Eco. Env. & Cons. 19 (2) : 2013; pp. (417-423)

ISSN 0971–765X

Survey of rotifers to evaluate the water quality of the river Gadhi and its reservoir

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(Received 29 October 2012; accepted 7 December, 2012)

ABSTRACT

The rotifer diversity was studied for a period of 16 months for River Gadhi and its reservoir. The diversity and density was found to be abundant at downstream sites, especially at the sites which receive domestic sewage. The Deharang reservoir which was situated upstream was away from anthropogenic activities. This site showed very less density and diversity of rotifers. The *Brachionus calyciflorus* contributed more in the total density of rotifers towards downstream. Most of the species of *Brachionus* were confined to the downstream. The restriction of *B. paracollurella and B. patulus* at upstream may suggest their preference to the clean water. The correlation studies indicated the strong correlation between rotifers and nitrates and phosphates, however, the relation was found to be negative with silicates. Phytoplankton density and rotifers were also very strongly correlated. The study indicated that rotifers are the indicators of nutrient rich water which are the representative of domestic pollution.

Key words : Rotifer, Pollution indicator, Pollution tolerant, Pollution sensitive, Coefficient correlation

Introduction

Rotifers are smallest multicellular, 'wheel bearing' organisms found in all aquatic and semi aquatic habitat, but are predominantly freshwater inhabitants. Because of their high feeding and assimilation efficiencies, they play important role in energy flow and nutrient cycling, accounting for more than 50% of the zooplankton production in some freshwater systems (Saler and Sen, 2002).

Rotifers are sensitive indicator of water quality (Sheeba and Ramanujan, 2005). Schindler and Noven (1971) reported enormous growth of rotifers in lakes and reservoirs indicating eutrophic conditions. Presence of rotifers is also described as indicator of eutrophy by Saksena and Sharma (1981) as they observed it in Gandhi Sagar, Chhattri tank, Sawarkar sarovar and Matsya Sarovar in Gwalior.

During the present study, the samples were collected from Dehrang reservoir and River Gadhi which runs on the outskirts of Panvel town. The river originates from Dehrang reservoir which is at the bottom of mountains and collects water from streams that run down the mountains. The river flow downward collecting waste, especially domestic sewage. To study the Rotifer and its relation with the water quality, seven sites were selected. The first site, S1, was reservoir and remaining six sites were down stream to it. S2 and S3 are indicated as upstream sites and were far away from the town. These sites have comparatively less human hindrance. S4, S5, S6 and S7 are in the vicinity of the town and the impact of anthropogenic activities increases in these areas. These are referred as downstream sites.

Materials and Methods

The samples were collected monthly for a period of 16 months from seven different sites (Fig. 1) located

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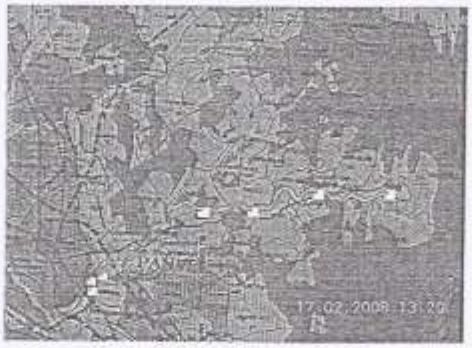

Fig. 1.

on river Gadhi and its Reservoir. The surface water from different spots of the sites mentioned above was collected so as to analyze Silicate by molybdosilicate method, nitrate by phenoldisulphoni acid method and phosphate by stannous chloride method.

With the help of wide mouth containers 40 ltrs surface water was filtered by using net of mesh size 45 µm. The filtered samples were preserved separately for each site with 4% Lugol's Iodine made in formalin in a separate container.

Identification of rotifers was done with the help of standard keys (Ward and Whipple, 1958; Battish, 1992; Pennak, 1995; and Dhanapathi, 2000).

The density count of rotifers was done by observing subsamples under compound microscope and the number was calculated in units per liter.

Using a wide mouth container, 500 ml of surface water sample was collected from different spots at every site from near the boundaries of the river and the reservoir. The samples from every station were preserved in separate container for phytoplankton. For immediate fixation, Lugol's Iodine solution made in formalin was used in the field and later 4% formaldehyde was used for long term preservation.

The phytoplankton were concentrated by allowing them to settle for about 15 to 20 days and then the upper water was decanted by using a rubber tube. The phytoplankton were identified by using standard identification keys (Fritsch, 1979; Sarode and Kamat, 1984; and Bellinger, 1992).

For quantitative estimation, the counting was done by using Lackey's Drop method (APHA 1985).

The correlation coefficient was calculated to study the relation between density of rotifers and some chemical parameters of water.

Results

The chemical analysis of water indicated that silicates ranged between 0 and 44.80 mg L^{-1} (Table 1). It

Table 1. Silicates (mg L^{-1}) at study sites

Site/Month	Upstream			Downstream			
	S1	S2	S3	S4	S5	S6	S7
Apr-06	6.50	6.20	6.50	6.50	6.50	6.50	6.50
May-06	8.30	14.20	13.80	16.40	14.80	12.60	10.40
Jun-06	0.40	0.40	0.80	0.80	0.00	0.40	0.40
Jul-06	0.60	1.00	1.00	0.60	1.00	1.00	1.00
Aug-06	0.80	5.20	4.10	5.20	5.20	4.20	4.00
Sep-06	10.20	12.80	0.00	1.12	12.60	1.95	11.00
Oct-06	3.60	3.50	4.20	4.80	2.80	4.80	4.80
Nov-06	10.80	6.60	11.20	12.20	15.40	10.40	14.40
Dec-06	4.80	5.20	8.00	8.80	8.20	8.40	5.80
Jan-07	8.40	6.80	7.80	4.80	9.80	7.80	9.20
Feb-07	6.60	18.00	15.00	15.60	10.60	10.70	5.80
Mar-07	12.80	5.20	6.80	6.20	1.95	5.00	5.20
Apr-07	3.60	4.80	44.80	8.00	0.00	5.20	28.20
May-07	24.00	26.30	27.00	37.95	28.00	11.70	20.30
Jun-07	11.20	11.20	10.80	11.20	6.00	4.40	3.40
Jul-07	33.00	8.37	19.25	9.48	35.00	35.00	33.00
Max.	33.00	26.30	44.80	37.95	35.00	35.00	33.00
Min.	0.40	0.40	0.00	0.60	0.00	0.40	0.40
Average	9.10	8.49	11.32	9.35	9.87	8.13	10.21

did not show any site specific dominance. Its average value was between 8.5 to 11 mg L[-1].

Nitrates ranged between 0 and 16.4 mg L^{-1} (Table 2). Phosphates ranged between 0 and 19.65 mg L^{-1} (Table 3).

Both the nutrients showed slight increase towards downstream. The increase towards town is due to inlet of sewage and increased anthropogenic activities.

The phytoplankton densities also showed in-

Table 2. Nitrate (mg L^{-1}) at study sites

SiteMonth	Upstream			Downstream			
	S1	S2	S3	S4	S5	S6	S7
Apr-06	6.50	6.20	6.50	6.50	6.50	6.50	6.50
May-06	8.30	14.20	13.80	16.40	14.80	12.60	10.40
Jun-06	0.70	0.50	0.70	0.45	0.70	0.50	0.50
Jul-06	0.28	0.42	0.48	0.34	0.34	0.26	0.40
Aug-06	0.65	0.85	1.10	1.00	1.10	1.00	0.65
Sep-06	1.71	2.60	1.40	1.70	1.80	1.60	1.50
Oct-06	0.00	0.18	0.27	0.00	0.18	0.27	1.30
Nov-06	0.36	2.15	0.90	0.65	0.70	0.80	0.72
Dec-06	0.18	0.00	0.00	0.00	0.00	0.18	0.27
Jan-07	5.60	5.60	6.20	6.20	6.20	6.20	6.20
Feb-07	0.36	0.09	0.09	0.18	0.09	1.50	1.00
Mar-07	0.09	0.09	0.65	0.72	0.36	0.72	0.36
Apr-07	1.50	0.40	2.15	2.50	2.60	2.55	2.15
May-07	0.65	0.54	0.72	0.65	0.81	0.45	0.81
Jun-07	0.34	0.34	0.34	0.34	0.34	0.34	0.50
Jul-07	5.60	5.60	6.20	6.20	6.20	6.20	6.20
Max.	8.30	14.20	13.80	16.40	14.80	12.60	10.40
Min.	0.00	0.00	0.00	0.00	0.00	0.18	0.27
Average	2.05	2.49	2.59	2.74	2.67	2.60	2.47

Table 3. Phosphate (mg L^{-1}) at study sites

SiteMonth	Upstream			Downstream			
	S1	S2	S3	S4	S5	S6	S7
Apr-06	0.12	0.06	0.00	0.31	0.19	0.44	0.19
May-06	0.19	0.12	0.38	0.57	1.60	3.40	0.89
Jun-06	0.00	0.00	0.00	0.00	0.12	0.31	0.12
Jul-06	0.00	0.00	0.12	0.12	0.06	1.80	0.19
Aug-06	0.06	0.06	0.06	0.06	0.06	0.12	0.12
Sep-06	0.06	0.06	0.63	0.12	0.25	19.65	0.82
Oct-06	0.06	0.06	0.48	0.10	0.33	10.80	0.82
Nov-06	0.06	0.06	0.12	0.06	0.63	8.03	1.08
Dec-06	0.63	0.70	0.70	0.89	2.40	3.70	1.08
Jan-07	0.12	0.25	0.25	0.25	3.00	2.70	1.20
Feb-07	0.12	0.19	0.25	0.12	0.19	2.70	1.02
Mar-07	0.38	0.38	0.63	1.14	2.70	4.20	0.70
Apr-07	0.19	0.44	0.44	1.20	2.70	1.80	2.70
May-07	0.06	0.12	0.19	1.30	1.70	5.40	1.40
Jun-07	0.86	0.86	0.92	0.92	3.42	4.30	2.60
Jul-07	0.20	0.14	0.14	0.14	0.62	0.62	0.27
Max.	0.86	0.86	0.92	1.30	3.42	19.65	2.70
Min.	0.00	0.00	0.00	0.00	0.06	0.12	0.12
Average	0.22	0.24	0.35	0.48	1.30	4.99	1.00

creased number towards downstream due to increased nutrients.

The total density of rotifer was 34,79,919 ind L^{-1} (Table 4). In all 27 different genera of rotifers comprising 58 species were encountered (Table 4). More abundance and diversity was seen in summer season which could be due to the absence of inflow of the water leading to the stability to the water body.

The highest density 15,18,994 ind L^{-1} was recorded at site S6 which receives sewage and the minima 12,107 ind L^{-1} was at site S1 which is reservoir and lies upstream far away from the town. The sites near the town having various anthropogenic activities showed more densities of rotifers than the sites away from the town having less or no human hindrance.

Among the various species encountered during the present study, the maximum diversity and density was seen in the *Brachionus* spp. It was represented by 19 different species and contributed 82% of the total rotifer density. Their dominance and diversity was seen at the downstream sites, except S7 which had only 6 species of the *Brachionus* (Table 4). Nutrient enrichment due to inlet of sewage and availability of food due to heavy growth of phytoplankton could be the possible reasons for increased downstream density.

B. calyciflorus was dominant among *Brachionus* which was found to be maximum at downstream sites. The higher densities at downstream sites may indicate that *B. calyciflorus* is a pollution tolerant genera. The other species of *Brachionus* found at downstream sites fed with waste water are *B. angularis, B. bidentata, B. budapestenensis, B. caudatus, B. diversicornis, B. plicatilis, B. quadricornis and B. quadridentatus.*

The species *B. patulus* was found abundant at S2 indicating its preference to the clear water as this site is clean comparative to the other sites and does not have considerable impact of anthropogenic activities.

Keratella was next dominant genus. It has contrib-

Table 4. Different species of Rotifers encountered during the study

Sr. No	Species of Rotifers	S1	S2	S3	S4	S5	S6	S7	Total
1	*Anureopsis* spp.	0	550	1085	3517	2530	3977	130	11789
2	*Asplanchana* spp.	420	1730	1529	8807	18615	29260	2420	62781
3	*Brachionus* spp.	0	0	0	120	460	0	0	580
4	*B. angularis*	375	2125	2900	7210	2454	15175	2800	33039
5	*B. bidentata*	0	255	250	262	6710	310	3531	11318
7	*B. budapestenensis*	0	0	800	0	750	480	2140	4170
8	*B. Calyciflorus*	2600	12985	4513	153999	304418	1501550	88929	2068994
9	*B. Caudatus*	1452	1180	0	155141	530017	34625	6530	728945
10	*B. dimidiatus*	0	0	0	525	0	0	0	525
11	*B. divercornis*	350	140	0	9443	700	15980	200	26813
12	*B. falcatus*	200	0	401	5143	280	1540	0	7564
13	*B. forficula*	0	0	100	5464	19780	620	316	26280
14	*B. havanensis*	0	0	0	2131	0	0	0	2131
15	*B. paracollurella*	775	115	0	0	0	0	0	890
16	*B. patulus*	0	53695	730	7338	140	0	103	62006
17	*B. plicatilis*	710	1275	930	8432	16681	5180	11465	44673
18	*B. quadricornis*	100	0	0	11052	1520	5025	538	18235
19	*B. quadridentatus*	100	0	0	262	410	1755	4380	6907
20	*B. rubens*	100	75	845	722	5786	2900	0	10428
21	*B. vulgatus*	0	0	0	0	1080	0	0	1080
22	*Collurella obtusa*	0	140	0	0	140	0	0	280
23	*Cyrtonia tuba*	0	0	0	460	0	0	0	460
24	*Diplosis davieisae*	0	0	0	0	180	0	0	180
25	*Durella sulcata*	0	0	0	108	0	375	0	483
26	*Elosa worralli*	0	0	0	0	3150	0	0	3150
27	*Euchlains* spp.	0	0	0	2000	910	1095	0	4005
28	*F. longiceta*	0	0	1850	106637	88230	36347	2185	235249
29	*Gastropus* spp.	0	0	0	0	0	750	0	750
30	*K. choclearis*	0	300	0	0	0	720	1780	2800

Table 4. *Continued...*

Sr. No	Species of Rotifers	S1	S2	S3	S4	S5	S6	S7	Total
31	*K. grilenta*	0	0	0	0	0	800		800
32	*K. tropica*	0	1145	2858	214418	1870	16950	2565	239806
33	*K. procurva*	0	0	0	131	0	0	0	131
34	*K. quadrata*	0	0	500	0	0	0	0	500
35	*Keratella spp.*	0	0	140	0	0	2480	130	2750
36	*L. ionopinata*	0	440	280	0	540	2200	400	3860
37	*Lecane luna*	0	610	0	0	0	0	2875	3485
38	*Lecane polenensis*	0	690	317	727	900	0	530	3164
39	*Lepadella bicornis*	0	0	0	108	0	0	0	108
40	*Lepadella cresta*	0	0	0	131	0	0	0	131
41	*Lepadella ovalis*	0	0	0	0	0	620	0	620
42	*Lepadella patella*	0	0	345	0	0	320	0	665
43	*Lepadella* spp.	0	0	635	120	420	0	0	1175
44	*Microcodieles robustus*	0	0	0	0	140	0	0	140
45	*M.bula*	200	543	811	4313	9990	2633	0	18490
46	*M. closteocerca*	0	0	0	1858	0	310	0	2168
47	*M.decipens*	0	510	805	112	180		0	1607
48	*Monostyla* spp	0	220	80	8345	0	931	0	9576
49	*Megalotrocha* spp.	0	0	0	108	0	0	0	108
50	*Notholca* spp.	0	200	175	8000	650	0	0	9025
51	*Notomata* spp.	0	900	1237	2240	260	0	0	4637
52	*Philodina* spp.	0	140	115	0	500	100	0	855
53	*Ploima* spp.	0	0	0	0	280	0	0	280
54	*Pompholyx complanata*	0	0	0	108	0	0	0	108
55	*Polyathra* spp.	0	0	250	0	0	375	0	625
56	*Rattulus* spp.	0	450	100	456	0	995	0	2001
57	*Testudinella* spp.	0	9930	950	2348	740	0	2970	16938
58	*Trichocerca* spp.	0	0	0	0	0	80	0	80
	Total	7382	90343	25531	732296	1021411	1686458	136917	3700338

Table 5. Correlation cooefficient between nutrients and rotifer

Category	Silicate	Nitrate	Phosphate	Hardness	Chlorides	Phytoplankton
Rotifers	-0.47	0.52	0.87	0.53	0.67	0.58
Brachionus spp.	-0.48	0.43	0.92	0.57	0.68	0.45
B. Patulus	-0.41	0.01	-0.29	-0.42	-0.42	-0.35
B. paracollurella	-0.23	-0.93	-0.30	-0.18	-0.45	-0.56

uted 7% of the total rotifer density. It was represented by five different species namely *K. choclearis, K. grilenta, K. procurva, K. quadranta and K. tropica.* Among the various species *K. tropica* was dominant. More diversity and richness was seen in summer season especially at downstream sites. However, the density at S5 was very less, which was equally polluted to that of S4 and S6 which had very high densities of *K. tropica.* The other species of *Keratella* encountered rarely.

The species like *Monostyla, Asplanchna, Filinia* were dominant at downstream sites indicating that they are pollution tolerant. The high densities of *Lecane* at S2 in postmonsoon period when the water was clean indicated that it is a pollution sensitive genus.

Statistical analysis indicated that the rotifers show strong positive correlation with nitrate, phosphate, and phytoplankton (Table 5). All these parameters indicate nutrient enriched condition. The correlation for the species like *B. patulus* and *B. paracollurella* which were seen only upstream was found to be negative denoting that they are found only in clean waters.

Discussion

As observed in the present study factors that support eutrophication favors the growth of specific rotifers whereas some rotifers get inversely affected with increase in these parameters.

The above results indicate that all the nutrients increased downwards indicating that the inlet of sewage and anthropogenic activities increase as the river approaches the town. The phytoplankton densities also increased downstream due to availability of nutrients. The nutrient and densities of phytoplankton and zooplankton also found to be increased in summer season which could be due to stagnancy and availability of food due to production of organic matter and decomposition (Kiran *et al.* 2007).

When the correlation among the rotifers and the nutrients was observed, the phosphate and nitrate showed very strong correlation with rotifers. The strong correlation between rotifer and phosphate is in accordance with Varghese and Krishnan (2011). Among the different species of rotifers, Brachionus spp. comprises largest proportion of rotifers, and thus its correlation with phosphate and nitrate was studied which was also found to be highly positive. According to Bahura *et al.* (1993) Brachionus is the indicator of eutrophication. According to Stevenson *et al.* (1998) and Mukhopadhyay *et al.* (2007) the density of B. calyciflorus increases with increasing concentration of waste water. Sampaio *et al.* (2002) are of opinion that B. calyciflorus is a good indicator of eutrophication. This is in accordance with the present study. However, the species of Brachionus such as B. paracollurella and B. patulus showed negative correlation with phosphate indicating their preference to oligotrophic water. *Lecane* spp. did not show any significant correlation with any of the nutrient nor with phytoplankton. This may indicate its incompatibility as pollution indicator. However, Pejler and Berzins 1994, Michalaudi et al. 1997, El-Bassat 2002 recorded this species in eutrophicated water.

Conclusion

From the present study, it is concluded that the density and diversity of rotifers increases with pollution. The genera like *Brachionus, Keratella, Filinia, Monostyla* and *Asplanchna* are pollution tolerant as their densities were observed to be very high at the downstream sites which had more anthropogenic impact. They are suitable to use as pollution indicator. *Brachionus patulas* and *B. paracollurella* are pollution sensitive genera and were confined to upstream sites where the water was clear.

Acknowledgement

The authors are thankful to the B.N. Bandodkar College of Science, Thane and C.K. Thakur College of Arts, Commerce and Science College, New Panvel for providing support to complete the research wrok.

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