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Research Paper

Pollution and Zooplankton Diversity in Koyali and Dumad Pond of Vadodara, Gujarat, India

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Abstract: *In present study, the Dumad pond was considered as non-polluted site and the Koyali pond as the polluted site, being in the middle of the industrial area. A comparison of the zooplanktonic community structure, population density and species richness clearly describe the deteriorating status of Koyali pond. Unfortunately, the pond is routinely used for fish culture practice, posing threat to the consumers and to the ecosystem as a whole. The zooplankton diversity of koyali and dumad pond can be chiefly represented by phyla Rotifer and Arthropoda. The rotifer community composed of one class, one order, 6 families and 20 genera/species. Family Branchionidae dominated with maximum of 14 genera. Family Filidinae and Lacinidae were represented by 2 genera while other 3 included one genus each (Table 1). Arthropods were classified into three classes, 4 orders, 11 families and 24 genera/ species.*

Keywords: *Pollution, Diversity, Arthropods, Species*

INTRODUCTION –

Zooplankton community structure is an indicator of biotic status of the ecosystem. A variation in community diversity and species density was correlated with toxicant inputs. Experiments on both freshwater and marine ecosystems have revealed that different pollutants can be dangerous to planktonic and benthic biodiversity. They have also shown that zooplankton rack up metals thousands of times more than those found in water (George and Kureishy, 1979; Khan and Rao, 1981; Gajbhiye *et al.*, 1985; Gautam, 1990; Zauke *et al.*, 1996; Pandya *et al.*, 2007). So, this study investigates the Pollution impacts on zooplankton. In India there are about 60000 inland water bodies i.e., ponds, lakes etc. with 3x10 6 ha of area (Mahajan, 1985).

The zooplanktons are good indicator of changes in water quality because they are strongly affected by environment conditions and responds quickly to changes in environment quality. The zooplanktons occupy a central position between arthropods and other heteropods and form an important link in food web of fresh water ecosystem. A knowledge of their abundance and seasonal variation therefore, is an essential pre-requisite for any successful aqua culture programme.

The present work has been undertaken to study the occurrence of particular group of Zooplankton or disappearance of specific group of zooplanktons in contaminated water of Koyali pond. The occurrence of or absence of zooplankton in water may be co-related with human activities & water quality. The zooplankton can be used as indicator specific water pollution causative factors in pond (Koyali) and it can be confirmed by comparing with the zooplankton The physico chemical condition of water influences the distribution of zooplanktons.

It has been found that survivality of the rotifers belonging to differ rent families are being determined by different sets of parameters viz. the most of the species of family branchionidae (branchionus calyciflorus, keretella cochlearis) was found to have been more independent on DO but species with well develop lorica such as branchionus, keretella built higher population during the period when the alkalinity was high (dhanpati2000).

MATERIALS ANS METHODS –

Sampling of Zooplankton

The Plankton Net: Fine nylon filament mesh of 20-micron size was used to prepare the plankton net of 30 cm diameter X 100 cm length. A bottle was attached to the end of the net cone for collection of the plankton.

Collection of Samples: The plankton net was drawn through the water and surface as well as sub-surface samples up to one meter depth were collected. The collected planktons were transferred to 100 ml containers for further processing. Alternatively, 20 l water was drained through the net and the plankton were collected and processed further.

Narcotizing, Relaxing and Preservation: The samples were subjected to low and gradual narcotization using menthol crystals and alcohol over a period of around six hours to permit relaxation of organisms. Then gradually formalin was added to the samples. After 24 h, the samples were centrifuged at low rate for 5 min and then transferred to fresh water and preserved with formalin.

Microscopic Observations: The preserved samples without any further dilutions or concentration were used for qualitative and quantitative studies of zooplanktons. Larger animals were observed under simple microscope while all other analyses were carried out using compound microscope at 45X. The unstained preparation of zooplankton was studied. The identification of zooplankton was done using descriptive or illustrative keys (Needham and Needham, 1962; Edmondson, 1959; Tonapi, 1982; Adoni, 1985). Attempts were made to identify all the zooplankton up to genus and species level. However, in some cases it was not possible due to either insufficient literature or due to ambiguity of identification character, therefore, such specimens were identified at least up to family/genus level. Recent taxonomic keys were utilized to classify the plankton.

Quantification Studies: Quantitative analysis was carried out from same samples to study the density of various zooplanktons. This is finally represented as no of zooplankton per liter of water samples. The Sedzwick-Rafter (SR) counter was used for quantification. The sample was gently, but thoroughly shaken and was placed immediately on the SR counter and covered with the cover glass. One end of the cover glass was focused under microscope and after careful scanning of species and its number, the SR counter was shifted to next field and proceeded parallel to first observation in reverse direction. Depending on the density, further dilution was made and zooplanktons were counted to note density and percentage composition (Verma, 2010).

Number of organisms per liter = (crude count of plankton) X (standard factor)
Standard factor = [Net towing distance (length)] X [net towing instances] X [area of net operation (cylinder of water corresponding to the net)]
Alternatively, where samples were also collected by measured volume of water, drop count method was employed as below:
Number of organisms per liter = A x 1/L x N/V

Where A= number of organisms per drop,
L= Volume of original sample
N= Volume of concentrated sample,
V= Volume of one drop
In all the cases the first method was used predominantly. The other method was employed for comparison purpose only (Verma, 2010).

Data Analysis: The data were subjected to statistical analysis using various population indices.
Species density, D (No./ l) = Total number of animals of a species / Volume of sample.
Group wise relative density, RDG =Species density / total density of a phylum x100.
Total relative density, RDT = Species density / total density at a site x 100.

Population Indices: Several population indices were calculated for comparison of the diversity at the study sites; e.g., Shannon, Simpson, Menhinick, Mergalef and Burger and Parker (Shannon and Weaver, 1949; Simpson, 1949; Menhinick, 1964; Margalef, 1968; Berger and Parker, 1970).

RESULT AND DISCUSSION –
The zooplankton diversity was chiefly represented by phyla Rotifer and Arthropoda. The rotifer community composed of one class, one order, 6 families and 20 genera/species. Family Branchionidae dominated with maximum of 14 genera. Family Filidinae and Lacinidae were represented by 2 genera while other 3 included one genus each (Table 1). Arthropods were classified into three classes, 4 orders, 11 families and 24 genera/ species. Dumad pond system had comparatively higher density of zooplanktons then that noticed at Koyali. The annual averages of copepods were high at Koyali (63.3 No/l), while at Dumad (49.2 No/l). The average of total zooplanktons population over the year was 250.9 No/l and 171 No/l at Dumad and Koyali, respectively.

Both at Dumad and Koyali maximum density of zooplankton was during December which gradually reduced with minimum density during March. During Monsoon the population density increased. It was interested to note that the pattern of month wise variation in zooplankton density were almost similar at both the study sites (Table -4). At Koyali, maximum density was 200 No/l, in November 2007, while at Dumad it was noted 303.8 No/l in December 2007. The minimum planktonic density at Koyali was 130.32 No/l in May 2008 while the lowest at Dumad was 211.7 No/l in March 2008 (Table -2). The season wise percentage composition of overall zooplankton community did not differ much between Koyali and Dumad (Table -1,2,3,4) (Verma, 2010). When group wise analysis was carried out, it was noted that copepods constituted more than 35% of zooplankton community at Koyali, while they range between 16% to 25% at Dumad (Table -4). On the other, the rotifer population at Dumad ranged from 28% to 34% while, at Koyali it ranged from 19% to 22%. At Dumad of the total 44 taxa, maximum 39 taxa were recorded in August 2008, while minimum (31) was recorded during October, March, April, May (Table 3). At Koyali maximum 32 taxa were recorded in October 2007 and minimum 18 taxa were recorded in December 2007. The annual average numbers of taxa were 32 and 22 at Dumad and Koyali, respectively (Verma, 2010).

Of the total 4 species recorded of Cladocera and Ostracoda at any given time the number of species recorded at Dumad and Koyali were 8 to 12 and 8 to 11 respectively (Table 4).

At Dumad, for major portion of the observation period, only 4 out of 10 copepod species were recorded while at Koyali mostly 5-6 species were generally recorded with maximum numbers of 8 taxa in November 2007 (Table 4).

Table -1: Check list and classification of Planktonic Rotifers and Arthropods

CLASS	FAMILY	ORDER	GENUS
Seisonidea	Bdelloida	Philodinidae	*Philodina, Rotaria*
Monogononta	Ploimida	Brachionidae	*Brachionus angularis, Brachionus Calyciflorus, Brachionus divercicornis, Branchionus plicatalis, Brachionus quadrideantatus, Brachionus rubens, Keratella quadrata, Keratella cochleris, Keratella Tropica, Keratella valga, Aneurea, Nothelca, Platyais quadricornis, Platyais longispinosus*
		Filinidae	*Filinia*
		Lecanidae	*Lacaneae bulla, Lecane ploenensis*
		Scarididae	*Scaridium longicaudatum*
		Asplanchnidae	*Asplacha periodontal*
Mandibulata	Cladocera	Sididae	*Sida Latreille*
		Bosminidae	*Bosmina logirostris*
		Chydoridae	*Alonella, Alona, Leydigia, Polyphemus*
		Daphnidae	*Ceridephania quadragula, Daphnia longishonia, Daphniopsis, Simocephalus*
Ostracoda	Podocopa	Moinidae	*Moina, Moinodaphnia*
		Cyprididae	*Cypris*
		Macrothricidae	*Macrothrix*
Copepoda	Calanoida	Calanidae	*Calanus*
		Psudo Calanidae	*Psudocalanus*
		Diaptomidae	*Diaptomus, Heliodiaptomus viduus, Neodiaptomus, Streptocephalus diaptomus*
	Cyclopoida		*Cyclops, Eucyclopus agilis, Eucylops sepratus, Mesocyclop aspericornis, Microcyclopus*

Table-2: Zooplanktons Density at Koyali and Dumad Ponds (No. /l)

		Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08
Rotifers	Dumad	66.6	100.0	117.6	85.3	67.6	66.6	61.7	56.8	65.7	77.4	77.4	77.4
	Koyali	40.2	55.9	30.4	33.3	32.3	32.3	28.4	21.6	36.3	30.4	35.3	41.2
Cladocera and Ostracoda	Dumad	123.5	100.0	106.8	112.7	104.9	61.7	71.5	71.5	97.0	110.7	99.0	91.1
	Koyali	56.8	53.9	56.8	51.9	56.8	34.3	56.8	52.9	53.9	58.8	60.8	56.8
Copepods	Dumad	47.0	40.2	39.2	43.1	50.0	54.9	58.8	58.8	45.1	46.1	42.1	65.7
	Koyali	65.7	69.6	66.6	65.7	60.8	46.1	60.8	44.1	63.7	81.3	63.7	70.6
Arthropod Larvae	Dumad	23.5	28.4	40.2	28.4	28.4	28.4	29.4	29.4	28.4	28.4	28.4	28.4
	Koyali	19.6	20.6	21.6	22.5	18.6	20.6	17.6	11.8	15.7	19.6	19.6	18.6
Total Zooplanktons	Dumad	260.7	268.5	303.8	269.5	250.9	211.7	221.5	216.6	236.2	262.6	247.0	262.6
	Koyali	182.3	199.9	175.4	173.5	168.6	133.3	163.7	130.3	169.5	190.1	179.3	187.2

Table -3: Occurrence of number of taxa during the observation period at the study sites

		Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Annual average
Rotifers	Dumad	15	14	17	14	15	13	13	13	13	13	13	13	13.83
	Koyali	6	8	4	6	6	8	4	6	5	4	8	8	6.08
Cladocera and Ostracoda	Dumad	10	11	11	12	10	10	9	8	10	11	10	11	10.25
	Koyali	9	9	9	9	8	9	9	9	11	10	10	8	9.17
Copepods	Dumad	4	4	4	4	4	4	6	6	6	5	4	5	4.67
	Koyali	2	3	5	3	3	3	3	3	3	3	2	3	3.00
Arthropod Larvae	Dumad	6	8	4	4	5	5	5	4	5	6	5	6	5.25
	Koyali	1	1	1	1	1	1	1	1	1	2	2	1	1.17
Total Zooplanktons	Dumad	31	32	37	23	32	31	31	31	32	33	39	32	32.00
	Koyali	32	26	18	20	21	22	19	20	21	22	25	22	22.33

Table -4: Population Indices

Population Indices	Study sites	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08
Shannon	Dumad	2.19	2.17	2.3	2.19	3.17	3.04	2.63	2.88	2.83	2.56	2.19	2.39
	Koyali	2.07	2.07	1.94	1.79	2.63	2.63	2.3	2.39	2.19	2.39	2.02	2.07
Merglef	Dumad	3.64	3.64	3.9	3.64	7.23	6.56	4.92	5.64	5.64	4.67	2.36	4.17
	Koyali	3.36	3.36	3.08	0.27	4.92	4.92	3.9	4.17	3.64	4.17	3.36	3.36
Dominance	Dumad	0.11	0.11	0.11	0.11	0.16	0.04	0.04	0.07	0.05	0.05	0.76	0.11
	Koyali	3.36	3.36	3.08	0.27	4.92	4.92	3.9	4.17	3.64	4.17	3.36	3.36
Simpson	Dumad	0.11	0.11	0.11	0.11	0.16	0.04	0.04	0.07	0.05	0.05	0.76	0.11
	Koyali	0.87	0.87	0.85	0.83	0.92	0.92	0.92	0.9	0.9	0.88	0.9	0.87
Berger Parker	Dumad	0.11	0.11	0.11	0.11	0.16	0.04	0.04	0.07	0.05	0.05	0.76	0.11
	Koyali	0.12	0.12	0.14	0.16	0.07	0.07	0.1	0.09	0.11	0.09	0.12	0.12

CONCLUSION –

The complexity of lentic system increase multi folds due to prominent climatic and seasonal influences and variable inputs; as diverse as precipitation inflow, domestic waste and industrial pollutants. Under such circumstances it is necessary to comprehensively analyze and integrate the biotic and abiotic components. The responses of animals may be seen as generalized or specialized adaptations, alterations in reproductive strategies or even evacuation of habitat (Adam, 2000). If the pollution sensitive taxa decrease in diversity or are lost then the food webs are disturbed and overall diversity and density of several other groups may get reduced. On the other hand, pollution tolerant species may flourish even at the cost of other taxa (Nassar, 2009). During past few decades aquatic toxicology, particularly in stream and river systems, has been the major area of research owing to pollution inputs from domestic and industrial wastes (Beck, 1954; Desai *et al.*, 1981; Cottenie *et al.*, 2001; Nanda, 2003; Begum *et al.*, 2003; Sharma, 2006; Rejomon *et al.*, 2008). Studies both on freshwater and marine systems have reported toxic potentials of various pollutants on planktonic and benthic fauna as well as demonstrated that zooplankton accumulate metals several thousand times more than those detected in water (George and Kureishy, 1979; Khan and Rao, 1981; Gajbhiye *et al.*, 1985; Gautam, 1990; Zauke *et al.*, 1996).

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