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Occurrence and Spatial Distribution of Brachionus Species: A Bioindicator of Eutrophication in Bhoj Wetland, Bhopal

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Abstract. The aim of this study conducted during 2008-2009 was to explore the impact of water quality on *Brachionus* species in littoral zone of Bhoj wetland as they are particularly sensitive to changes in water quality. Since *Brachionus* species are usually considered to be useful indicators of water quality their community structure not only allows estimates of the level of pollution but also indicate the trend of general conditions over time. In the present investigation seven species viz., *Brachionus caudatus*, *Br. falcatus*, *Br. calyciflorus*, *Br. angularis*, *Br. forficula*, *Br. quadridentata* and *Br. urceus* were recorded in the wetland.

Keywords: *Brachionus* spp., bioindicator, trophic status, Bhoj wetland.

Introduction

Zooplankton grazing on phytoplankton can transfer more than 50% of carbon fixed by primary production to higher trophic levels (HART *et al.,* 2000; LAWS *et al.,* 1988; SCAVIA, 1980). Zooplanktons are microscopic organisms which do not have the power of locomotion and move at the mercy of the water movements. The organization of biological communities in aquatic ecosystems is closely dependent on the variations of physical and chemical conditions linked to natural and anthropogenic factors (POURRIOT & MEYBECK, 1995). The zooplankton communities, very sensitive to environmental modifications, are important indicators for evaluating the ecological status of these ecosystems (MAGADZA, 1994). The presence and the relative predominance of various copepod species have been used to characterize the eutrophication level of aquatic ecosystems (PARK & MARSHALL, 2000; BONECKER *et al.,* 2001). Herbivorous zooplankton is recognized as the main agent for the top-down control of phytoplankton, and the grazing pressure exerted by cladocerans and copepods on algae and cyanobacteria is sometimes an important controlling factor of harmful algal blooms (BOON *et al.,* 1994).

Rotifers occur almost everywhere and constitute an important group of zooplankton community in aquatic ecosystems of the world. The abundance of rotifers is more or less governed by the interaction of a number of physical, chemical and biological properties of ambient waters. Rotifers, especially *Brachionus*, constitute an important link in the food chain of inland waters. They are considered preferred food for many fish

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larvae (GUERGUESS, 1993). The rotifer communities of Bhoj wetland – an important man made Ramsar site of central India has great biogenic, ecological and socio-economic importance. It is under severe environmental stress on account of anthropogenic pressure. Attempts are being initiated for its management and biodiversity conservation.

Materials and Methods

Bhoj wetland (located in the Bhopal city, the state capital of Madhya Pradesh, India (latitude 23° 12′-23° 16′ N and longitude 77°18′–77° 23′ E), is the backbone of Bhopal having profound economic and irrigational importance. It has an area of 31 km^2 and a catchment area of 361 km^2. The various physico-chemical characteristics such as temperature, pH, conductivity, TDS, D.O, Free CO2, total alkalinity, Hardness (total, calcium and magnesium), Chloride, nitrate and phosphate were analysed using the standard APHA (2000) and ADONI (1985) methods.

For the quantitative analysis of zooplankton, 10 liters of surface water samples were collected with minimal disturbance and filtered through a No. 25 bolting silk cloth net of mesh size 63 µm and concentrated to 100 ml and were preserved by adding 2ml of 4% formalin simultaneously. The quantitative analysis of zooplankton was carried in Sedgwick-Rafter cell. Identification of the samples was performed following the works of EDMONDSON (1959) and ADONI (1985). The results have been expressed as ind.l^{-1} (WANGANEO & WANGANEO, 2006).

$$\text{Number of zooplankton “n” } = \frac{C \times 1000\ mm^2}{A \times D \times E}$$

where C = Number of organisms recorded; A = Area of field of microscope; D = Depth of field (SRC depth) in mm; E = Number of fields counted.

$$\frac{\text{Number of zooplankton}}{1} = \frac{n \times Vol.of\ concentrat}{(ml)}$$

Results

Physico-chemical characteristics

The physico-chemical parameters of water in upper basin of Bhoj wetland have been given in the Table 1. The atmospheric temperature ranged from 21.63 ^oC to 39.83 ^oC. Water temperature varied between 18.13°C to 27.13°C depending on the seasonal atmospheric temperature.The pH value ranged between 7.62 to 8.61units indicating its alkaline nature. Electrical conductivity values ranged from 231.11 to 413.75µS/cm at 25°C. Total dissolved solids fluctuated from 148.89 mg/l to 256.67mg/l. Dissolved oxygen content of water samples varied between 3.96 mg/l and7.78 mg/l. The total alkalinity value fluctuated between 48.11 mg/l and 128.75 mg /l. Increase in alkalinity values is related to the decrease in the water level. The value of total hardness fluctuated from 74.89mg/l to 146.25mg/l. In the wetland the average values of calcium hardness in waters varied from 60.40 mg/l to 102.23 mg/l. On the other hand, minimum magnesium hardness was noted to be 3.12 mg/l as against maximum value of 10.70 mg/l. The chloride concentrations in the wetland waters ranged between 23.9 mg/l and 54.5 mg/l. The nitrate nitrogen content varied aberrantly throughout the study period. Phosphorus, the most vital nutrient effecting productivity of natural water, fluctuated between 0.13 mg/l to 0.69 mg/l.

Study conducted on the zooplankton group revealed dominance of seven *Brachionus* spp., among the rotifer group. Each species viz., *Br. caudatus*, *Br. falcatus*, *Br. calyciflorus*, *Br. angularis, Br. forficula, Br. quadridentata* and *Br. urceus* contributed a percentage of 46%, 18%, 15%,14%, 5% and 1% respectively (Fig. 1).

Zooplankton

Seven species of genus *Brachionus* identified from the eight different sites of the Bhoj wetland revealed that site I (Kamla park) recorded relatively maximum population density (1030 Ind. l^{-1}) followed by site VII near Prempura Ghat (1000 Ind.l^{-1}). Site II (Gandhi medical college) recorded least density (60 Ind.1^{-1}) Table 2 and Fig. 2.

Table 1. Physico-chemical parameters on annual mean basis

Parameter	Unit	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan
AT	°C	29.33	34.67	37.44	39.83	30.56	34.89	29.67	29.44	29.67	27.78	23.78	21.63
WT	°C	18.56	26.33	24.44	24.44	27.13	20.44	22.22	25.44	24.11	22.00	20.67	18.13
pH	Units	8.20	8.19	8.61	8.59	7.87	7.79	7.62	7.82	8.09	8.12	8.22	8.50
TDS	$mg1^{-1}$	148.89	168.89	172.22	166.67	177.78	256.67	167.78	176.67	205.56	196.67	172.22	195.00
EC	µS/cm	231.11	245.56	265.56	251.11	267.78	286.67	257.78	264.44	307.78	305.56	288.89	413.75
DO	$mg1^{-1}$	6.09	6.21	7.13	7.78	7.60	6.83	7.24	6.47	6.79	5.29	7.04	3.96
T. Alk	$mg1^{-1}$	80.44	93.11	48.11	100.22	84.44	81.33	79.78	75.78	79.67	89.33	86.44	128.75
T. Ha	$mg1^{-1}$	84.89	97.11	94.56	98.11	74.89	86.22	83.11	83.33	97.56	98.67	114.44	146.25
Ca . Ha	$mg1^{-1}$	70.89	79.20	74.14	69.44	62.04	60.40	63.22	63.00	70.21	70.43	76.01	102.23
Mg. Ha	$mg1^{-1}$	3.40	4.08	4.95	6.96	3.12	6.27	4.83	4.94	6.64	6.86	9.34	10.70
Chloride	$mg1^{-1}$	23.9	25.1	33.7	34.3	32.3	33.2	29.6	31.8	35.5	44.8	47.2	54.5
Nitrate	$mg1^{-1}$	0.48	0.39	0.50	0.62	0.57	0.75	0.52	0.47	0.59	0.56	0.48	0.45
T. Phos	$mg1^{-1}$	0.17	0.18	0.18	0.27	0.24	0.26	0.27	0.25	0.29	0.33	0.13	0.69

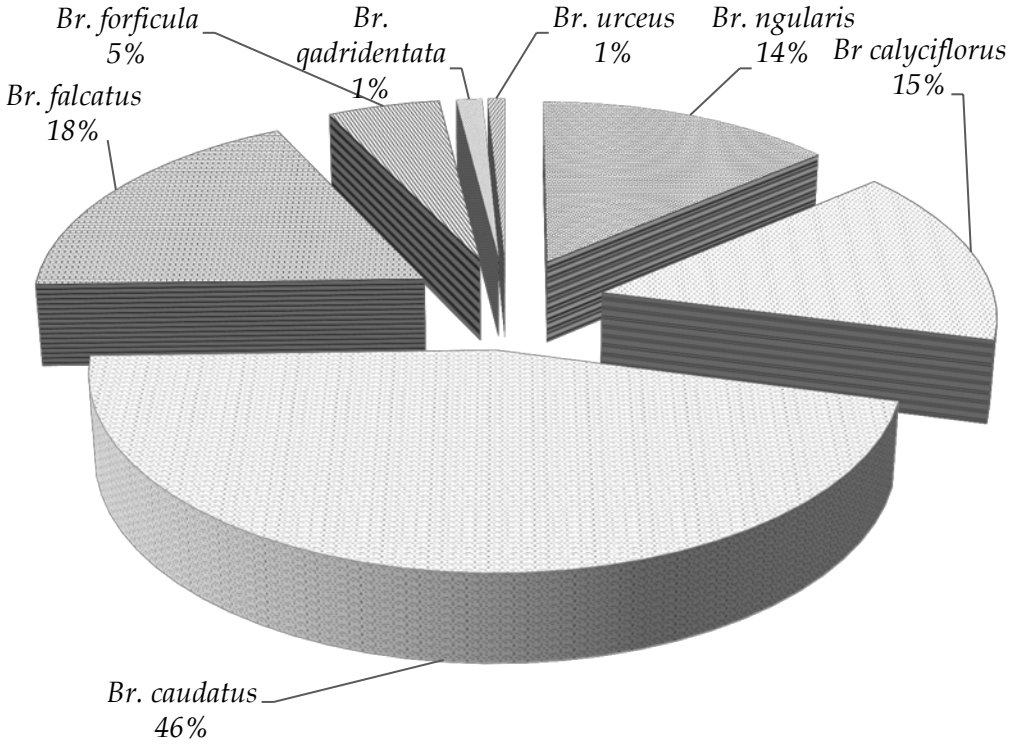


Fig. 1. Percent contribution of different species of *Brachionus* species.

On the basis of site average values, *Brachionus caudatus* contributed maximum density of 284 Ind. 1^{-1} while *Brachionus urceus* was represented by a least density of 5 Ind. 1^{-1}.

Brachionus caudatus recorded the highest population density throughout the study period except at sites II, VII, VIII respectively (10 Ind. 1^{-1}, 180 Ind. 1^{-1} and 80 Ind. 1^{-1}). At sites II (20 Ind.1^{-1}) and VIII (150 Ind.1^{-1}) it was *Brachionus calyciflorus* and at site VII *Brachionus angularis* (360 Ind.1^{-1}) was the dominant species.

In the present investigation of Bhoj wetland, on an average basis, *Brachionus caudatus* (189 Ind.1^{-1}) was recorded the maximum represented species density in the study period while *Brachionus urceus* (3.0 Ind.1^{-1}) was recorded least represented species (Table 3).

On an overall monthly basis, highest numerical density (990 Ind. 1^{-1}) was

documenting in the month of July while lowest (20 Ind.1^{-1}) was recorded in the month of August. On monthly basis among species, highest population density (620 Ind. 1^{-1}) was represented by *Brachionus caudatus* in the month of December while same species (500 Ind.1^{-1}) were also registered in the month of July (Table 3 and Fig. 3).

The similarity between stations depending on different *Brachionus* species, the results of the Bray-Curtis cluster analysis are shown in Fig. 4. During the period of study highest similarity were observed between sites V and VI. These were linked together at level 1 (first joint). Further, second highest similarity was observed between sites III and VIII hence linked together at level 2. All the species have similar distributional patterns at these two pair of sites. However, most dissimilar community composition was found at site II with rest of the sites (Fig. 4).

Table 2. Quantitative enumeration of *Brachionus* Species on the basis of site variation

Species	I	II	III	IV	V	VI	VII	VIII	$\bar{X}$	SD ±
Br. angularis	20	0	20	30	110	60	360	90	**86**	117
Br. calyciflorus	70	20	40	80	20	160	220	150	**95**	74
Br. caudatus	520	10	80	310	570	520	180	80	**284**	228
Br. falcatus	380	10	30	90	130	180	60	30	**114**	122
Br. forficula	40	10	20	20	10	20	140	0	**33**	45
Br. quadridentata	0	10	10	10	0	0	20	10	**8**	7
Br. urceus	0	0	0	0	0	0	20	20	**5**	9
Total	**1030**	**60**	**200**	**540**	**840**	**940**	**1000**	**380**		

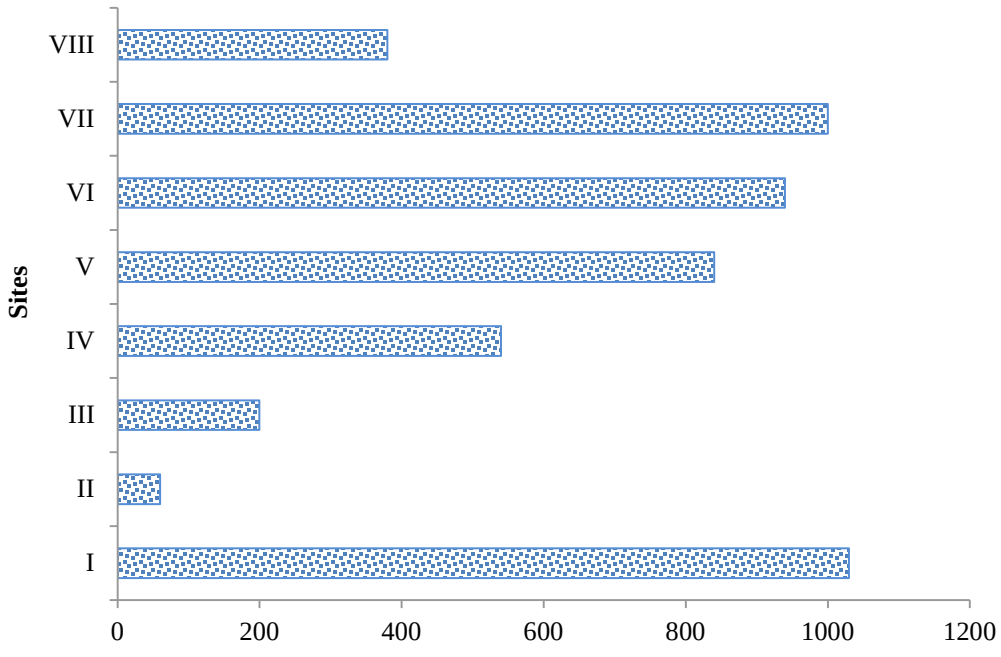
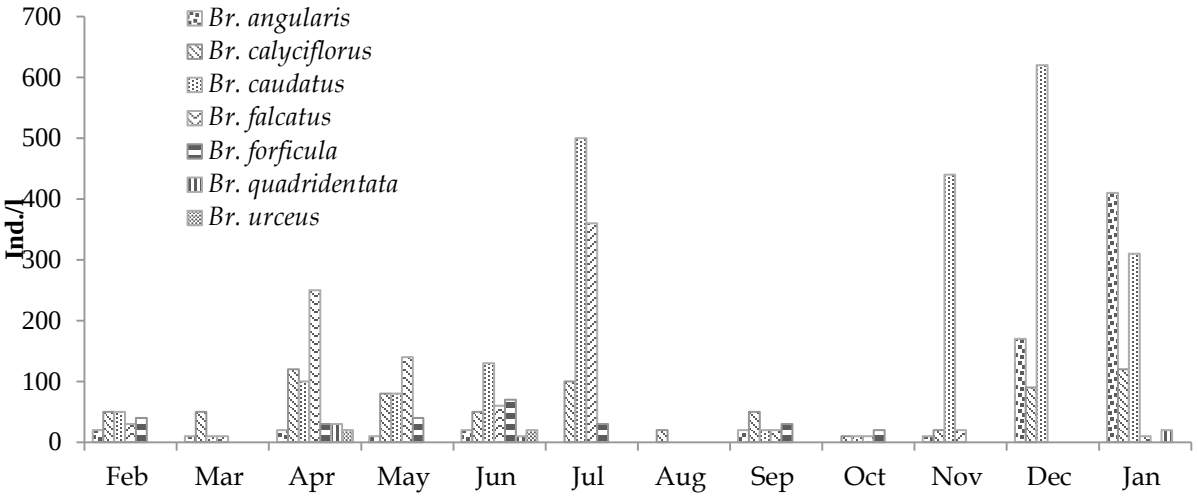


Fig. 2. Variation of different sites.

Table 3. Quantitative enumeration of *Brachionus* species (Ind. 1^{-1}) during 2008-2009.

Species	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Average
Br. angularis	20	10	20	10	20	-	-	20	-	10	170	410	**58**
Br. calyciflorus	50	50	120	80	50	100	20	50	10	20	90	120	**63**
Br. caudatus	50	10	100	80	130	500	-	20	10	440	620	310	**189**
Br. falcatus	30	10	250	140	60	360	-	20	10	20	-	10	**76**
Br. forficula	40	-	30	40	70	30	-	30	20	-	-	-	**22**
Br. quadridentata	-	-	30	-	10	-	-	-	-	-	-	20	**5.0**
Br. urceus	-	-	20	-	20	-	-	-	-	-	-	-	**3.0**
Total	190	80	570	350	360	**990**	20	140	50	490	**880**	**870**	**416**



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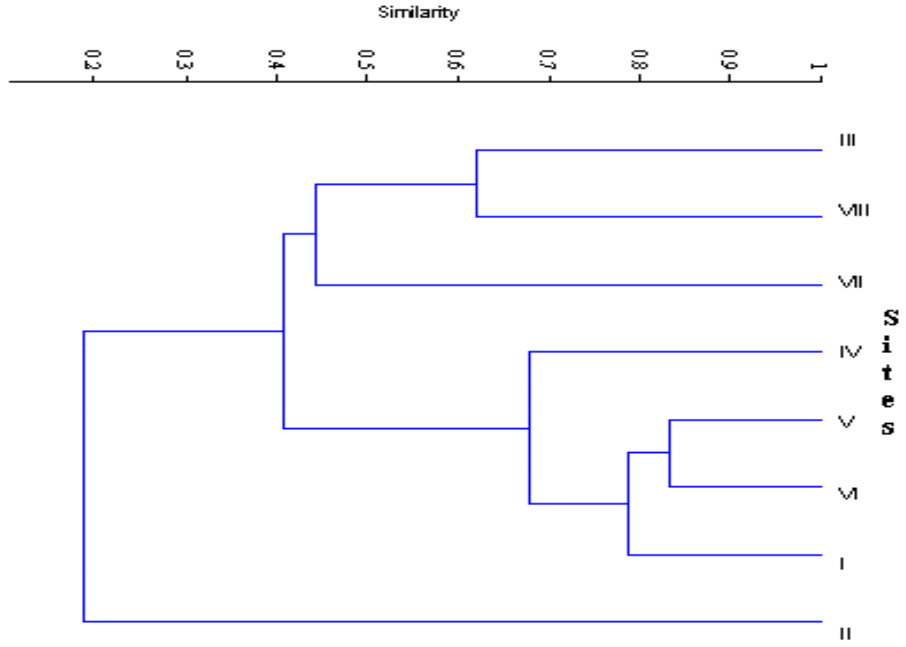

Fig. 4. Bray-Curtis cluster analysis.

Discussion

Brachionus formed the dominant and diversified genus among the rotifers throughout the study period. These species are found extensively in eutrophic waters (BERZINS & PEJLER, 1989; SAMPAIO *et al*., 2002). *Brachionus* species has cosmopolitan distribution in India and during the present study; it was represented by seven species viz., *Brachionus angularis, Br. calyciflorus, Br. caudatus, Br. falcatus, Br. forficula, Br. quadridentata* and *Br. urceus*. HUTCHINSON (1967) observed that *Brachionus* species are very common in temperate and tropical waters, having alkaline pH. MAGEED (2008) and UZMA (2009) stated that presence of more than five species of *Brachionus* reflects eutrophication of water bodies.

KAUSHIK & SAXENA (1995) have also reported abundance of *Brachionus* in various water bodies of central India. An abundance of *Brachionus* in tropical region has been registered and various species of this genus dominate plankton community in warmer part of peninsular India (FERNANDO, 1980; HILLBRITCH-ILKOWSKA, 1983; GULATI, 1990; ERBERN *et al*., 2002; YILDIZ *et al*., 2007). In the present investigation nutrients like phosphate and nitrate were in higher concentration due to decreased water level by evaporation and more organic load due to anthropogenic activities. These nutrients have been chiefly responsible for an increase in organic production particularly in the form of dense macrophytic growth and the overall deterioration of water quality. The deterioration of water quality and other associated problems as a result of racing eutrophication have reduced the recreational and aesthetic appeal of the wetland, besides other economic benefits.

Keratella with *Brachionus* is indicative of nutrient rich status of the water body (BERZINS & PEJLER, 1987). High concentration of rotiferan *Brachionus* species in the waterbody may be due the alkaline nature of water. According to DHANPATHI (2000) many species of rotifers are having preference for more alkaline water. The species like *Brachionus* build higher population during period when alkalinity is high.

Brachionides (*Brachionus* spp.) were the most dominant genera in the present study. Abundance of such species is considered as biological indicator for eutrophy (NOGUEIRA, 2001) and SLADECEK (1983) also suggests that this genus is the index of eutrophic water. MULANI *et al*., 2009) reported *Brachionus* spp. to be present in typical tropical conditions while SAMPAIO *et al*. (2002) reported *Brachionus* spp. to be indicator of eutrophication.

Among the 7 species of genus, *Brachionus caudatus* was the most dominant, which is supported by the observations of Nene (1985) observed its highest abundance in Masunda lake. PATHAK & MUDGAL (2002) recorded this spp. as one of the dominant rotifer member in Virla reservoir (M.P).

Brachionus calyciflorus in particular is considered to be a good indicator of eutrophication (SAMPAIO *et al*., 2002). Further, as per SAMPAIO *et al*., (2002); DULIC *et al*., (2006) and SOUSA *et al*., (2008) *Brachionus* genus is renowned to tolerate polluted waters.

However, quantitatively *Brachionus* was the main and significantly abundant genera interms of abundance and periodicity. This was in accordance with observations of GEORGE (1961); JAYA (1994); HIWARE & JADHAV (1998).

The sustainable domination structure and high species diversity in Bhoj wetland indicate a higher ecological status of the wetland, although high densities of Rotiferan *Brachionus* species can indicate the rising fertility of the wetland. The present studies indicate the bio diverse nature of rotifers of Bhoj wetland waters during the study period in which physico-chemical and environmental factors play a crucial role in determining the diversity and density of *Brachionus*.

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