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Water quality monitoring- Study of seasonal variation of rotifer and their correlation with physicochemical parameters of Yashwant Lake, Toranmal (M.S.) India

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ABSTRACT

Seasonal variation of rotifers density and species richness was studied of Yashwant Lake. This reveled that the density of rotifers was maximum in summer, while it was minimum in post- monsoon. Maximum species richness of rotifers was recorded in summer Minimum species richness was recorded in winter. The rotifer community structure depends on a variety of environmental factors that include biological parameters, such as predation or competition, as well as various physico-chemical factors.

Key Words: correlation, Seasonal variation, rotifers, Toranmal.

INTRODUCTION

Zooplanktons are minute heterotrophic organisms in water bodies that are present at various depths in their own niches in every type of aquatic environment. Zooplankton form an important link in the dynamic ecosystems of estuaries, bays, rivers and lakes. By their heterotrophic activity zooplankton transport the organic material of primary and secondary production. The study of fresh water fauna especially zooplankton, even if of a particular area, is extensive and complicated due to environmental, physical, chemical and geographic variations involving ecological, extrinsic and intrinsic factors [1].

Rotifera, also called Rotatoria or wheel animalcules is group of small, usually microscopic, pseudocoelomate animals which have been variously regarded either as a class of phylum Aschelminthes, or as a separate minor phylum. They are ubiquitous, occurring in almost all types of fresh water habitats, from large permanent lakes to small temporary puddles and feed on algae and bacteria. Being prey for plankton feeders, Rotifers play a crucial role in many freshwater ecosystems. They are permanently and obligatorily connected to aquatic habitats in all active stages, only their resting stages are draught resistant [2]. Rotifer distribution and diversity is influenced primarily by deteriorating quality of water in freshwater ecosystems and secondarily by eutrophication and salinization. The nutrients, primary production, temperature, abundance of predators and competitors, and potential food resources are important factors influencing the structure of rotifer community [3].

Most rotifers are not free floating, but are sessile and associated with littoral substrata. Population of rotifers is highest in association with submerged macrophytes, especially plants with richly divided leaves. In such conditions the densities may reach upto 25,000 per litre [4,5,6] and *vise a versa* with reduced sites of attachment and presumably less protection from predation, their density is low [7]. Even though most rotifers commonly exhibit maximal densities in early summer, in temperate regions they show wide range of temperature tolerance [8]. Various rotifer taxa serve as useful bioindicators of water quality of environments within the limits of Limnosaprobity.

Their ability to colonize diversified aquatic and semi-aquatic biotopes and inherent quality to build up substantial densities within short time- intervals make them ideal for ecological considerations as well as valuable tool for population dynamic studies.

MATERIALS AND METHODS

Yashwant Lake is located on Toranmal Plateau, one of the important plateaus in mid Satpura. This plateau forms a table land on the summit, covering about 41 Sq.Km. area at 1155 meter altitude (AMSL) extending between 21° 54´ North to 21° 61´ latitude and 74° 26´ to 74° 34´ East longitude. Yashwant Lake has a perimeter of 2.75 Km. and spreads in 39 hectares. The Yashwant Lake is a perennial water body and surrounded by forested land. Hydrological changes are noted here with seasonal changes from dry to wet. The southwest monsoon starts by mid June and stabilizes in July and August. The stream drainage input fills the Lake and maximum water level as well as water cover are achieved at Yashwant Lake by the post monsoon (Sept–Oct. period).Water level decreases in summer due to evaporation, percolation and domestic utilization by villagers. Geologically, the area covers Deccan trap basalt rock formation and lies under monsoon semiarid deciduous forest cover.

The rotifers along the periphery of Yashwant Lake were collected during each biweekly visit at the three stations namely Yashwant Lake Site-A, B and C (YLA, YLB and YLC). Ten liters of water was filtered through the plankton net No. 25 of bolting silk with mesh size 64 micron Net was washed with the water by inverting it to collect the rotifers attached to the net and the volume of sample was made to 100 ml. The samples were taken in separate vials and fixed in the field with 1 ml of 4 % formalin and 1 ml of Lugol's Iodine at the collection site. 10 ml of sample from each station was further concentrated by centrifuging at 2000 RPM for 10 min. For quantitative estimation of rotifers, one ml well mixed sample was taken on 'Sedgewick Rafter Cell'. To calculate density of rotifers the averages of 5 to 10 counts were made for each sample and the results are expressed as numbers of organisms per litre of sample. Qualitative studies of rotifers were carried out up to the genus/species level using the standard keys given by [9, 10, 11]. Hence, species richness of rotifers is considered as number of species observed per visit.

The data of the two years (from December-2006 to November-2008) was pooled and separated for three months and analyzed for seasonal variations, with respect to winter (December, January, February), Summer (March, April, May), Monsoon (June, July, August) and Post-monsoon (September, October, November). Further, the Mean, Standard Error of Mean (SEM) and One-Way ANOVA with No post test for various parameters for four seasons was performed. The Pearson correlation between the physicochemical parameters and the rotifer density and species richness was calculated.

RESULTS

Seasonal variations in the density and species richness of rotifers for two years of investigations are presented in Table.1Total nine genera and twenty four species were recorded from Yashwant Lake. Maximum density of rotifers (Table.1) was recorded in summer. At YLA, it was 1158 ± 41 ind./L while at YLB and YLC it was nonsignificantly higher with 1180 ± 77.8 and 1340 ± 53.42 ind./L respectively. The density at all the stations decreased in monsoon and varied with 783 ± 76 ind./L at YLA, 973.3 ± 86.82 ind./L at YLC and 900 ± 85.01 ind./L at YLB. In post-monsoon it further decreased to 395 ± 28 ind./L at YLA, 483.3 ± 39.47 ind./L at YLB and 500 ± 59.1 ind./L at YLC. The density was almost maintained in winter when it was 444.5 ± 63 ind./L at YLA, 400 ± 61.97 ind./L at YLB and 493.3 ± 79.11 ind./L at YLC with $P < 0.0001$.

Table: 1 Seasonal Variations in density (No. of individuals /Litre) and species richness of rotifers at YLA, YLB and YLC of Yashwant Lake during November 2006 to December 2008

Parameters	Stations with F value	Winter	Summer	Monsoon	Postmonsoon
Rotifer Density	YLA $F_{3\ 20}$ 40.04	444.5 ± 63	1158 ± 41	783.3 ± 76	395 ± 28
	YLB $F_{3\ 20}$ 28.60	400 ± 61.97	1180 ±77.80	900 ± 85.01	483.3 ± 39.47
	YLC $F_{3\ 20}$ 33.29	493.3 ± 79.11	1340 ± 53.42	973.3 ± 86.82	500 ± 59.1
Rotifer Species richness	YLA $F_{3\ 20}$ 34.26	6.167 ± 0.945	17.67 ± 0.6667	15.50 ± 0.991	11.17 ± 0.8333
	YLB $F_{3\ 20}$ 21.67	7.333 ± 1.174	19.50 ±0.6708	15.67 ± 1.476	12.33 ± 0.9545
	YLC $F_{3\ 20}$ 35.80	8.333 ± 1.054	21.17 ± 0.7491	17.33 ± 0.802	15.50 ± 0.9574

Maximum species richness of rotifers was recorded in summer with 17.67 ± 0.66 species, 19.5 ± .67 species and 21.17 ± 0.74 species at YLA, YLB and YLC respectively (Table 1). In monsoon, the species richness varied within 15 to 18 species with mean species richness 15.5 ± 0.99 at YLA, 15.67 ± 1.47 at YLB and 17.33 ± 0.8 species at YLC. In post-monsoon it was 11.17 ± 0.83 at YLA, 12.33 ± 0.95 at YLB and 15.5 ± 0.95 at YLC. Minimum species richness was recorded in winter with 6.16 ± 0.94, 7.33 ± 1.17 and 8.33 ± 1.05 at YLA, YLB and YLC respectively.

Table: 2 Pearson correlations of Rotifers density and Species richness with physicochemical parameters at YLA, YLB and YLC of Yashwant Lake during December 2006 to November 2008

Sr.No	Parameters	YLA-Site Density	YLB-Site Density	YLC-Site Density	YLA-Site (Spp. Richness)	YLB-Site (Spp. Richness)	YLC-Site (Spp. Richness)
1	Acidity	0.917**	.873**	.819**	.879**	.802**	.651**
2	Alkalinity	0.841**	.830**	.824**	.825**	.800**	.465*
3	Atm.Temperature	0.798**	0.402	.569**	.926**	.444*	.468*
4	Chloride	0.950**	.911**	.868**	.785**	.789**	.682**
5	CO_2	0.792**	.612**	.514*	.938**	.612**	.495*
6	DO	-0.677	-0.534**	-.460*	-.790**	-.604**	-.338
7	NO_2	0.366	-0.104	-.166	.629**	-.009	.067
8	NO_3	-0.272	-0.604**	-.630**	.064	-.495*	-.198
9	pH	.926**	.774**	.698**	.897**	.715**	.543**
10	PO_4	.538**	.341	.288	.779**	.390	.219
11	Total Dissolved Solids	.916**	.886**	.738**	.810**	.696**	.746**
12	Total Hardness	.519**	.686**	.684**	.223	.498*	.401
13	Transparency	-0.193	.021	.089	-.580**	-.147	-.085
14	Total Solids	.635**	.410*	.295	.738**	.366	.567**
15	Total Suspended Solids	-0.132	-401	-.499*	.197	-.311	-.004
16	Water Temperature	.860**	.731**	.655**	.805**	.639**	.536**

******** *Correlation is significant at the 0.01 level (2-tailed).*
******* *Correlation is significant at the 0.05 level (2-tailed).*

DISCUSSION

Zooplankton play a functionally important role in aquatic systems by consuming phytoplankton and bacteria and then releasing nutrients back in the ecosystem or by serving as prey for transferring nutrients to higher trophic levels [12]. The Zooplankton community composition in shallow water systems are not only influenced by predation [13,14] but also by, water chemistry and hydrology [15], the hydro-period and water cover are the major physical factors responsible for formation of the various ecological communities [16]. According to [17, 18] plankton are abundant during the slow water current, while rise in water brings about a sharp decline in their density. In the present study, at the higher altitudinal lake in the semi arid-zone of Maharashtra, India, the water level and the resultant water cover have proven to be the important factors in regulating the density of the plankton.

24 species (Annexure), was recorded at Yashwant Lake. It is known to dominate several water bodies [19]. This pattern is common in tropical and subtropical freshwaters irrespective of being a lake, pond, reservoir, river or stream [19]. The rotifer community structure depends on a variety of environmental factors that include biological parameters, such as predation or competition, as well as various physico-chemical factors [20]. With the help of Canonical Correspondence Analysis (CCA), [21] have identified two main environmental gradients that shape up the rotifer assemblage, a temporal gradient- mainly related with the temperature and a eutrophic gradient. When the mercury goes down during extreme environmental conditions of winter the rotifers are also known to undergo diapauses [22]. This is the season when rotifer density was low at Yashwant Lake too. However the increase in the density of rotifers in summer corresponds to decrease in water level that concentrated rotifers in shallow waters. Further, the littoral vegetation exposed during summer creates an ideal habitat for growth of the rotifers [20, 23]. Thus, Maximum numbers of rotifers seen during summer indicates the influence of temperature supported by positive correlation at 0.01 levels between temperature and rotifer density (Table 2). This observation is corroborated with [24, 25, 26]. High temperature, duration of the day length intensity of sunlight during summer and accelerating phytoplankton are some of the limiting factors that have been correlated with the growth and abundance of rotifers [27, 28]. Bacterioplankter and phytoplankton are important food resources for rotifers [3].

The seasonal pattern in the rotifer communities is difficult to interpret, although with the abundance there is a tendency for increase in rotifer species richness during summer [21]. As said earlier, in the present investigation, the rotifers dominated Yashwant Lake with total maximum 24 species in summer. Among various genera of rotifers, *Brachionus* was the most dominant genus followed by *Keratella* in Yashwant lake throughout the study period (Annexure). The genus *Keratella* also contribute to significant fraction of rotifer population in the Yashwant lake with 3 species. Among these *Keratella tropica* was numerically higher than *Keratella cochlearis*. According to

[29], the species of genus *Keratella* and genus *Brachionus* are the pollution tolerant species and indicate accumulation of organic matter. [30] have reported abundant population of *Brachionus* in both eutrophic and mesotrophic lakes. Among the other genera, genus *Trichocera* and some species of genus *Filina* noted at Yashwant Lake are reported to occur in eutrophic environment [31] while genera *Lecane* and *Trichocera* have been shown to provide large contributions in terms of abundance and richness in macrophyte associated habitats [32]. Further, *Testudinella* is considered to be littoral genus [33].

When the three different stations of Yashwant Lake were considered more species were noted at station YLC which has good macrophyte coverage compared to station YLA and YLB. [34] stated that the rotifers are typically littoral and that few species are purely pelagic. This is probably a consequence of the spatial heterogeneity of littoral habitats, which allows them to sustain themselves as a greater diversity of forms. The macrophyte habitats are usually richer in terms of rotifer taxa than euplanktonic (pelagic) environments [32]. At station YLA which has a pelagic environment, *Keratella sp*. Dominated. [35] reported that these loricate forms prefer water of higher alkalinity as is noted for Yashwant Lake.

Rotifers are considered as ideal indicators of water quality assessment [8]. More work is still required to designate regional indicator species from different parts of India. It is presumed that rotifers utilize the nutrients as well as phytoplankton more rapidly to build up their population. This may be the reason for the worldwide distribution of rotifers [36].

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Annexure

Rotifers of Yashwant Lake observed at Toranmal in Satpura ranges during December 2006 to November 2008

Phylum - Rotifera (Pennak, 1953)
Class - Monogonota (Remane, 1933)
Order – Ploimida (Delage, 1997)
Family – Brachionidae ((Ehrenberg, 1938)
Sub-family – Brachioninae
Genus – Brachionus (Pallas, 1938)
1. *Brachionous caudatus (Barrois and Daday, 1894)*
2. *Brachionous bidentata (Anderson, 1889)*
3. *Brachionous qudridentatus (Hermann, 1783)*
4. *Brachionous fulcatus (Zacharias, 1898)*
5. *Brachionous diversicornis (Daday, 1883)*
6. *Brachionous plicatilis (Muller, 1786)*
7. *Brachionous forficula (Wierzejski, 1891)*
8. *Brachionous caliciflorus (Pallas, 1776)*
9. *Brachionous havanaensis (Illinois)*
10. *Brachionous urceolaris (Muller, 1773)*

Genus – Keratella (Bory de St. Vincent, 1822)
11. *Keratella tropica (Apstein, 1907)*
12. *Keratella procurva (Thorpe, 1891)*
13. *Keratella cockleris (Gosse, 1851)*

Family – Lecanidae
Genus – Lecane (Nitzsch, 1827)
14. *Lacana luna (Muller, 1776)*
15. *Lacana ohioensis (Herrick, 1885)*

Genus – Monostyla (Ehrenberg, 1830)
16. *Monostyla bulla (Gosse, 1851)*
17. *Monostyla lunaris (Ehrb., 1832)*

Family – Trichofercidae
Genus – Trichocera (Lamarck, 1801)
18. *Trichocera cylindrical species*

Family – Asplanchnidae
Genus – Asplanchna (Gosse, 1850)
19. *Asplanchna priodonta Gosse, 1850)*

Order – Floscullariacea
Family – Filinidae
Genus – Filina (Bory de St. Vincent, 1824)
20. *Filina opaliensis (Zach, 1898)*
21. *Filina logesita (Ehrb., 1834)*
22. *Filina pegleri (Hutchinson, 1964)*

Family – Testudinellidae
Genus – Testudinella (Bory de Vincent, 1826)
23. *Testidunella mucranata (Gosse, 1886)*

Class – Bdelloidea (Dujardin, 1841)
Order – Bdelloida
Family – Philodinidae (Ehrb., 1838)
Genus – Rotaria (Scapoli, 1777)
24. *Rotaria neptunis (Ehrb., 1832)*