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# Population dynamics of planktonic rotifers in the southern coastal area of Bangladesh

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## ABSTRACT

The assemble of rotifer communities as well as their relationship to several environmental variables and with other planktonic communities were studied in some coastal ponds of Bakerganj, Barisal during April 2006 to March 2007. In this study five groups of zooplankton were recorded and these were rotifers, nauplii, copepoda, cladocerans and protozoa. The occurrence of different groups of zooplankton was rotifer 41.26 %, nauplii 27.28 %, copepoda 22.34 %, cladocera 8 %, protozoa 1.12 %, respectively. A total of 19 genera and 38 species of rotifer were identified from the seven ponds and a river of the studied area and among them the abundance of major genera of rotifers were brachionus> polyarthra> trichocerca> filinia> keratella >other species, respectively. The highest abundance of rotifer was found in winter and lowest in monsoon. On the other hand, cladocera, copepoda and bauplii were recorded highest in summer and lowest in winter where as protozoa was highest in monsoon and lowest in summer. In this study, protozoa, copepoda, cladocera were considered as biotic factor of the ponds. Some physicochemical parameters of the water such as pH, dissolved oxygen (DO), air and water temperatures of the study areas were recorded during the study period. The water quality was positively or negatively related to the abundance of rotifer. Among the rotifer two types were responded to temperature. One type (*Brachionus, Trichocerca, Filinia*) preferred high temperature (29-31ºC) and other type (*Polyarthra, Keratella*) preferred low temperature (20-24ºC). It is also observed that total rotifer density was largest at 24ºC. In conclusion, among the environmental factors the influence of temperature on rotifer species is abundance and river did not appear to be rich in planktonic rotifer community.

**Key words:** Zooplankton, rotifer, temperature, Barisal, Bangladesh.

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## INTRODUCTION

The steadily deteriorating quality of surface waters is a common and widespread problem all over the world. Different environmental factors determine the characters of water which have great important upon the growth, maturity, reproduction and development of aquatic organism specially zooplankton. Changes in environmental factors like temperature, pH, dissolved oxygen, free carbon dioxide, alkalinity, and some other salts affect the growth, development and maturity of zooplankton and other aquatic organisms (Nikolsky, 1963). Zooplankton is composed of aquatic organisms with high environmental sensitivity, which can be used as bio indicators of environmental changes (Pinto-Coelho et. al, 2005). Among the zooplankton, rotifer are small organism and react faster to changes in water conditions than other zoological groups of freshwater due to their short development cycle. Rotifer are considered to be the most sensitive group to physical and chemical environmental changes (Gannon and Stemberger, 1978) and may be useful for biological monitoring . Many studies have been focused on rotifer responses to abiotic factors and tried to establish one to one causal relationships between rotifer composition and trophic conditions (Castro et.al, 2005; Duggan et. al, 2002; Sellami et. al, 2009; Biela´nska-Grajner,

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2005; May and O'Hare, 2005; Arora,1966; Duggan et.al, 2001).The aim of this study is to documented the changes in the density and species composition of planktonic rotifers as well as their relationship to several environmental factors particularly the influence of temperature. The study will be helpful to understand the ecological status of rotifers in the southern coastal area of Bangladesh in relation to environmental change.

## MATERIALS AND METHODS

This study was conducted at Bakerganj of Barisal District located about 68 Km far from the Bay of Bengal during the period of April 2006 to March 2007. Geographical location of the study area was between 22°-29' N to 22°-30' N and 90 °-22' E. The area is in between the junction of costal and freshwater flood plain. Samplings were done at eight different sites including seven ponds (5 pristine and 2 culture ponds) and one river. The whole year during the study period was divided into three seasons namely winter (November to February), Summer (March to June), Monsoon (July to October). Sampling was done twelve times at these sites.

### Sampling Sites

Site-1: Bakerganj Helipad Govt. Pond (Pristine pond)
Site-2: Bharpasa Mukherji Bari Pond (Pristine pond)
Site-3: Bharpasa Jam-E-Mosque Pond (Pristine pond)
Site-4: Upazila health complex mosque pond (Pristine pond)
Site-5: Tulatuli river side
Site-6: Harun Dakua's pond (culture pond)
Site-7: Bara Aulia's Mazar pond (Pristine pond)
Site-8: Bairam Kha's lake (culture pond)

### Water quality reading

Assessment of dissolved oxygen (DO) was recorded by using the HACH water quality analysis kit (FF2, USA), pH was measured by pH meter (HANNA, Field X-2, Italy). Estimation of air temperature, water temperature was recorded by digital thermometer.

### Collection of sample

Sampling were done monthly basis so twelve times sample were collected during the study period. Collection of sample was done from the selected area between 9 a.m. to 12 a.m. on the sampling day. In each pond samples were collected from five surface points and five column points. Surface points were the four corners and the middle of the pond. Column points were same to surface and one meter deep from the surface. Zooplankton was collected in each sampling site through plankton net of 64 µm mesh nylon net (Millipore corp, Bedford, MA) size by passing 100 liter of water through it. Fifty milliliter (ml) of condensed zooplankton sample was preserved by 5% buffer formalin. Part of this sample was supplied to the Department of Zoology for Zooplankton analysis by ICDDR, B. To avoid the risk of overlapping zooplankton 1 ml of the 50 ml concentrates were diluted with 5ml distilled water. Enumeration of plankton was performed by using counting cells. Sedgeweak-Rafter (S-R) counting cell was used to enumerate the zooplankton. The supplied sample was usually observed under compound microscope (10x eye piece and 4X-20X objective).The identification of zooplankton species was done with the help of different literatures (Edmonson1959, Needham and Needham1961, Mellanby1971, Tonapi1980, Ali and chakraborti 1992). Following formula was used for the total counting of the zooplankton:

$$Z_L = \frac{Z_C}{W}\left(\frac{S\ X\ B}{s\ X\ S_b}\right)$$

Where,
ZL = Zooplankton/Liter.
ZC = Total number of organism counted in total 3 ml sample
S = Volume of sample in ml
B = Volume of bucket sample in ml
s = Volume of examined sample in ml
Sb = Volume of sub-sample (part of sample examined) in ml.

### Statistical Analysis

The relationship between the environmental factors and biological parameters was observed by using the standard formula of Karl Pearson's co-efficient of correlation (r). T test was used to measure the level of significance of relationship between the different parameters.

## RESULTS AND DISCUSSION

### Abundance of zooplankton

The monthly abundance of total zooplankton varied from 497 indiv/L in March to 4933 indiv/L in May with an average of 1781 indiv/L (figure 1). This study mainly focused on the abundance of rotifer. From the accumulated data in a year the monthly abundance of rotifer varied from 280 indiv/L in September to 2059 indiv/L in February with an average of 736 indiv/L (table1). Among the different groups of zooplankton the occurrence of rotifer, copepoda, nauplii, cladocera and protozoa was 41.26%, 22.34%, 27.28%, 8% and 1.12%, respectively (figure 2).

Rotifers were found to be the most dominant group of zooplankton in the ponds of Bakerganj. The highest abundance of rotifer was recorded in winter 3462 indiv/L (average number of the eight sites) and the lowest was recorded in monsoon 2367 indiv/L and in summer it was 2994 ind/L. Whereas copepod, nauplii and cladocera were recorded highest in summer and lowest in winter. Protozoa was highest in monsoon and lowest in summer (supplementary figures 1-5).

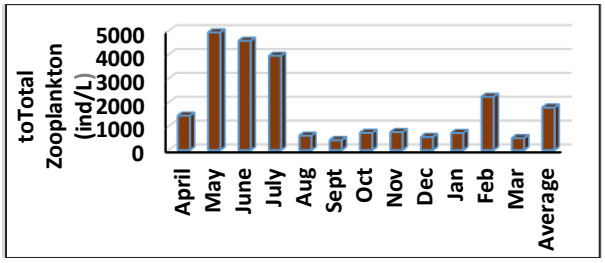


Figure 1
Monthly variation of total zooplankton

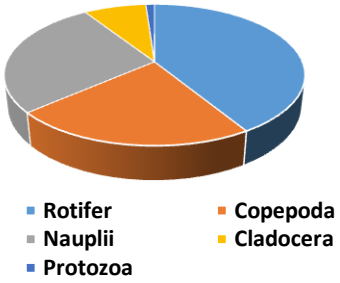


Figure 2
Occurrence of different group of zooplankton

The rotifer population was varied in 8 sites during the study period (table1). In site-1, the highest number of rotifer was recorded in July 5340 indiv/L and the lowest in January 54 indiv/L. In site-2, the highest number of rotifer was recorded in April 3554 indiv/L and the lowest was recorded in November 66 indiv/L. In site-3, the highest number of rotifer was recorded in November 2394 indiv/L and the lowest number was recorded in May 66 indiv/L. In site-4, the highest number of rotifer was recorded in February 11628 indiv/L and the lowest in April 66 indiv/L. In site-5, the highest number of rotifer was recorded in February 276indiv/L and the lowest was recorded in April 66 indiv/L. In site -6, the highest number of rotifer was recorded in May 6276 indiv/L and the lowest was recorded in October 66 indiv/L. In site-7, the highest number of rotifer was recorded in April 1173 indiv/L and the lowest number was recorded in May 66indiv/L. In site-8, the highest number of rotifer was recorded in July 2973 indiv/L and the lowest was recorded in April 120 indiv/L. However, in the present study among the zooplankton, rotifer occupied the top most position (41.26%) in their abundance which observed highest in February (2059 ind/L) and in general the abundance of rotifer was highest in winter. Moshe Gophen (2005) found rotifer to be more abundant during December to June and decline in summer months. Khan and Siddique (1974) observed that the abundance of rotifer was highest in November and Hasan et.al (2001) observed

peak abundance in a semi intensive fish pond in April and accounted for about 52% of the total zooplankton population. On the other hand the lowest abundance of rotifer was observed in monsoon whereas Banik (1995) observed the lowest abundance of rotifers in summer months.

A total of 19 genera of rotifers were identified in the present work. All genera were also reported in Bangladesh by other researchers, notably by Das and Bhauyain (1974), Patra and Azadi (1987), Habib et.al. (1988) both in closed water and open water. During the present investigation some genera of rotifers were found perennial and some were seasonal. *Brachionus* were perennial and most dominant genus among the rotifers in the study which is also reported by others (Khan and Siddiqui, 1974; Patra and Azadi,1987; Begum et.al, 1992; and Banik,1995). Arora (1966) stated that Brachionus was the most common and abundant genus throughout the year. Perennial distribution of Brachionus was also supported by Ali et.al. (1992).

**Abundance of rotifers in relation to environment**

The variation of plankton and their seasonal abundance are greatly related to water qualities. Water pollution refers specially to degradation of water quality as measured by physical, chemical and biological criteria. In this study total 38 species of rotifer were identified as shown in table 1. The total rotifer population was increased with the decrease of water temperature (figure 3), air temperature (figure 4) and pH (figure 5) and increase dissolved oxygen (figure 6). The results indicated that all the species do not prefer same temperature. There were two types of rotifer responses to temperature. One type preferred high temperature (29-31ºC) which includes *Brachionus*, *Trichocerca*, *Filinia* where as other type preferred low temperature (20-24ºC) which include Polyarthra, Keratella. The total rotifer density was largest at 24ºC (figure 3).

Among the rotifers, *Brachionus* were the most dominant genus (supplementary table 3). The plankton community of this genus occurred throughout the year. The highest number of *Brachionus* was observed in June 1458 indiv/L (total number of eight sites) at temperature was 30°C (supplementary figure 6). In the present investigation the different species of Brachionus were found such as *Brachionus forficula, B. falcatus, B. angularis, B. Caudatus, B. Diversicornis, B. Quadridentatus, B. havenaensis, B. Calyciflorus B. Nilsoni, B.donneri, B.urceolaris.* Among them *B. angularis* were most abundant and then *B. forficula* and *B. diversicornis* respectively. On the other hand, *Polyarthra* was the second dominant genus and it was more abundant in February 641 indvi/L (total number of eight sites) (supplementary table 3) at that time the water temperature was 24°C (supplementary figure 7) and only one species *polyarthra vulgaris* of this genus was identified. Trichocerca ranked third dominant rotifers. In general, they were more abundant in May 252 indiv/L (Supplementary table 3) at water temperature 29°C (supplementary figure 8). Two species of Trichocerca were identified as *Trichocerca cylindrica, Trichocerca similis. Filinia* occupied the fourth position in order of dominance. This genus of rotifer was more abundant in June 207 indiv/L (supplementary table 3) at water temperature 30°C (supplementary figure 9). The species of this genus *Filinia longiseta, Filina opoliensis, Filinia terminalis* were indentified. *Keratella* was the fifth dominant genus among the rotifers. This genus of rotifer was more abundant in January 312 indiv/L (supplementary table 3) at water temperature 20°C (supplementary figure 10). In the present observation four species of *keratella* were recorded viz *Keratella cochlearis, Keratella valga, Keratella tropica and Keratella quadrata.* A few number of other Rotifer species also found in this study (supplementary table 3).

Cladocera and copepoda densities were found to be extremely low in all seasons except summer. The main cladoceran species were *Diaphanosoma* spp, *Bosmina* sp and, *Moina* spp. The identified copepods were mainly of cyclopida (*Cyclopes spp, Mesocyclopes* spp, *Diaptomus* spp). The seasonal changes of zooplankton in ponds have also been reported by many authors (Mathew, 1975; Ali et.al, 1980; Arora et al., 2003; Patnaik et al 1988).

Table 1
List of rotifer recorded in the study area during the study period

| Genera | Species |
|---|---|
| *Brachionus* | *Brachionus forficula,B. falcatus,B. angularis, B. Caudatus, B. Diversicornis,B. Quadridentatus, B. havenaensis, B. Calyciflorus B. Nilsoni,B.donneri,B.urceolaris* |
| *Polyarthra* | *polyarthra vulgaris* |
| *Filinia* | *Filinia longiseta, Filina opoliensis, Filinia terminalis* |
| *Trichocerca* | *Trichocerca cylindrica, Trichocerca similis* |
| *Keratella* | *Keratella cochlearis, Keratella valga,Keratella tropica, Keratella quadrata.* |
| *Asplanchna* | *Asplanchna sp* |
| Colurella | *Colurella* sp |
| Conochilus | *Conochilus* sp |
| Hexarthra | *Hexarthra* sp |
| Horaella | *Horaella* sp |
| Lecane | *Lecane luna* |
| Monogononta | *Monogononta* sp |
| Lepadella | *Lepadella imbricate* |
| Monostyla | *Monostyla bulla, Monostyla lunaris, Monostyla quadridentata* |
| Testudinella | *Testudinella* sp |
| Platyias | *Platyias patulus, Platyias quadricornis* |
| Pompholyx | *Pompholyx* sp |
| Rotaria | *Rotaria* sp |
| Notholca | *Notholca* sp |

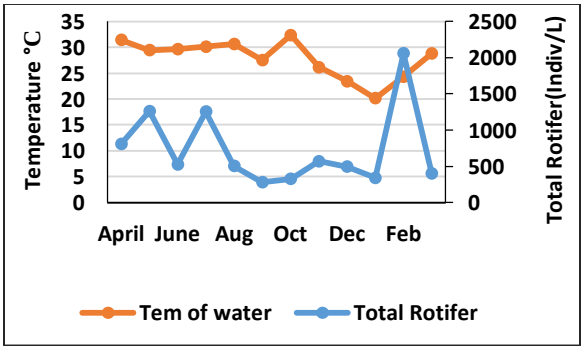


Figure 3
Effects of water temperature on abundance of rotifer

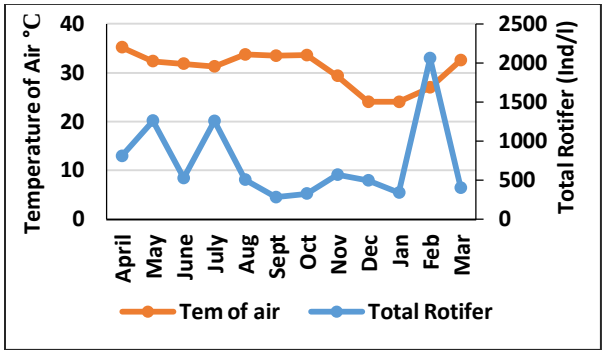


Figure 4
Effects of air temperature on abundance of total rotifer

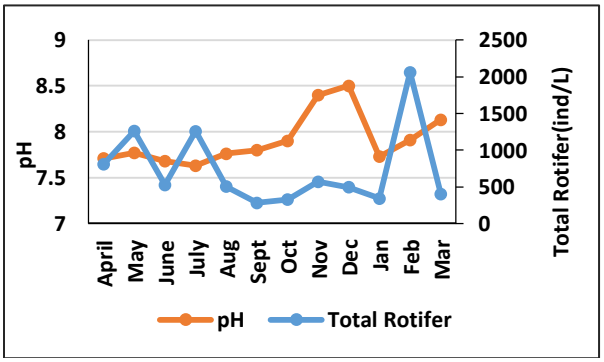


Figure 5
Effects of pH on abundance of total rotifer

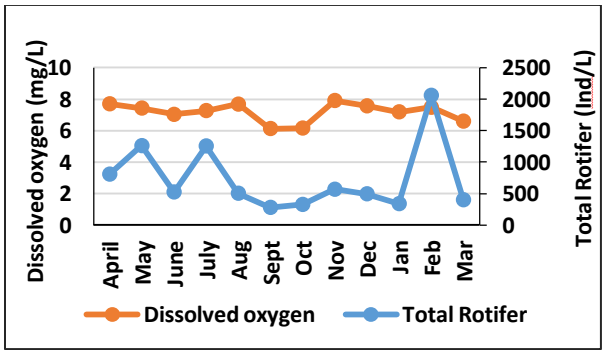


Figure 6
Effects of dissolved oxygen on abundance of total rotifer

The rotifer community variations were correlated with the changes of abiotic and biotic environmental factors. In this study, the total rotifer density reached its maximum at approximately 24ºC which is almost similar with the report published by Gaohua et al. (2013) where

maximum rotifer was found at 23ºC. But individual species differed with temperature preferences in this study. Rotifers generally have a very wide tolerance to temperature (Berzin et.al, 1989). In this study polyarthra species were highest in population at approximately 24ºC. *Filinia Terminalis* were considered to prefer temperature below 10ºC (Galkovskaya et.al, 2006) but they were also abundant at 29ºC in this study. *Brachionus sp.* also found to prefer high temperature similar as Berzins et.al (1989). The thermal preference discrepancy of the same species between different individual lakes may be attributed to the fact that temperature alone does not generally decide when and where a species occurs.

All the abiotic parameters were positively or negatively correlated with rotifer. Water temperature, air temperature and pH were negatively correlated with rotifer but dissolved oxygen was positively correlated during the study period (supplementary table 4). The pH value of the ponds showed to be alkaline (7.71-8.50) in nature during the study period which was suitable for planktonic rotifer (figure 5). The average maximum and minimum value of dissolved oxygen of eight sites were 7.91 mg/L to 6.13 mg/L (figure 6).

Rotifers may act as predator on bacteria, protozoa including ciliates and heterotrophic flagellates and algae including pico- and nano phytoplankton. Algae, bacteria, protozoa, and debris are considered as food for rotifers (Arnidt 1993). Changes in the population dynamics thereafter may affect the preys on predator rotifers that leads to impact on the ecosystem (Herzig et.al, 1987). Cladocera had a negative correlation with rotifer densities in this study. When cladocera decreased in winter the population of rotifer were increased as cladocera often show dominance over rotifers due to their large body sizes and other factors (MacIsaac et. al, 1989). Similarly, reverse population were observed for copepods and rotifers as copepods prey on rotifers (Williamson, 1986; Conde-Porcuna, 1998). Although most rotifers require oxygen concentrations significantly above 1.0mg/L (James et.al, 2001), the average dissolved oxygen was recorded higher in this study. Effects of pH on distribution and abundance of rotifer may be a good deal of attention although studies of rotifer occurrence as a function of pH are of limited value. The rotifer species found in oligotrophic water at optimum pH or below neutrality (Berzins et al., 1987). The pH value of the ponds showed to be alkaline in nature during our study period. The increasing planktonic rotifer density with temperature could be related to the enhancement of their reproductive rates due to the higher metabolic rates; and prey and predator populations. From the study it can be elicited that there is a close relationship among these factors with the abundance of zooplankton as well as rotifer in different regions of the coastal area. However, further studies should be needed to determine and understand the influence of temperature and other possible factors that affect the planktonic rotifer population dynamics in Bangladesh.

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