molly and Krishnan (2011) studied the ecology of rotifers from Cochin backwaters, however there is no report available so far on the distribution of *Brachionus* species in Cochin backwaters in relation to environmental characteristics. The present study focused on the interrelationships between the distribution of different species of *Brachionus* and environmental characteristics in the Cochin backwater ecosystem.

The study was conducted along Cochin backwaters including certain canals adjoining the system, during the period from August 2000 to July 2002. Simultaneous collections of rotifers and water samples were made at monthly intervals, from nine stations *viz*., Vypeen, Puthuvypu, Narakkal, Cherai, Eloor, Cochin Fisheries Harbour, Ernakulam Market canal, Mangalavanam and Poothotta respectively, as already described in Molly Varghese e*t al*. (2011). These stations were selected based on their uniqueness and difference in environmental characteristics. Fig.1 depicts the map indicating the sample collection sites.

From the rotifer samples collected from each station, different species under the genus *Brachionus* were enumerated and quantified. Correlation coefficients were calculated between different species of *Brachionus* and environmental characteristics prevailing in each station, as well as in the study area as a whole, using Microsoft excel and t-test was employed to test the statistical significance.

The correlation between hydrography and *Brachionus* species were worked out to understand the extent of influence of the various environmental characteristics on different species of *Brachionus*. *Brachionus* species formed a major share in total rotifer population in most of the stations (Fig. 2).

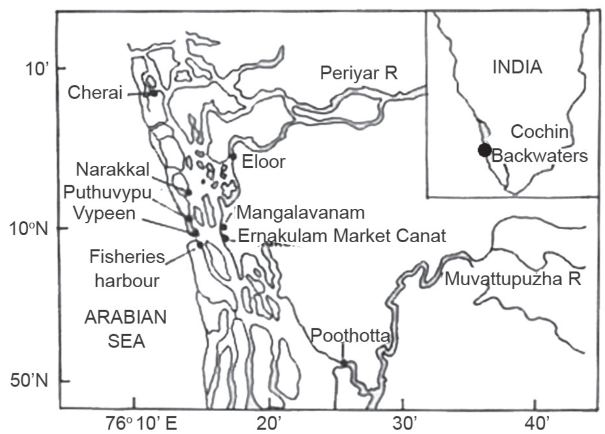

Fig. 1. Map showing the location of sample collection stations

Month-wise fluctuations in rainfall, water temperature, pH, dissolved oxygen, salinity, alkalinity, phosphate-phosphorus, nitrite-nitrogen, ammonia-nitrogen, BOD, hydrogen sulphide, chlorophyll *a* and TSS in the same

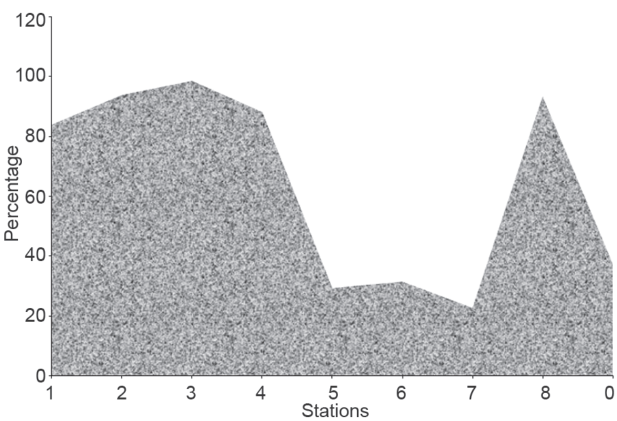

Fig. 2. Percentage of *Brachionus* spp. out of total rotifers in different stations

smpling locations were already reported by the same authours (Molly Varghese *et al*., 2011). Month-wise distribution of different species of *Brachionus* is presented in Fig. 3. Molly Varghese *et al*. (2006) have given a detailed systematic account of all major rotifer species reported from Cochin backwaters.

The results of the correlation analysis between the 13 environmental parameters and numerical abundance of different species of *Brachionus* in all the nine stations are discussed here. At station I, temperature showed significant positive correlation ($p<0.05$) with *B. rotundiformis*, whereas alkalinity showed negative correlation with *B. angularis* ($p<0.05$). At station II, the correlation of *B. rotundiformis* with temperature, BOD, chlorophyll *a* and TSS were significant at 5% level and that with dissolved oxygen was significant at 1% level. Salinity was found to be negatively correlated ($p<0.05$) with *B. plicatilis*, *B. urceolaris* and *B. rubens*. Gopakumar (1998) also recorded negative correlation between *B. plicatilis* and salinity in Dalavapuram waters, Kollam district.. The positive correlations between nitrite and *B. urceolaris* and that between rainfall and *B. plicatilis* were significant ($p<0.01$). Rainfall also showed significant positive correlations with *B. angularis, B. urceolaris* and *B. rubens*.

At station III, significant positive correlations of *B. plicatilis* with phosphate and chlorophyll *a* were noticed. Significant positive correlation of *B. plicatilis* with chlorophyll *a* was also observed by Gopakumar (1998) in Anchuthengu backwaters of Thiruvananthapuram District. BOD was closely related to the distribution of *B. rotundiformis* ($p<0.01$). Salinity was found to be negatively correlated with *B. angularis* ($p<0.05$) but, Anitha (2003) noticed significant positive correlation between them in Poonthura Estuary. The distribution of *B. urceolaris* was found to be influenced by dissolved oxygen and chlorophyll a ($p<0.05$). Also, a positive correlation was observed between *B. urceolaris* and H_2S ($p<0.01$). At station IV, the nitrite content showed positive correlation with *B. rotundiformis* ($p<0.05$). The ammonia content showed significant negative relation with *B. calyciflorus* and *B. forficula*. The positive correlations of chlorophyll *a* with *B. plicatilis* and *B. angularis* were significant ($p<0.05$), while with that of *B. rotundiformis* was highly significant ($p<0.01$). The BOD showed significant positive correlation with *B. rotundiformis* ($p <0.05$). Significant positive correlations were observed between rainfall and *B. plicatilis, B. rotundiformis* and *B. angularis* ($p<0.05$).

At station V, the temperature influenced the abundance of *B. quadridentatus* ($p<0.01$). Significant positive correlation was noticed between salinity and *B. plicatilis*, the positive correlations of salinity with *B. rotundiformis*, *B. urceolaris* and *B. rubens* were significant at 5% level. Positive correlation of salinity with *B. plicatilis* and *B. rotundiformis* was also recorded by Anitha (2003) in Veli-Aakulam Estuary. The relationships of alkalinity with *B. rotundiformis* and *B. urceolaris* were significant at 1% level. Alkalinity showed significant positive correlation with *B. plicatilis* also ($p<0.05$). The abundance of *B. mirabilis* was found to be positively correlated with phosphate content ($p<0.01$). The nitrite concentration was positively correlated with *B. plicatilis* and showed inverse relationship with *B. quadridentatus* and the correlations were significant at 5% levels. The distribution of *B. rotundiformis* and *B. urceolaris* were found to be positively correlated to the nitrite levels ($p<0.01$). *B. forficula* showed significant correlations with ammonia and BOD ($p<0.05$). The availability of *B. angularis* was found to be influenced by chlorophyll *a* ($p<0.01$).

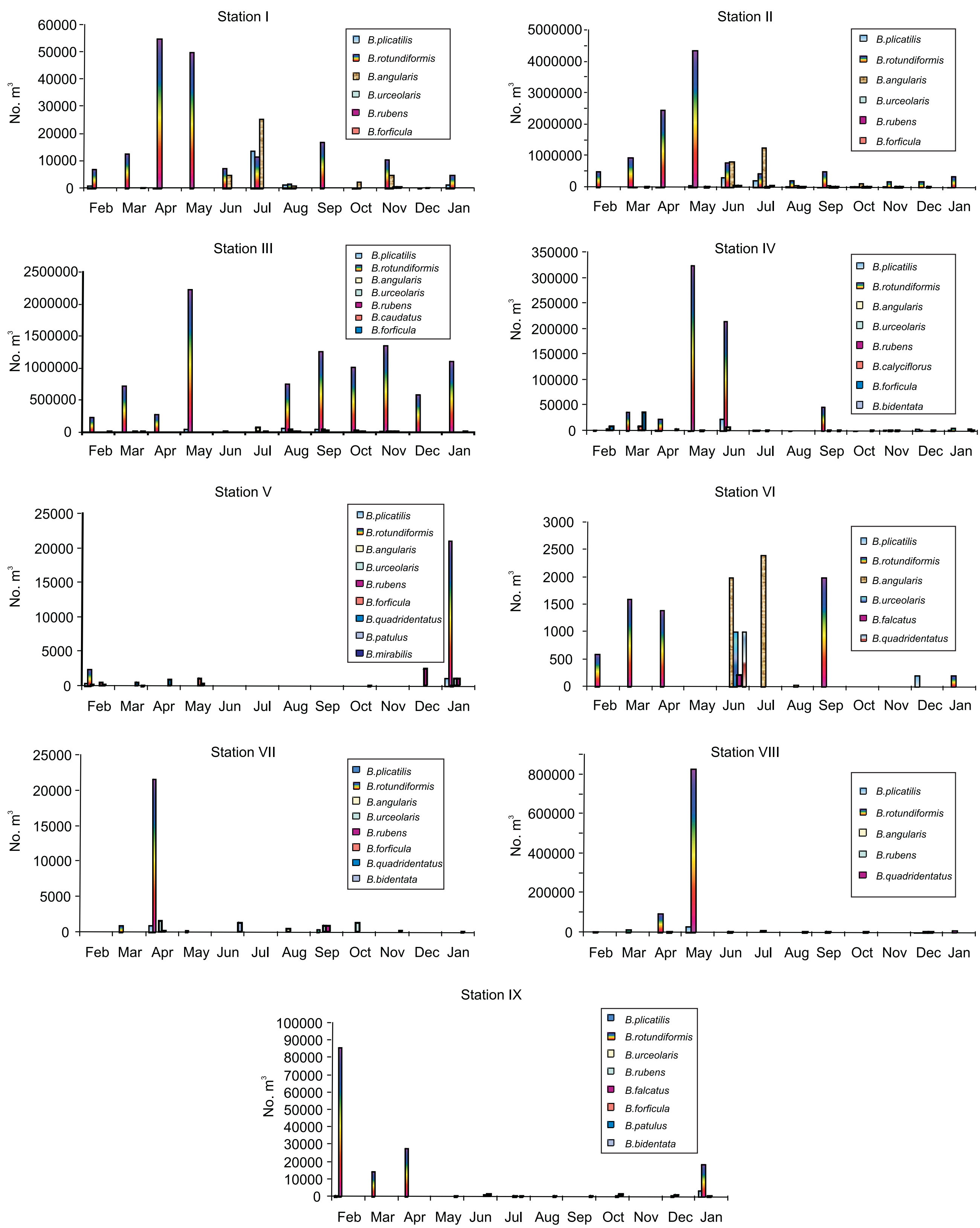

Fig. 3. Monthwise distribution of *Brachionus* species in different stations

At station VI, the amount of rainfall was positively correlated ($p<0.05$) to the numerical abundance of *B. angularis, B. urceolaris, B. falcatus* and *B. quadridentatus*. *B. rotundiformis* showed positive correlation with H_2S ($p<0.05$). Significant correlation was also noticed between *B. angularis* and phosphate level (pp<0.05). but, negative correlation of *B. angularis* with phosphate was observed at Poonthura Estuary by Anitha (2003). At station VII, *B. plicatilis* showed significant positive correlation with temperature and chlorophyll *a*, and it showed significant negative correlation with ammonia. The distribution of *B. rotundiformis* was positively correlated ($p<0.01$) with temperature and chlorophyll *a* and it exhibited negative correlation with ammonia ($p<0.05$). *B. angularis* showed significant positive correlation with ammonia ($p<0.05$) and *B. forficula* showed significant negative correlation with pH. The interrelation of *B. bidentata* with rainfall was positive and with alkalinity it was negatively correlated and both were significant at 5% level.

At station VIII, the numerical abundance of *B. plicatilis* and *B. rotundiformis* showed similar relationships with physico-chemical parameters prevailing at this station. They showed significant correlations with alkalinity, TSS and with phosphate as well as nitrite ($p<0.05$). Gopakumar (1998) too observed a significant positive correlation between nitrite and *B. plicatilis* at Dalavapuram. Rainfall influenced the distribution of *B. angularis* ($p<0.05$). The correlation coefficients of *B. rubens* with temperature, dissolved oxygen and chlorophyll *a* were significant at 5% level. At station IX, the distribution of *B. plicatilis* was positively correlated to salinity ($p<0.05$) and *B. rotundiformis* showed correlation with nitrite ($p<0.05$). Anitha (2003) noticed a significant positive correlation between salinity and *B. plicatilis* at Veli-Aakulam estuary. The correlations of *B. forficula* and *B. patulus* with environmental parameters at this station were the same, but levels of significance varied. Both the species showed significant negative correlation with dissolved oxygen. *B. forficula* exhibited positive correlation with phosphate ($p<0.01$) and rainfall ($p<0.05$) while *B. patulus* showed positive correlation with phosphate and rainfall at 5 and 1% levels of significance respectively.

The distribution of *Brachionus* species in relation to salininty differs in different stations. Among the 13 species of *Brachionus* recorded during the present study, *Brachionus rotundiformis* and *B. plicatilis* were observed from all the nine stations with varying salinity regimes which indicate the euryhaline nature of these two species. Sharma (1991) reported *B. plicatilis* as euryhaline. In a similar study conducted in the Mediterranean wetlands of Spain, Miracle *et al.* (1987) observed *B. plicatilis* from a salinity range of 0.5 to 88 ppt. Carmona *et al.*, (1995) reported a salinity range of 5-64 ppt for *B. rotundiformis*.

B. rotundiformis showed significant positive correlation with BOD at stations II, III and IV. Pandit and Kaul (1981) also designated *Brachionus* sp. as an indicator of eutrophic pollution in the wetlands of Kashmir. A close correlation between BOD and *B. plicatilis* has been observed by Rao and Mohan (1976) in Visakhapatnam backwaters and they consider *B. plicatilis* as an indicator of pollution. It is worthwhile to mention here that the species, *B. rotundiformis* was considered as *B. plicatilis* in 1976, by Rao and Mohan, and only during 1990's *B. rotundiformis* has been taxonomically accepted as a separate species (Segers, 1995). Thus, what the authors described as *B. plicatilis* in 1976 could in reality be *B. rotundiformis*.

Table 1. Monthwise distribution of *Brachionus* species (no. m^{-3}) in the study area irrespective of stations

Month	*B. plicatilis*	*B. rotundiformis*	*B. angularis*	*B. urceolaris*	*B. rubens*	*B. forficula*	*B. caudatus*	*B. bidentata*	*B. calyciflorus*	*B. quadridentatus*	*B. patulus*	*B. mirabilis*	*B. falcatus*
Feb	211	95247	22	0	0	1685	0	0	133	22	0	0	0
Mar	0	193763	3	0	222	4394	0	0	778	44	0	11	0
Apr	671	329833	0	178	244	167	0	0	0	89	0	0	0
May	14744	866950	0	0	100	111	0	0	0	24	22	0	0
Jun	37178	114389	92467	2333	2267	111	0	133	0	111	133	0	22
Jul	27400	51267	150833	222	4167	0	0	0	0	0	22	0	22
Aug	11489	107513	10327	833	783	0	0	0	0	22	2	0	0
Sep	6667	202110	9446	1389	117	11	0	44	0	0	0	0	0
Oct	2027	116102	15156	1024	1336	33	0	0	0	0	122	0	0
Nov	5363	172289	1711	1600	1489	0	0	0	0	22	0	0	0
Dec	407	85104	22	304	422	0	0	0	2	0	0	0	0
Jan	1344	167656	2	111	133	224	6	44	0	0	0	0	0

Table 2. Monthwise distribution of environmental characteristics in the study area irrespective of stations

Months	Water temp. (°C)	pH	D.O. (ml l^{-1})	Salinity (ppt)	Alkalinity (mg 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 (mg l^{-1})	H_2S (mg l^{-1})	Chlorophyll *a* (mg m^{-3})	TSS (mg 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

In order to have an overall understanding about the study area, the data collected from all the nine stations were pooled together (Table 1 and 2) and correlation between *Brachionus* species and environmental characteristics were computed and described.

Salinity showed significant negative correlations with *Brachionus plicatilis* ($p<0.01$), *B. angularis* ($p<0.05$), *B. urceolaris* ($p<0.05$), *B. rubens* ($p<0.05$) and *B. patulus* ($p<0.05$). Rainfall was found to affect the numerical abundance of *B. plicatilis* ($p<0.01$), *B. angularis* ($p<0.05$), *B. rubens* ($p<0.05$), *B. patulus* ($p<0.05$) and *B. falcatus* ($p<0.05$) positively. In fact, salinity was negatively correlated with 8 species and rainfall was positively correlated with 9 species out of the 13 species of *Brachionus* observed from this area. These indicate the affinity of *Brachionus* species to lower salinities. Sharma (1991) noticed that majority of *Brachionus* spp. inhabit freshwater bodies. Shiel (1979) while studying rotifers of the River Murray in south Australia also observed that no single factor can be described as limiting, but increasing salinity had the most marked influence on the rotifer plankton. Gopakumar (1998) too emphasised a similar role of salinity in the distribution of *Brachionus* species in southern part of Kerala.

Alkalinity was negatively correlated to *B. urceolaris* ($p<0.01$) and it did not exhibit a significant correlation with other species of *Brachionus*. Phosphate and ammonia-nitrogen were positively correlated to *B. plicatilis* ($p<0.05$). *B. rotundiformis* showed significant positive correlation with nitrite ($p<0.01$), biochemical oxygen demand ($p<0.05$), chlorophyll *a* ($p<0.05$) and total suspended solids ($p<0.01$). Here, it is worth mentioning that *B. rotundiformis* dominated and contributed 85.76% among the thirteen species of *Brachionus* with a range of 45-96% in different stations.

The results indicated that the same pattern of correlation between each species and respective parameters was not observed in all stations. The abundance of a particular species may be governed by the combined interaction of different variables existing in the particular station. But, it was obvious that significant correlations exhibited between one species and certain parameter did not contradict between stations except for salinity. In the case of salinity, it showed significant negative correlations with *B. plicatilis, B. urceolaris* and *B. rubens* at station II, negative correlation with *B. angularis* at station III but, salinity exhibited significant positive correlation with *B. plicatilis, B. rotundiformis, B. urceolaris* and *B. rubens* at station V and also showed positive correlation with *B. plicatilis* at station IX. This difference in relationship between same species and salinity in different stations may be due to the near freshwater condition prevailing at station V and IX throughout the study period unlike other stations. The salinity never exceeds 6 ppt in these two stations.

From the results of the present study, it is evident that ecological characteristics have a direct impact on the numerical abundance of different species of *Brachionus* in a particular aquatic ecosystem. This preference of species to certain environmental conditions can be simulated in hatchery for better growth of the required species of *Brachionus.* As *Brachionus* species is considered as an important live feed, the information on interrelationships between different species of *Brachionus* and environmental parameters can be of great help in live feed production for fish/shellfish larval rearing.

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References

Anitha, P. S. 2003. *Studies on certain selected live feed organisms used in aquaculture with special reference to rotifers (Family: Brachionidae).* Ph. D.thesis, Central Institute of Fisheries Education, Mumbai.

APHA 1998. *Standard methods for the examination of water and waste water*, 20th edn., Lenore, S. C., Arnold, E.G. and Andrew, E. E. (Eds.), Washington, 543 pp.

Arora, H. C. 1966. Responses of rotifera to variations in some ecological factors. *Proc. Indian Acad. Sci*., 63(B): 57-66.

Boyd, C. E. and Tucker, C.S. 1992. *Water quality and pond soil analyses for aquaculture*. Alabana Agricultural Experiment Station, Auburn University, 183 pp.

Carmona, M. J. Gomez, A. and Serra, M. 1995. Mictic patterns of the rotifer *Brachionus plicatilis* Mueller in small ponds. *Hydrobiologia*, 313-314: 365-371.

Gopakumar, G. 1998. *Studies on brackishwater rotifers of Kerala with special reference to B. plicatilis O. F.Muller as live feed for aquaculture*. Ph. D. thesis, University of Kerala.

Holland Leslie, E., Bryan, C. F. and Preston Newman Jr., J. 1983. Water quality and the rotifer populations in the Atchafalaya River Basin, Louisiana. *Hydrobiologia*, 98: 55-69.

Kumar, A. 1994. Periodicity and abundance of rotifers in relation to certain physico-chemical characteristics of two ecologically different ponds of Santhal Parganas (Bihar). *Indian J. Ecol*., 21(1): 54-59.

Laal, A. K. 1984. Ecology of planktonic rotifers in a tropical freshwater pond in Patna, Bihar. *Indian J. Anim. Sci*., 54: 291-294.

Miracle, M. R., Serra, M., Vincente, E. and Blanco, C. 1987. Distribution of *Brachionus* species in Spanish Mediterranean wetlands. *Hydrobiologia,* 147: 75-81.

Molly Varghese and Krishnan, L. 2011. Ecology of rotifers in Cochin backwaters, Kerala, India. *Indian J. Fish.,* 58 (3):109-115.

Molly Varghese, Krishnan, L. and Kuttyamma, V. J.. 2006. Systematic account on rotifers of the genus *Brachionus* from Cochin Backwaters. *J. Mar. Biol. Ass. India,* 48 (2): 147-155

Pandit, P. K. and Kaul, V. 1981. Trophic structure of some typical wetlands. In: Gopal, R. E., Turner, R. G. Wetzel and Whigham D. F. (Eds.), *Wetlands ecology and management*, Part II. B. International Scientific Publications and National Institute of Ecology, p. 55-82.

Rao, R. K. and Mohan, P. C. 1976. Rotifers as indicators of pollution. *Curr. Sci*., 46: 190.

Sampathkumar, R. 1991. On the taxonomy and ecology of rotifers in fish ponds. *J. Bombay Natur. Hist. Soc*., 89: 204-209.

Segers, H. 1995. Nomenclatural consequences of some recent studies on *Brachionus plicatilis* (Rotifera, Brachionidae). *Hydrobiologia,* 313-314: 121-122.

Sharma, B. K. 1991. Rotifera. In: *Animal resources of India (Protozoa to Mammalia)*. State of the Art Report Zoological Survey of India, Calcutta, p. 69-88.

Sharma, B. K. 1992. Systematics, distribution and ecology of freshwater rotifers in West Bengal. In: Mishra, S. R. and Saksena, D. N. (Eds.), *Aquatic ecology*. Ashish Publishing House, New Delhi, p. 231-273.

Shiel, R. J. 1979. Synecology of the Rotifera of the River Murray, South Australia. *Aust. J. Mar. Freshwat. Res*., 30(2): 255-263.

Strickland, J. D. H. and Parsons, T. R. 1968. A practical handbook of seawater analysis. *Fish. Res. Bo. Can. Bull*., 167: 311 pp.

Vasisht H. S. and Sharma B. K. 1977. Seasonal abundance of *Brachionus* spp. in relation to temperature and pH. *Indian J. Ecol*., 4(2): 233-235.

Zolorzano, L. 1969. Determination of ammonia in natural waters by the phenol hypochlorite method. *Limnol. Oceanogr*., 14: 799-801.

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