Community structure of epiphytic rotifers of a floodplain

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ABSTRACT

Present study was conducted to determine the diversity and density of epiphytic rotifers of a floodplain. Epiphytic rotifers were collected from January 2012 to June 2012. In total, 33 different species belonging to 12 genera were identified. The highest population density of rotifers (66.2 ± 4.22/ml) was observed during the month of June while the lowest mean number of rotifers (37.0 ± 1.81/ml) was found during the month of January. Most prominent genera with respect to the relative (%) representation of species were Lecane > Lepadella > Cephalodella, which were 38.70%, 28.44%, and 5.64% respectively. Through analysis of variance it was observed that there was statistically significant difference in the physico-chemical parameters and density of rotifers of floodplain from January to June. Rotifers population density showed positive correlation with water temperature, air temperature, electrical conductivity, turbidity and negative correlation with dissolved oxygen, TDS, and pH.

Key words: Rotifers, Epiphytic invertebrates, Floodplain, Physico-chemical parameters,

INTRODUCTION

Rotifers make up a crucial component of the zooplanktons found in freshwaters. Rotifers play a vital role in aquatic food chain by transferring energy and transporting nutrients. Generally, rotifers show great density and diversity among zooplankton, being pioneer organisms having the ability to inhabit different types of habitats, such as temporary floodplains (Martínez et al., 2000, Lansac-Tôha et al., 2009) rivers, lakes and reservoirs (Almeida et al., 2009, Borges & Pedrozo, 2009).

Rotifers are usually present on mosses and lichens, in rain puddles and gutters, in leaf litter or in soil, on mushrooms, in tanks of sewage treatment plants and also on freshwater crustaceans and larvae of aquatic insects (Wallace & Snell, 2010).

Rotifers exhibit a wide range of feeding habits. They are direct consumers of phytoplanktons (Malik & Sulehria, 2003, 2004). Rotifers which live on merged and submerged leaves, roots, and stems of macrophytes are named as epiphytic rotifers. Epiphytic invertebrates are an important portion of riverine food webs, being significant consumers of algae, detritus and metazoans and are an essential food source for many fish. The abundance of epiphytic invertebrates may be strongly influenced by seasonal or annual climatic cycles through their influence on life-history attributes of such biota (Balcombe et al., 2007).
Seasonal occurrence of planktonic rotifers and their relationship with physico-chemical parameters of water such as temperature, dissolved oxygen, salinity, pH, total alkalinity, total hardness, electrical conductivity, phosphates, nitrates and primary productivity have been reported from some water bodies of Pakistan (Mahar et al., 2000, Malik & Sulehria, 2003, 2004, Baloch, et al., 2008, and Sulehria et al., 2009a, 2009b). The most prominent rotifers described from Pakistan are *Brachionus*, *Lecane* and *Keratella* species (Sulehria & Malik, 2012). Still there are several water bodies which should be explored for their zooplanktons.

The aim of the present study was to investigate:
- Density and diversity of rotifers in floodplain.
- Relationship between the density and diversity of rotifers and different physical-chemical parameters of water.

**MATERIALS AND METHODS**

The study was carried out in a floodplain of Dhan No. 3 Balloki Headworks having latitude of 31.22 (31° 13’ 10 N) and a longitude of 73.86 (73° 51’ 35 E). It is located on River Ravi about 65km (42 miles) from Lahore in South West direction near Phool Nagar on Multan road. The elevation of the site is 196m above sea level. The annual temperature range is 15-40°C.

Sample bottles were first soaked in dilute HCl solution (2-5% HCl) before sampling. Bottles were then washed three times with distilled water and then dried in air. Sample water was used for the rinsing of sample bottles. Water samples were then taken from 5 different selected sites of the floodplain.

Epiphytic rotifers were collected monthly from January to June 2012. Macrophytes were collected with minimal disturbance, placed individually in polyethylene bags with water and then transferred to laboratory in polyethylene troughs. For epiphytic community analyses, a few roots and floating and submerged leaves of water plants were separately placed into labeled plankton bottles containing 4% formalin in filtered water collected from the respective sampling sites (Koste, 1978; Arora & Mehra, 2003).

Identification of rotifers was done by observing their body shapes, morphological features and behavior (Ward & Whipple, 1959; Pennak, 1978; Segers, 1995, 2007). Quantitative analysis of rotifers was done with Sedgewick-Rafter chamber or cell at 60-100 x magnification using an inverted OLYMPUS microscope. The rotifers were identified up to species level. Specimens were photographed by using LAICA HC 50/50 microscope with 5.0 megapixel Cannon camera fitted on it.

Water samples were used to determine the concentration of physico-chemical parameters: Water and atmospheric temperatures were determined using a thermometer (HANNA HI-8053). Dissolved oxygen and oxygen saturation were measured with the help of D.O. meter (YSI-Eco Sense DO 200), which directly gave the reading. The pH of the water of each sampling site was determined by pH meter (YSI-Eco Sense pH 100). Conductivity and TDS were...
determined using a (YSI-Eco Sense EC 300) conductivity meter. Turbidity was
determined by using a turbidity meter (HANNA, Model # HI 93703).

Pearson’s correlation test was performed to evaluate the relationships
between the rotifer species and various observed physical-chemical parameters
of water that may be regulating their population. Analysis of variance (ANOVA)
was applied to the data of rotifers obtained in various months from different
sampling sites in order to find the differences. Pearson’s correlation and ANOVA
were performed using the software Minitab 13 for windows. Graphs were plotted
with the help of MS Excel 2010 for Windows.

RESULTS AND DISCUSSION

In the present study, 33 different rotifer species belonging to 12 genera
were identified (Table 1).

Table 1: List of epiphytic rotifer species collected from floodplain
(\( R = \) Roots, \( L = \) Leaves).

<table>
<thead>
<tr>
<th>Epiphytic Rotifer species</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Beauchampia crucigera</em> Dutrochet : R, L</td>
<td><em>L. quadridentata</em> (Ehrb): R, L</td>
</tr>
<tr>
<td><em>Brachionus falcatus</em> Zacharias: L</td>
<td><em>L. signifera</em> (Jennings): R, L</td>
</tr>
<tr>
<td><em>Cephalodella gibba</em> (Ehrb): R, L</td>
<td><em>L. unguulata</em> (Gosse): R, L</td>
</tr>
<tr>
<td><em>C. obtusa</em> (Gosse): R, L</td>
<td><em>Lepadella acuminata</em> (Ehrb): R, L</td>
</tr>
<tr>
<td><em>Floscularia ringens</em> Linnaeus : R</td>
<td><em>L. eurysterna</em> Myers : R, L</td>
</tr>
<tr>
<td><em>Keratella coechlearis</em> (Gosse): R, L</td>
<td><em>L. heterostyla</em> (Murray): R, L</td>
</tr>
<tr>
<td><em>Lecane aculeata</em> (Jakubski): R</td>
<td><em>L. ovalis</em> (Müller): R, L</td>
</tr>
<tr>
<td><em>L. bulla</em> (Gosse): R, L</td>
<td><em>L. patella</em> (Müller): R, L</td>
</tr>
<tr>
<td><em>L. inermis</em> (Bryce): R, L</td>
<td><em>L. triba</em> Myers: R, L</td>
</tr>
<tr>
<td><em>L. inopinata</em> (Harring &amp; Myers): R</td>
<td><em>Plationus patarius</em> Müller: R</td>
</tr>
<tr>
<td><em>L. luna</em> (Müller): R, L</td>
<td><em>Trichocerca porcellus</em> (Gosse): L</td>
</tr>
<tr>
<td><em>L. lunaris</em> (Ehrb): R, L</td>
<td><em>Trichotria tectris</em> (Ehrb): R, L</td>
</tr>
<tr>
<td><em>L. pyriformis</em> (Daday): R, L</td>
<td></td>
</tr>
</tbody>
</table>

The highest population density of rotifers (66.2 ± 4.22/L) was observed
during the month of June while the lowest mean number of rotifers (37.0 ±
1.81/L) was found during the month of January (Table 2, Fig., 1).
## Table 2: Density of epiphytic rotifers (Individuals/Litre) found in floodplain from January to June 2012

<table>
<thead>
<tr>
<th>Rotifers</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>Mean</th>
<th>Stdv</th>
<th>SEM</th>
<th>VAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>41</td>
<td>34</td>
<td>32</td>
<td>41</td>
<td>37</td>
<td>37</td>
<td>4.62</td>
<td>1.81</td>
<td>16.5</td>
</tr>
<tr>
<td>February</td>
<td>54</td>
<td>51</td>
<td>44</td>
<td>55</td>
<td>59</td>
<td>52.6</td>
<td>5.59</td>
<td>2.50</td>
<td>31.3</td>
</tr>
<tr>
<td>March</td>
<td>65</td>
<td>54</td>
<td>52</td>
<td>71</td>
<td>52</td>
<td>58.8</td>
<td>8.71</td>
<td>3.89</td>
<td>75.7</td>
</tr>
<tr>
<td>April</td>
<td>70</td>
<td>62</td>
<td>59</td>
<td>57</td>
<td>55</td>
<td>50.6</td>
<td>5.85</td>
<td>2.61</td>
<td>34.3</td>
</tr>
<tr>
<td>May</td>
<td>74</td>
<td>61</td>
<td>61</td>
<td>59</td>
<td>69</td>
<td>64.8</td>
<td>6.41</td>
<td>2.87</td>
<td>41.2</td>
</tr>
<tr>
<td>June</td>
<td>70</td>
<td>62</td>
<td>58</td>
<td>60</td>
<td>81</td>
<td>66.2</td>
<td>9.44</td>
<td>4.22</td>
<td>89.2</td>
</tr>
</tbody>
</table>

S1 = sample 1; S2 = sample 2; S3 = sample 3; S4 = sample 4; S5 = sample 5; Stdv = standard deviation; SEM = standard error of mean; VAR = Variance

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**Fig. 1:** Rotifer density (Individuals/litre) from January to June

Majority of the rotifers are cosmopolitan because the same species occur all over the world (Segers, 2008; Wallace *et al*., 2008) and only a few are restricted in distribution (Segers *et al*., 1993a; Segers 1995b). However, rotifers may show cryptic speciation (Schröder & Walsh, 2007; Walsh *et al*., 2009) which means specimens from nearby sites or very far away may look very much alike, but they are genetically very different.

In present study, most prominent genera with respect to the relative (%) representation of species were *Lecane > Lepadella > Cephalodella*. Genus *Lecane* and *Cephalodella* had already been described in different studies in Pakistan (Mahar *et al*., 2000, Malik & Sulehria, 2003, Sulehria *et al*., 2009a). (Fig. 2)
The results of analysis of variance of rotifers versus months showed statistically highly significant difference ($F=12.08, p=0.000$) in the rotifers density from January 2012 to June 2012 as the value of $p$ was less than 1% ($\alpha=0.01$). However, analysis of variance of rotifers versus sampling sites did not have any significant difference in rotifer density (Table 3, & 4).

**Table 3: One-way ANOVA: Rotifers versus Months**

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months</td>
<td>5</td>
<td>2901.9</td>
<td>580.4</td>
<td>12.08</td>
<td>0.000***</td>
</tr>
<tr>
<td>Error</td>
<td>24</td>
<td>1152.8</td>
<td>48.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>4054.7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DF=Degree of freedom, SS=Sum of squares, MS=Mean square, $F=F$-distribution, $P=Probability; \alpha<0.01; ***highly significant

**Tukey's pairwise comparisons**

Family error rate = 0.0500
Individual error rate = 0.00501

Critical value = 4.37
Intervals for (column level mean) - (row level mean)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>-29.14</td>
<td>-2.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-35.34</td>
<td>-19.74</td>
<td>-8.26</td>
<td>7.34</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-37.14</td>
<td>-21.54</td>
<td>-15.34</td>
<td>-10.06</td>
<td>5.54</td>
</tr>
<tr>
<td>5</td>
<td>-41.34</td>
<td>-25.74</td>
<td>-19.54</td>
<td>-17.74</td>
<td>-14.26</td>
</tr>
</tbody>
</table>

Table 4: One-way ANOVA: Rotifers versus Sampling sites

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling sites</td>
<td>4</td>
<td>458</td>
<td>114</td>
<td>0.80</td>
<td>0.540*</td>
</tr>
<tr>
<td>Error</td>
<td>25</td>
<td>3597</td>
<td>144</td>
<td>0.540*</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>4055</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DF=Degree of freedom, SS=Sum of squares, MS=Mean square, F=F-distribution, P=Probability; α>0.05, *non-significant

**Fig. 3:** Physico-chemical parameters of water.
Taking into consideration the present results (Fig., 3), it is evident that physico-chemical parameters of water had a strong influence on density and diversity of rotifers throughout the period of observation (Siegfried et al., 1989, Zarfdjian, et al., 2000, Chittapun et al., 2007). Rotifers are opportunistic organisms and their densities alter with respect to the ecological environment (Allan, 1976).

Water temperature plays a significant role in designing the community structure of rotifers (Bērziņš & Pejler, 1989). Rotifers have a wide range of tolerance of temperature extremes (Ahlstrom 1933). During this study, a significant positive correlation was present between number of epiphytic rotifers and water temperature (Fig., 4). These results are similar to some previous studies done by Malik & Sulehria, 2003 & 2004; Sulehria et al., 2009a, 2009b and Sulehria & Malik 2012. This relationship is thought to be because of rapid rate of reproduction at higher temperatures (Galkovskaya, 1987).

![Graph showing positive correlation between water temperature and rotifer density](Image)

**Fig., 4:** Positive correlation between water temperature and rotifer density

The number of epiphytic rotifers is also affected by the oxygen concentration in water (Allan, 1976; Wetzel, 1983). According to Kitchell (1998), oxygen concentration is a significant limiting factor for aquatic organisms. In the present studies the highest mean D.O. was observed in January, while lowest mean values of D.O. was found in June. Density and diversity of rotifers was negatively correlated with D.O. which may be due to the fact that dissolved oxygen in water decreases with increase in temperature (Fig., 5). These results were different from some previous studies conducted in the River Ravi, Jallo Lake and certain fish ponds in Pakistan (Malik & Sulehria, 2003, 2004; Sulehria et al., 2009a, 2009b) where rotifers exhibited positive correlations with D.O. concentration. However, these results were similar to the work done by Sulehria & Malik (2012) at Balloki Headworks.
The pH range preferred by rotifers is from 6.5 to 8.5 (Barnes, 1974; Bērziņš & Pejler, 1987; Neschuk et al., 2002). In the present studies, it ranged from 7.2 to 8.6, that is, near to the recommended range. The pH was negatively correlated with the density and diversity of rotifers in six months from January to June (Fig., 6). Similar results were also obtained in some previous studies conducted by Sulehria et al., (2009a) and Sulehria & Malik (2012), however, these results differed from the findings of Sulehria et al., (2009b).

Conductivity is also considered to be one of the important trophic state indicators (Bērziņš & Bertilsson, 1989). Conductivity was recorded highest in June and it was lowest in February (Fig., 3). It showed positive correlation with rotifer density and diversity in the present studies (Fig., 7). Neschuk, et al., (2002) found that the species having high conductivity tolerance were common. Conductivity is also a good measure of salinity in water. Salinity affects the potential dissolved oxygen levels in the water. Similar conclusions had also been
obtained in certain studies in Pakistan (Sulehria et al., 2009a and 2009b; Sulehria & Malik, 2012). These results were different from some other studies conducted by Malik & Sulehria (2003, 2004).

![Graph](image)

**Fig., 7:** Positive correlation between electrical conductivity and rotifer density

The influence of turbidity on some biotic factors (rotifer densities) was observed in some large rivers (Pollard et al., 1998; Lair, 2005). In the present studies lowest turbidity was recorded in March and highest in April. A positive correlation was found between turbidity and rotifer density and diversity.

![Graph](image)

**Fig., 8:** Positive correlation between turbidity and rotifer density

The highest mean value of total dissolved solids 0.212 g/L was observed in the month of February and lowest mean value 0.15 g/L in the month of April. TDS showed negative correlation with rotifer density.
Fig. 9: Negative correlation between Total Dissolved Solids (TDS) and rotifer density.

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