Water quality and Rotifer diversity in the fish pond at district Mianwali, Pakistan

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ABSTRACT

Present study was conducted seasonally to assess the rotifer species richness, diversity, and evenness in a fish pond from December 2006 to June 2007. An attempt was also made to explore the state of the pond in relation to physico-chemical parameters. 16 rotifer species belonging to 11 genera were identified. Rotifers were more prevalent in summer than in winter. Seasonal variations were observed in the correlation of rotifer population and physico-chemical characteristics. However, rotifers expressed, usually, positive correlation with temperature, pH, DO and conductivity, whereas negative correlation with all the other factors. Species diversity, evenness and richness were highest in summer and lowest in winter. Analysis of variance showed that there were significant differences in the physico-chemical characteristics of water as well as rotifer diversity in different seasons.

Keywords: Seasonal variation, Rotifers, Physico-chemical parameters

INTRODUCTION

It is a well acclaimed fact that almost 95 percent of the known rotifer species are found in freshwaters which is thought to be their original habitat. Rotifers are generally present, in great numbers and with high species richness, in tropical zooplankton colonizing a wide variety of habitats: from flooded areas (Martinez et al., 2000, Lansac-Toha et al., 2009) to large rivers, lakes and reservoirs (Sendacz et al., 2006; Almeida et al., 2009; Borges & Pedrozo, 2009).

As intermediate links in the food web, invertebrates are important members of the aquatic community. By analyzing the gut contents of several common larval fish such as the bluegill and yellow perch, Siefert (1972) has shown that rotifers form an integral part of a larval fish's diet. In biological waste treatment, rotifers are members of the aquatic community responsible for BOD reduction by bioflocculation and sedimentation. In both, natural waters and in sewage treatment facilities, rotifers aid in keeping microbial communities in balance by grazing upon bacterial, algal, and protozoan populations. It is conceivable that if a substantial portion of the larval fish food is dead or just not-reproducing (especially at a critical time in the fish's life cycle), this could affect fish production. It also seems reasonable that if most of the organisms, which are responsible for grazing upon bacterial or algal mass, are dead or encysted, this could lead to a bloom of fouling microbial organisms.

The purpose of present study was to investigate rotifer diversity, physico-chemical characteristics of water and their correlation in different seasons in a fish pond.
MATERIALS AND METHODS

District Mianwali is situated on the eastern bank of the Indus River in the north-west of Punjab province, Pakistan. Its geographical coordinates are 31° 53' 0" North, 73° 6' 0" East. Thal canal passes through the city making it a charming place. The area of Mianwali district is 5,840 square kilometres. An extreme climate is observed in Mianwali, with cold, dry winter season and long, hot summers. Average highest temperature is 42 °C, observed in June while average lowest temperature may be 3 to 4 °C, experienced in December and January. The average rainfall is about 385 mm.

The pond was visited from December 2006 to June 2007 and plankton as well as water samples were taken seasonally from the five selected sites which were: Eastern side (PE), Southern side (PS), Western side (PW), Northern side (PN), and central area (PC) of the pond, usually between 7.00 to 10.00 am. The standard plankton net (50 μ mesh size) was used to collect plankton samples. 40 to 50 litres of water was taken from a maximum depth of 15-25 cm and filtered through the net. The plankton samples were put in 50 ml plastic bottles and two drops of 5% formalin were added to fix rotifers.

Water and air temperature, conductivity, dissolved Oxygen and pH were measured with the help of thermometer (HANNA HI-8053), a HANNA 8033 conductivity meter, Oxygen meter (YSI Model-57), and pH meter (Lutron PH-206), respectively. Before water collection, the sample bottles were first soaked in dilute HCl solution (2-5% HCl) and later washed three times with distilled water and dried. These bottles were rinsed about three times with sample water in the field. Water samples were collected in BOD bottles, from just below the surface of pond water to determine other physico-chemical parameters. Standard methods were applied to find out other parameters of waters (APHA, 2005).

Rotifer species were identified after thoroughly consulting standard literature (Malik & Sulehria, 2003 & 2004), and by examining morphology and body shape. The quantitative analysis of planktonic rotifers was carried out using Sedgwick Rafter counting cell and Binocular microscope at 40-100x.

The Shannon-Weaver equation was used to study the diversity indices:

$$H = -\sum P_i \ln P_i$$  \hspace{1cm} (Shannon & Weaver, 1949)

Where $P_i$ is the proportion of each species in the sample. $P_i = n_i/N$, while $n_i$ is the number of individuals of a particular species and $N$ is the total number of individuals of all the species in the sample.

Species richness (SR), the number of species recorded from a region, was calculated by Margalef's formula (Margalef, 1951): $SR = (S - 1)/\ln N$, where $S =$ total number of species and $N =$ total number of individuals present in the sample.

Species evenness or equitability ($E$) was calculated according to Pielou (1966): $E = H / \ln S$, where $S =$ total number of species and $H =$ the Shannon-Weaver diversity index.

Pearson’s correlation test was performed to assess the relationships between the rotifer species with various physico-chemical parameters that may be controlling rotifer population. Analysis of Variance (ANOVA) was applied to the data of the various seasons in order to find the differences. Pearson's
correlation and ANOVA were performed using the software Minitab 13 for Windows.

**RESULTS**

16 species of 11 genera were identified to be present in the fish pond. Five species i.e., *Brachionus calyciflorus*, *B. quadridentatus*, *Filinia longiseta*, *Philodina roseola* and *Polyarthra vulgaris* were found in all seasons (Table 1). The highest number of rotifer species i.e., 14, was observed in summer season while lowest number of species, i.e., 7, was found in winter season. In spring and autumn seasons the number of rotifer species was 13 and 8, respectively (Fig. 1).

**Table 1: Prevalence of Rotifer species in different seasons**

<table>
<thead>
<tr>
<th>Rotifer Species</th>
<th>Aut</th>
<th>Spr</th>
<th>Sum</th>
<th>Win</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Asplanchna brightwellii</em> Gosse</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Brachionus angularis</em> Gosse</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Brachionus calyciflorus</em> Pallas</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>Brachionus caudatus</em> Barrios &amp; Daday</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Brachionus falcatus</em> Zacharias</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td><em>Brachionus quadridentatus</em> Hermann</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>Cephalodella gibba</em> (Ehrenberg)</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Filinia longiseta</em> (Ehrenberg)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>Filinia terminalis</em> (Plate)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Keratella cochlearis</em> (Gosse)</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>Lecane luna</em> (Muller)</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Philodina roseola</em> (Ehrenberg)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>Platyias quadricornis</em> (Ehrenberg)</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Polyarthra vulgaris</em> Carlin</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>Testudinella patina</em> (Hermann)</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Trichocera similis</em> (Wierzejski)</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Win = winter season, Aut = autumn season, Spr = spring season, Sum = summer season

Shannon-Weaver index, species richness and species evenness had highest values in summer season while lowest in winter season (Table 2). Rotifers showed positive correlation with water temperature, pH, DO and electrical conductivity, while negative correlation with Total Hardness, alkalinity, chloride, calcium, magnesium, free carbon dioxide and total dissolved solids (Table 3).
Table 2: Diversity indices, richness and evenness of rotifers in four seasons

<table>
<thead>
<tr>
<th>Season</th>
<th>Diversity index $H = \sum P_i \ln P_i$</th>
<th>Species richness $SR = (S - 1)/\ln n$</th>
<th>Species evenness $E = H / \ln n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Win</td>
<td>1.864</td>
<td>1.772</td>
<td>0.896</td>
</tr>
<tr>
<td>Aut</td>
<td>2.348</td>
<td>2.452</td>
<td>0.979</td>
</tr>
<tr>
<td>Spr</td>
<td>2.471</td>
<td>2.595</td>
<td>0.963</td>
</tr>
<tr>
<td>Sum</td>
<td>2.535</td>
<td>3</td>
<td>0.936</td>
</tr>
</tbody>
</table>

The physico-chemical characteristics of water of the pond varied during different seasons. Mostly, highest and lowest values were observed in summer and winter seasons, respectively (Fig., 2). Analysis of variance showed that there was significant difference in the physico-chemical characteristics of water in different seasons.
DISCUSSION

It is evident from the results that all the physico-chemical characteristics of water under study affected the diversity and distribution of rotifers either positively or negatively throughout the period of study. Similar reports have been made by Chittapun et al. (2007).

Species diversity fluctuated seasonally. Shannon-Weaver index (H) had high value in summer which is an indication of the greater planktonic diversity in summer season and low value in winter, which showed lesser rotifer diversity in winter season. The value of species evenness near to one shows even distribution of species in autumn, spring and summer. High value of species richness is the characteristic of larger food chains which was observed in summer season. Evenness was comparatively high during the autumn season showing a decline in the rotifer diversity during this period (Adesalu & Nwankwo, 2008). Peet (1974) reported that species diversity causes both richness and evenness in the number of species and equitability for the distribution of individuals among the species. Therefore, high rotifer density and diversity were observed in summer season, while low density and diversity in winter season.

Temperature, an essential and variable environmental factor, has an effect on the growth and dispersal of plant and animal life. Gaikwad et al. (2008) reported that water temperature in the range of 13.5°C and 32°C is appropriate for the growth of the planktonic organisms. In the present study, the density and diversity of rotifers showed significantly positive correlation with temperature because both got enhanced with rise in temperature of the pond. These results agree well with the reports in certain other studies (Malik & Sulehria, 2003 & 2004; Baloch et al., 2008).

The density and diversity of rotifers have significantly positive correlation with DO of water. The DO was highest during summer season, while lowest during winter season. These results are contrary to those reported by Malik & Sulehria (2003 & 2004); and Baloch et al. (2008).

The pH values ranged between 6.66 and 7.28, which showed slightly acidic to mildly alkaline nature of the pond water. High pH value was recorded
during spring and lowest in summer. High pH may be the result of decrease in water level and high photosynthetic activity of phytoplankton and other aquatic plants causing high level of free carbon dioxide (Shiddamallayya & Pratima, 2008). According to Tanner et al. (2005) the pH range between 6.0 and 8.5 shows medium productivity; more than 8.5 high productivity and less than 6.0 low productivity of a water body.

In the present study, electrical conductivity (EC) was found between 477.50±157.87 and 552.25±156.83 µS/cm. Electrical conductivity was highest in summer which might be because of high temperature, less solubility and high degradation of organic substances. EC was also positively and significantly correlated with the density and diversity of rotifer population.

Other physico-chemical characteristics of water such as total hardness, chloride, calcium, magnesium, free carbon dioxide, and total dissolved solids had significantly negative effect on the density and diversity of rotifers. These findings do not agree with that reported by Park & Shin (2007).

16 species belonging to 11 genera were determined in the pond. Five species of genus Brachionus were observed i.e., B. angularis, B. quadridentatus, B. plicatilis, B. falcatus and B. calyciflorus. Four of these species had also been reported from the River Ravi by Malik & Sulehria, (2004) and Manchar Lake by Mahar et al. (2000). B. quadridentata and B. calyciflorus are regarded as indicators of eutrophication (Gannon & Stemberger, 1978; Maemets, 1983). The Filinia longiseta is also considered as an indicator of eutrophication (Maemets, 1983; Baloch et al. 2000).

REFERENCES


