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Species Diversity and Community Assemblage of Planktonic Rotifers in Pipnakha Pond, Gujranwala, Pakistan

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ABSTRACT

Species diversity and community assemblage of planktonic rotifers were determined with respect to seasonal variations in a pond of Pipnakha village, Gujranwala. Sampling was executed on monthly basis at three sites of the pond from October, 2011 to September, 2012. Altogether, 74 rotifers belonging to 24 genera and 13 families were identified. Highest (128.7±40 ind/ml) ppopulation density of rotifers was observed in June while lowest (64.9±22 ind/ml) population density was seen in January. *Brachionus havanaensis* was found to the the dominant species with the highest mean population density (40±11.9 ind/ml) while *Philodina roseola* was a least dominant with lowest population density (3±1.2 ind/ml). ANOVA displayed a significant difference in population density of rotifers among months. Rotifers exhibited positive correlations with temperature, total hardness pH, TDS, electrical conductivity and turbidity however, DO and transparency indicated negative correlations. Shannon-Weaver index stretched from 3.036 to 3.802 and exhibited great diversity. Values of species evenness extended from 0.932 to 0.970 that showed even distribution.

Key Words: Species diversity, rotifers, seasonal fluctuations, abiotic parameters

INTRODUCTION

Freshwater zooplanktons are classified into Rotifers, Cladocerans and Copepods. The members of the phylum Rotifera are distributed into three classes i.e. Bdelloidea, Monogononta and Seisonidea and represented by about 2200 described species (Ejaz *et al*., 2016). About 95% rotifer fauna is found in freshwater bodies and remaining 5% in marine (Miller & Harley, 2007). Rotifers live in lotic waters (rivers, streams, canals,) and lentic water bodies (ponds, floodplains, lakes) (Lansac-Toha *et al*., 2009). These are important members of the littoral and limnetic un-segmented, pseudocoelomate, bilaterally symmetrical invertebrates (Wallace & Snell, 2010; Segers, 2007; Sulehria *et al*., 2013).

Some rotifer species dwell boundary covering aquatic and terrestrial settings i.e., they colonize film of water covering lichens, mushrooms, mosses and liverworts. This type of habitat is called as limnoterrestrial. They are also found in soil, rainy puddles, tree holes, pitcher plants, gutters and on aquatic larvae of insects, freshwater crustaceans and also in sewage treatment plants (Wallace *et al*., 2015). There are also some epiphytic rotifers (Sulehria *et al.,* 2012).

A small number of rotifer species is very particular in their feeding habits, but most are opportunistic and ingest numerous types of food such as algae, bacteria and ciliates although some are detritivorous (Sulehria & Malik, 2013).

Larvae of most planktivorous fish, due to high protein content use rotifers as food for rapid growth (Clarke *et al*., 2013). Several large animals feed on rotifers such as tadpoles (Barua, 1988) and small rotifers are eaten by bryozoans and copepods and they also fall prey to bigger rotifers (Wallace *et al*., 2006).

Dispersal of rotifers is affected by ecological barriers instead of geographical obstructions (Pejler, 1995). Abundance of predators, food resources, temperature and contestants are the main issues that upset the community structure of rotifers (Ekhande *et al*., 2013). As compared to other zooplankton rotifers react more sharply and quickly to the deviations in aquatic environment. The study

Author's Contribution: M.E., Research scholar; **M.J.Y.,** Helped in write up and biochemical tests; **A.M.,** Helped in data collection and analysis. **A.H.,** Helped in sampling; **A.Q.K.S.,** contributed in identification of rotifer species of rotifers is vital to assess the features of a pond (Kumar *et al*., 2011).

In this study we identified the rotifer species of pond from study area and recorded their seasonal dynamics. We also explored and studied the correlation of abiotic factors with the rotifer fauna.

MATERIALS AND METHODS

Study area

In the centre of the Pipnakha village, a pond is located on the western side, at the distance of 14 km from Gujranwala city. This pond is approximately 234 ft long and 150 ft wide. In the pond three sites (PS1, PS2 and PS3) were selected for sampling which were further divided into three sub-sites.

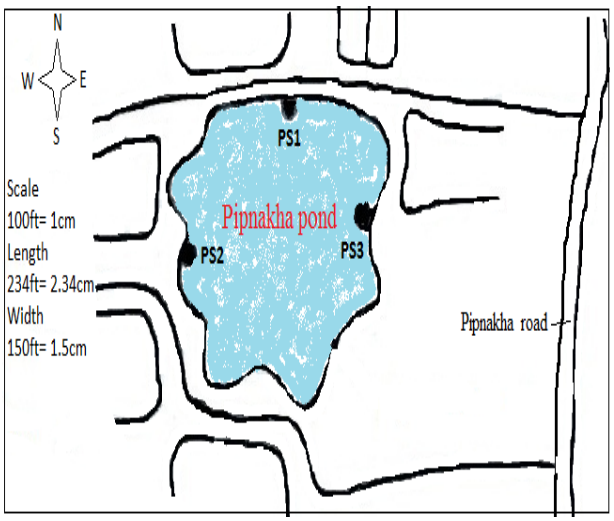


Fig., 1: Map of a pond in Pipnakha village. Physico-chemical analysis of water

For physico-chemical analysis, water sampling was done for one year (October, 2011 to September, 2012). HCl (2-5%) solution was used for soaking the bottles before sampling and then washed by using distilled water. Just before sampling the bottles were rinsed with pond water. Samples were collected from below the surface (20-25 cm) of the pond.

Temperature (°C), electrical conductivity (µS/cm), total dissolved solids (mg/l), dissolved oxygen (mg/l), turbidity (NTU) and pH were noted at the spot by using their respective metres such as thermometer (HANNA HI-8053), conductivity meter (YSI-Eco Sense EC300), TDS meter (YSI-Eco Sense EC 300), D.O meter (YSI-Eco Sense DO 200), turbidity meter (HANNA HI-93703) and pH meter (YSI-Eco Sense pH 100). A Secchi disc was used to measure transparency (cm). Total hardness (mg/l) was noted by using the technique given in APHA (2005).

Rotifer Collection

A net of 37µm mesh size was used for rotifer sampling on monthly basis. This net was towed for 2 to 3 minutes horizontally, so that 40 to50 L of water could pass through it. From each site three samples of rotifer were taken and mixed to make a composite sample. Calculation of sampled volume was done after Perry (2003). Rotifers were conserved by putting a few drops of 4 to 5% formaldehyde solution (Koste, 1978). To study live rotifers an additional rotifer sample was taken from each site.

Rotifer Counting and Identification

Rotifer species were recognized by observing their morphology, behavior, shape and size (Ward & Whipple, 1959; Pennak, 1978; Segers, 2007). By using a Sedgewick-Rafter cell and inverted Olympus microscope, rotifers were counted at 60-100x (APHA, 2005) and studied after staining with 1% neutral red (vital stain).

Diversity Indices

Diversity indices (Simpson and Shannon-Weaver) were applied to figure out the rotifer diversity. Diversity indices, Species evenness (SE) and Species richness were exhibited by the method used by Sulehria *et al*. (2013); Ejaz *et al.* (2016).

Data analyses

Pearson's correlation was applied to anticipate the relationship between physico-chemical limits and rotifer species. To find the difference among rotifer density of various months ANOVA was applied. Software MINITAB 2013 was used for ANOVA and Pearson's correlation. MS Excel 2010 was used to draw aabundance curve and graphs.

RESULTS AND DISCUSSION

Physico-chemical limitations of water influence the diversity and community assemblage of rotifers either negatively or positively (Chittapun *et al*., 2007; Sulehria *et al*., 2012). Highest water temperature (37.46±0.23) was seen in June and lowest (9.67±0.19) in the month of January (Fig. 2). Results of this study, showed a positive correlation of rotifers with temperature (Table I). Density of rotifers was observed highest (128.7±40 ind/ml) in June while lowest (64.9±22 ind/ml) in January (Fig. 3). Results indicated that the rate of rotifer population growth enhanced with the rise in temperature. Related findings were also reported in various studies by Baloch *et al*., 2008; Schöll & Kiss, 2008; Ejaz *et al*., 2015. Increase in temperature proportionately increases the rate of growth of rotifer population.

pH is the total of proton activities and ideal pH for rotifer growth ranges from 6.5 to 8.5 (Neschuk *et al*., 2002). The maximum pH (8.9±0.01) was seen during the month of June while minimum pH (6.59±0.06) was noted during January (Fig. 2). During this study, Pearson correlations reflected positive relationship between rotifers and pH (Table I). Dai *et al*. (2014) and Ejaz *et al*. (2016) reported similar findings. Contrary results were obtained by Sulehria and Malik (2012) in some earlier studies. Increase in pH in hot months may be due to increased quantity of nitrates, phosphates and $CaCo_3$.

Dissolved oxygen (DO) is critical for aquatic life. Highest DO (10±0.01) was seen in the month of January and lowest (6.5±0.05) in June (Fig. 2). During hot months this drop in DO might be due to falling solubility of oxygen and increasing decomposition. The correlations between rotifers and dissolved oxygen reflected negative influence (Table I). These conclusions agreed with the findings of Saler & Sen (2002), Sulehria *et al*. (2013) and Shumka (2014). However, these results were totally diverse from earlier studies conducted by Malik & Sulehria (2004); Sulehria *et al*. (2009b). Five genera i.e., *Testudinella Notholca, Lepadella, Synchaeta* and *Lecane,* revealed high density and diversity with rise in dissolved oxygen, which might be due to cold temperature rather than high level of DO.

Electrical conductivity was highest (891.33±0.88) in August and lowest (468.67±0.88) in January (Fig. 2). Highest conductivity in hot months might be due to lower solubility, high temperature and decomposition of organic matter. Rotifer density and diversity reflected positive correlations with electrical conductivity (Table I). Similar effects had also been reported in other studies in Pakistan by Sulehria & Malik (2012, 2013) and Ejaz *et al*. (2015, 2016).

Total Dissolved Solids (TDS) increased in the pond with natural means and also agricultural run-off and urban wastes. TDS are infilterable solids and show direct relationship with EC. Samal (2001) found that EC would increase with rise in TDS. Total dissolved solids were recorded maximum (579.36±0.64) in August and minimum (304.64±0.63) in January (Fig., 2). Total dissolved solids (TDS) revealed positive correlations with rotifers (Table I). Similar findings were also reported by Mustapha (2009) and Hussain *et al*. (2014). Increase in TDS might be due to natural resources, urban and agricultural run-off, industrial and sewage wastes.

The maximum total hardness (314.65±0.12) was calculated in June and minimum (242.73±0.13) in January (Fig., 2). Pearson correlations showed positive relationship between rotifers and total hardness (Table I). Increased hardness might be the result of more detergents, organic substances, chlorides and other pollutants. Similar results were also noted by Malik & Sulehria (2004) and Ejaz *et al*. (2016). Transparency extended from 10.33±0.20 and 20.13±0.19 and reflected negative correlations with the rotifer population. Turbidity reflected positive correlation with rotifer species (Fig., 2).

During this work, 74 rotifer species belonging to 24 genera and 13 families were identified (Table II). June reflected the maximum (128.7±40 ind/ml) mean density of rotifers and minimum was seen (64.9±22 ind/ml) in January. *Philodina roseola* showed lowest (3±1.2 ind/ml) density and highest (40±11.9 ind/ml) mean population density was shown by *Brachionus havanaensis* making it a dominant species (Fig. 3). Month of June revealed the highest (52 species) diversity of rotifers and lowest (26 species) diversity was observed in January (Fig., 4).

From 24 genera, *Brachionus* was the highest (8.37%) contributor and *Pleosoma* was the lowest (1.56%) one. Percentage composition of other rotifer genera was 6.71% *(Keratella)*, 5.57% *(Lecane),* 5.34% *(Lepadella),* 5.31% *(Filinia)*, 5.3% *(Testudinella)*, 5.15% *(Trichocerca),* 5% *(Rotaria)*, 4.99% *(Polyarthra)*, 4.74% *(Synchaeta)*, 4.65% *(Notommata)*, 4.65% *(Cephalodella)*, 4.5% (*Notholca)*, 4.38% *(Philodina)*, 3.71% *(Colurella)*, 3.59% *(Hexarthra)*, 3.3% *(Collotheca)*, 2.72% *(Macrochaetus)*, 2.47% (*Monommata)*, 2.39% *(Kellicottia)*, 1.98% *(Trichotria*), 1.81% *(Anuraeopsis)* and 1.81% *(Dicranophorus)* (Fig., 6). Similar findings were also reported by Ejaz *et al*. (2016).

ANOVA reflected a significant difference ($P<0.05$) in rotifer density during the study period (Table III).

Values of Shannon Weaver index ranged from 3.036 (lowest) in January to 3.802 (highest) in June. Minimum Simpson index of dominance (0.025) was observed in June and highest (0.053) in the month of January. Values of Simpson index of diversity exhibited minimum (0.947) in January and maximum (0.975) in June. Increase in temperature enhanced the rate of photosynthesis, and detritus which might be the cause of the high density and diversity of rotifers due to enhanced growth. Lowest species richness (2.256) of rotifers was observed in January and highest (6.998) in the month of March. In the month of January, minimum (0.932) value of species evenness was calculated and maximum (0.970) in March (Fig., 5).

In species abundance curve, *Brachionus havanaensis* showed the maximum abundance (40) and minimum (3) by *Philodina roseola*. All the remaining species ranged between these two borders (Fig., 7).

Table I: Correlations (Pearson) between Rotifers and physico-chemical parameters.

	Rotifers	Temp	pH	DO	EC	TDS	TH	Trans
Temp	0.821							
pH	0.718	0.641						
DO	-0.903	-0.869	-0.783					
EC	0.412	0.739	0.073	-0.424				
TDS	0.412	0.739	0.073	-0.424	1.000			
TH	0.571	0.726	0.176	-0.572	0.913	0.913		
Trans	-0.811	-0.882	-0.516	0.805	-0.688	-0.688	-0.681	
Turb	0.800	0.848	0.437	-0.794	0.683	0.683	0.695	-0.986

Temp= Temperature, DO= Dissolved oxygen, EC= Electrical conductivity, TDS= Total dissolved solids, TH= Total hardness, Trans= Transparency, Turb= Turbidity

Table II: List of rotifer species identified from Pipnakha Pond.

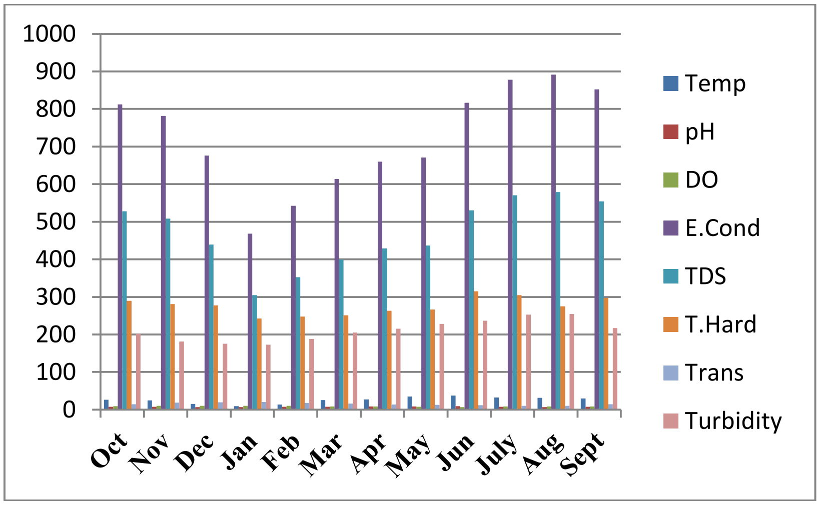
S. No	Family	Genus	Species
1	Brachionidae	*Anuraeopsis*	*Anuraeopsis fissa* Gosse, 1851
2		*Brachionus*	*Brachionus angularis* Gosse, 1851
3			*Brachionus budapestiensis* Daday, 1885
4			*Brachionus calyciflorus* Pallas, 1766
5			*Brachionus diversicornis* (Daday, 1883)
6			*Brachionus forficula* Wierzejski, 1891
7			*Brachionus havanaensis* Rousselet, 1911
8			*Brachionus quadridentatus* Hermann, 1783
9		*Keratella*	*Keratella tropica* (Apstein, 1907)
10			*Keratella cochlearis* (Gosse, 1851)
11			*Keratella quadrata* (Müller, 1786)
12			*Keratella testudo* (Ehrenberg, 1832)
13			*Keratella valga* (Ehrenberg, 1834)
14		*Kellicottia*	*Kellicottia longispina* (Kellicot, 1879)
15		*Macrochaetus*	*Macrochaetus collinsii* (Gosse, 1867)
16		*Notholca*	*Notholca striata* (Müller, 1786)
17			*Notholca acuminata* (Ehrenberg, 1832)
18			*Notholca caudata* Carlin, 1943
19			*Notholca labis* Gosse, 1887
20	Colluthecidae	*Collotheca*	*Collotheca pelagica* (Rousselet, 1893)
21	Dicranophoridae	*Dicranophorus*	*Dicranophorus epicharis* Harring & Myers, 1928
22			*Dicranophorus forcipatus* (Müller, 1786)
23	Filinidae	*Filinia*	*Filinia longiseta* (Ehrenberg, 1834)
24			*Filinia cornuta* (Weisse, 1847)
25			*Filinia pejleri* Hutchinson, 1964
26			*Filinia opoliensis* (Zacharias, 1898)
27			*Filinia terminalis* (Plate, 1886)
28	Hexarthridae	*Hexarthra*	*Hexarthra mira* (Hudson, 1871)
29			*Hexarthra fennica* (Levander, 1892)
30	Lecanidae	*Lecane*	*Lecane monostyla* (Daday, 1897)

31			*Lecane ohioensis* (Herrick, 1885)
32			*Lecane pyriformis* (Daday, 1905)
33			*Lecane stenroosi* (Meissner, 1908)
34			*Lecane ungulata* (Gosse, 1887)
35	Lepadellidae	*Leepadella*	*Lepadella biloba* Hauer, 1958
36			*Lepadella acuminata (*Ehrenberg, 1834)
37			*Lepadella triptera* (Ehrenberg, 1832)
38			*Lepadella eurysterna* Myers, 1942
39		*Colurella*	*Colurella adriatica* Ehrenberg, 1831
40			*Colurella uncinata* (Müller, 1773)
41	Notommatidae	*Cephalodella*	*Cephalodella gibba* (Ehrenberg, 1830)
42			*Cephalodella catellina* (Müller, 1786)
43			*Cephalodella forficula* (Ehrenberg, 1830)
44			*Cephalodella sterea* (Gosse, 1887)
45		*Monommata*	*Monommata grandis* Tessin, 1890
46		*Notommata*	*Notommata copeus* Ehrenberg, 1834
47			*Notommata aurita* (Müller, 1786)
48			*Notommata fasciola* Myers, 1933
49	Philodinidae	*Philodina*	*Philodina erythrophthalma* Ehrenberg, 1830
50			*Philodina megalotrocha* Ehrenberg, 1832
51			*Philodina roseola* Ehrenberg, 1832
52		*Rotaria*	*Rotaria rotatoria* (Pallas, 1766)
53			*Rotaria citrina* (Ehrenberg, 1838)
54			*Rotaria neptunia* (Ehrenberg, 1830)
55	Synchaetidae	*Ploesoma*	*Ploesoma lenticulare* Herrick, 1885
56		*Polyarthra*	*Polyarthra vulgaris* Carlin, 1943
57			*Polyarthra dolichoptera* Idelson, 1925
58			*Polyarthra euryptera* Wierzejski, 1891
59			*Polyarthra trigla* Ehrenberg, 1834
60		*Synchaeta*	*Synchaeta oblonga* Ehrenberg, 1832
61			*Synchaeta pectinata* Ehrenberg, 1832
62	Testudinellidae	*Testudinella*	*Testudinella patina* (Hermann, 1783)
63			*Testudinella emarginula* (Stenroos, 1898)
64			*Testudinella tridentata* Smirnov, 1931
65			*Testudinella parva* (Ternetz, 1892)
66	Trichotriidae	*Trichotria*	*Trichotria tetractis* (Ehrenberg, 1830)
67	Trichocercidae	*Trichocerca*	*Trichocerca porcellus* (Gosse, 1851)
68			*Trichocerca capucina* (Wierzejski & Zacharias, 1893)
69			*Trichocerca cavia* (Gosse, 1886)
70			*Trichocerca cylindrica* (Imhof, 1891)
71			*Trichocerca bicristata* (Gosse, 1887)
72			*Trichocerca flagellata* Haur, 1937
73			*Trighocerca longiseta* (Schrank, 1802)
74			*Trichocerca similis* (Wierzejski, 1893)
Total	**13**	**24**	**74**

Table III: Analysis of Variance of Rotifers (P<0.05).

Source	DF	SS	MS	F	P
Factor	1	40674	40674	134.70	> 0.001
Error	22	6643	302		
Total	23	47318			

DF= Degree of freedom, SS= Sum of square, MS= Mean of square, F= f-Distribution, P= Probability, Significance level= 0.05



Temp= Temperature, D.O= Dissolved oxygen, E.Cond= Electrical conductivity, TDS= Total dissolved solids, T.Hard= Total Hardness, Trans= Transparency

Fig., 2: Variations of different physico-chemical parameters in Pipnakha Pond

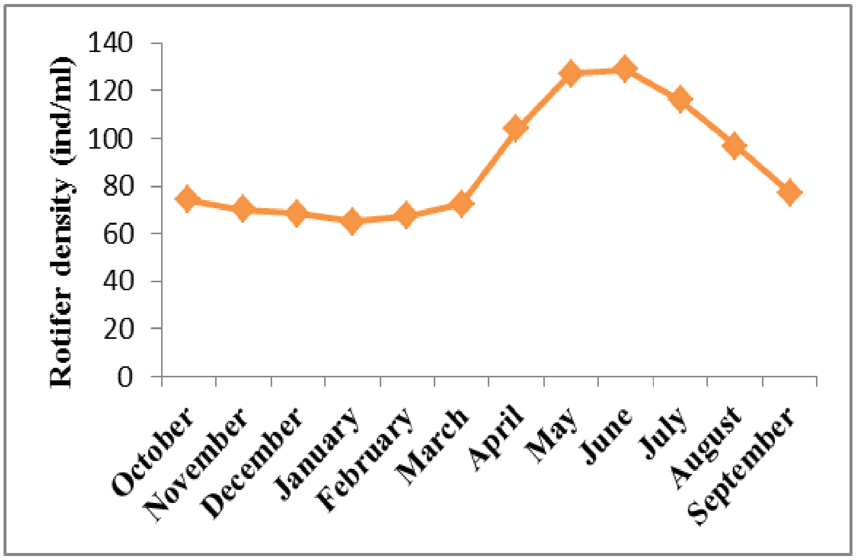


Fig., 3: Density of rotifers isolated from Pipnakha Pond.

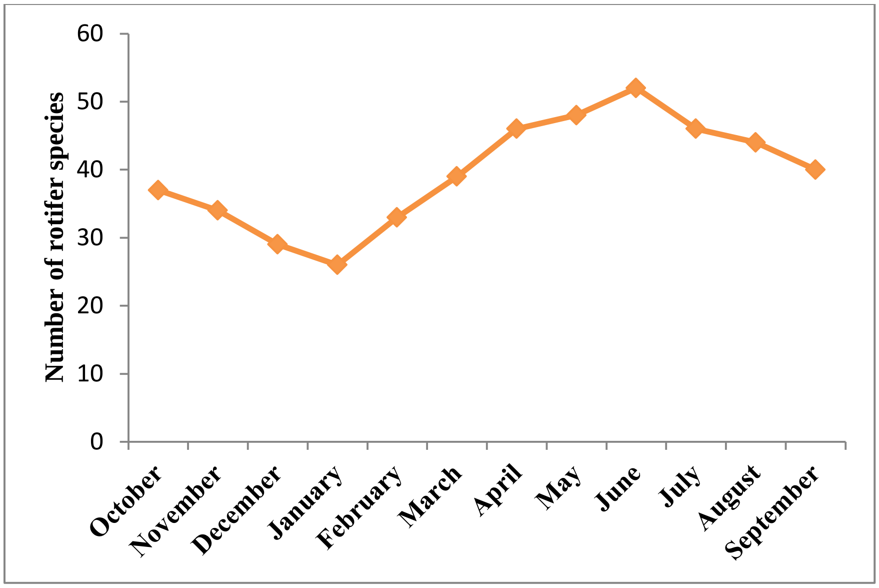
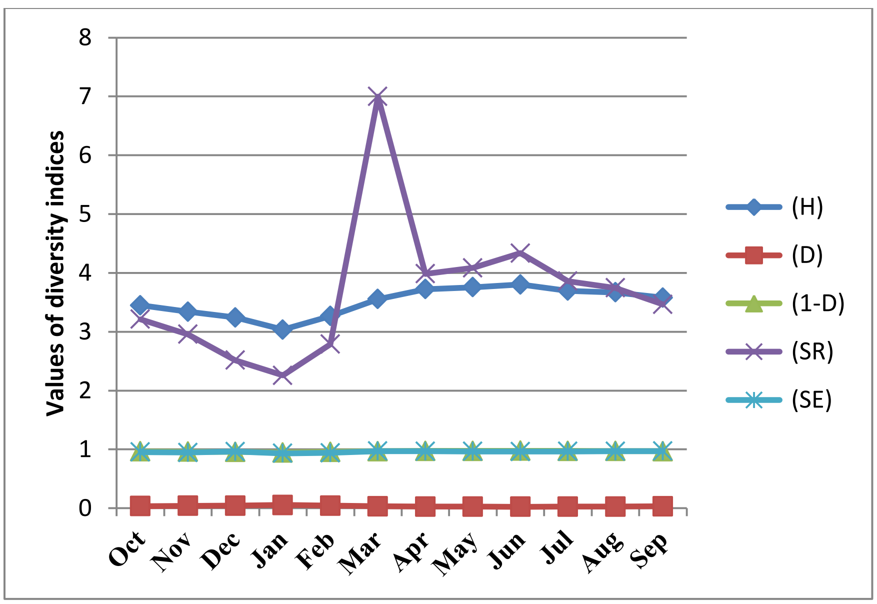


Fig., 4: Diversity of rotifers isolated from Pipnakha Pond.



H (Shannon-weaver diversity index), D (Simpson index of dominance), 1-D (Simpson index of diversity), SR (Species richness), SE (Species evenness)

Fig., 5: Variations of diversity indices of rotifers isolated from Pipnakha Pond.

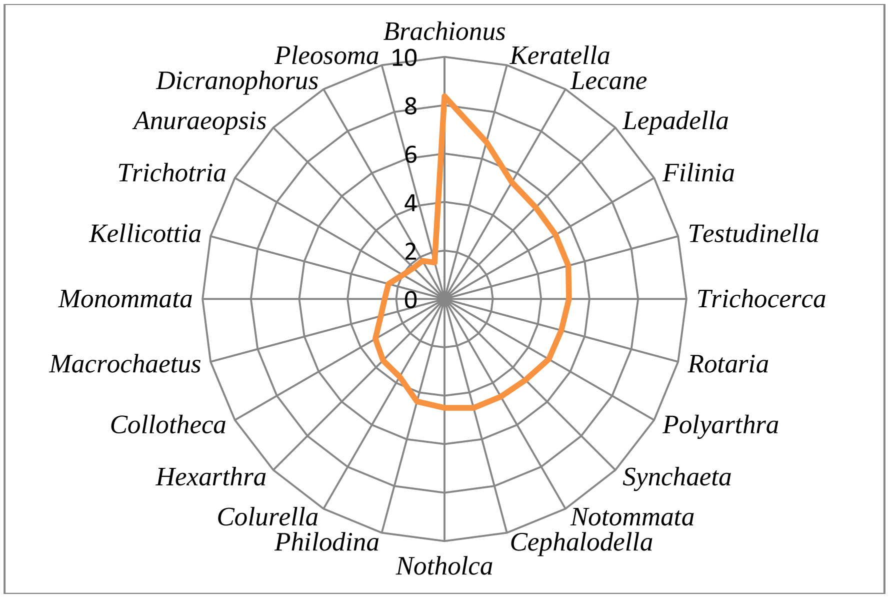


Fig., 6: Percentage representation of rotifer genera isolated from Pipnakha Pond

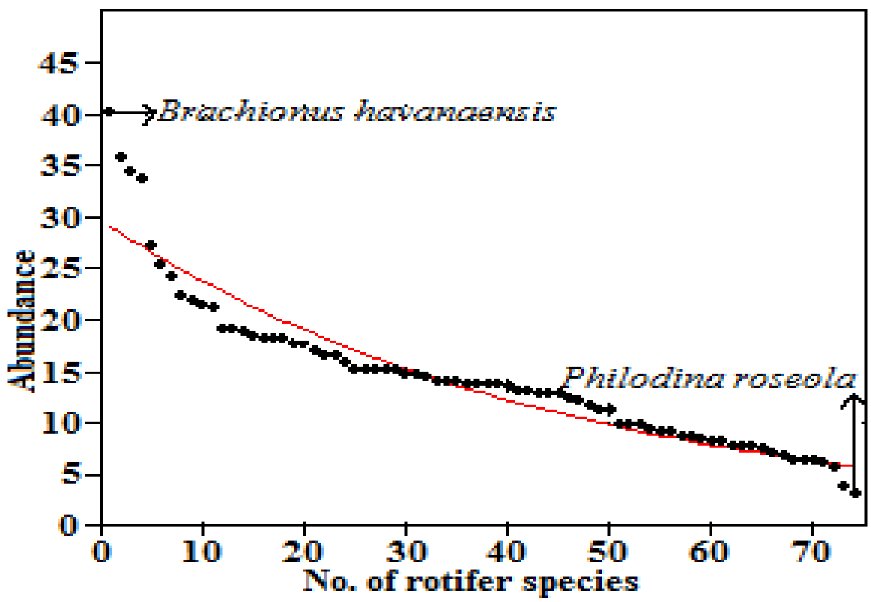


Fig., 7: Species abundance curve of rotifers isolated from Pipnakha Pond

CONCLUSION

Analysis of planktonic rotifers of Pipnakha Pond is the first work. Our knowledge regarding rotifer fauna of Gujranwala is still not thorough. This research work is an input to the existing knowledge of distribution of rotifers and desires further research work to obtain a consistent representation of planktonic rotifer fauna of lantic water bodies and ecology of this group.

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