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Short Communication

Changes in rotifer abundance and composition in two lakes in the Kashmir Valley (Himalayas)

I. A. WANI* AND B. A. SUBLA
Centre of Research for Development, University of Kashmir, Srinagar 190 006, India.

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Abstract

The seasonal abundance of Rotifera in two nutrient rich lakes of the Kashmir Valley (Himalayas) is described on the basis of quantitative and qualitative sampling between December, 1981 and November, 1982. The fluctuations in the numerical density of Rotifera are correlated with those of seasonal water temperatures and pH. Twenty-two species of Rotifera were identified from the two lakes and the low diversity indices related to high eutrophication.

Keyword: Trigamsar, Tilwansar, Rotifera, eutrophication, Himalayas.

1. Introduction

Although Rotifera is one of the numerically important groups in the zooplankton of Kashmir lakes, it has received little attention[1–4]. The earlier studies are mainly qualitative and taxonomic in nature. In the present paper, the species composition of Rotifera and their seasonal abundance from two lakes (Trigamsar and Tilwansar) in the Kashmir Valley, have been surveyed between December, 1981 and November, 1982.

Trigamsar (34°10′ N–74°39.6′ E) and Tilwansar (34°10.4′ N–74°39.5′ E) are two adjacent lakes situated 22 km north-east of Srinagar. The lakes which are closed without inflow and outflow channels probably originated as a result of meandering alluvial deposits and are of post-glacial age[5]. The two lakes are single basined covering areas of 6.0 and 43.5 ha with a maximum depth of 2.5 and 2.1 m, respectively. Large quantities of water are pumped out of Tilwansar for irrigation of paddy fields reducing the water level considerably during late spring and summer so that large areas of the basin dry out and are used for cultivation. The catchment area of both the lakes is under various agricultural and horticultural practices and is surrounded by densely populated settlements. Agricultural run-offs, pesticide residues as well as domestic effluents find their way into the lakes from the catchment. The climate of the area is sub-tropical.

2. Material and method

Samples were collected from the two lakes at monthly intervals. Zooplankton samples were collected from three stations in each lake, by passing a known volume of the

* Present address: Govt. Degree College, Sopore, 193 201, Jammu and Kashmir, India.

surface water through a standard plankton net no. 24 (mesh size 64 μm). The filtered samples were immediately fixed in 5% formalin. In the laboratory 1 ml sub-sample was examined in a Sedgwick–Rafter counting cell from each filtered sample. The numerical density of Rotifera was determined by averaging counts of all the three sub-samples collected from three different sites on a particular date. The chemical analysis of lake water was carried out following APHA procedures[7]. Water temperature at 0.1 m depth was taken with a standard centigrade thermometer (± 0.5°C).

Table I
Range and average values of important physico-chemical parameters in Trigamsar and Tilwansar (Average values given in parenthesis)

Parameter	Tilgamsar	Tilwansar
Temperature (°C)	4.5–31	5-31
Secchi transparency (m)	0.1–1.0	0.1–0.5
pH	7.5–9.1 (8.6)	7.5–9.0 (8.17)
Specific conductivity μmhocm^{-1} at 25°C	1162–2049 (1395.8)	843–1222 (1044.2)
Dissolved oxygen (mg l^{-1})	0.96–22.2 (9.49)	4.0–12.6 (9.39)
Total alkalinity (mg l^{-1})	272–580 (406)	80.0–284.0 (160)
Chloride (mg l^{-1})	128–432 (261.3)	32.0–104.0 (64.4)
Na (mg l^{-1})	37.0–344.0 (147.5)	31.0–330.0 (117)
K (mg l^{-1})	40.0–381.2 (156.19)	30.0–250.8 (79.7)
Ca (mg l^{-1})	18.0–88.8 (50.25)	12.0–103.6 (66.3)
Mg (mg l^{-1})	14.6–72.4 (39.1)	7.5–64.2 (29.03)
SiO_2 (mg l^{-1})	2.20–9.60 (4.72)	3.0–30.2 (10.46)
Fe (mg l^{-1})	0.442–2.65 (1.061)	0.310–3.82 (1.22)
NH_4–N (μg l^{-1})	204–976 (398.1)	252–2280 (735.17)
NO_3–N (μg l^{-1})	43.8–482.0 (124.8)	83.8–394.4 (148.7)
PO_4–P (μg l^{-1})	33.02–462.20 (143.75)	22.01–352.2 (72.16)
Total P (μg l^{-1})	55.0–880.5 (372.2)	22.0–484.3 (246.2)

Coefficient of correlation between rotifer density and abiotic factors

	Trigamsar	*Tilwansar*
Temp. *vs* Rotifera	0.10	0.15
pH *vs* Rotifera	0.00	0.00

Diversity index (H′) was calculated using the Shannon and Weaver[8] index.

$$H = \sum_{1}^{s} pi \log pi$$

where s is the total number of species in a sample and pi, the numerical proportion of the ith species. The higher the value of H, the greater the species diversity of the community.

3. Results

Water in both the lakes was turbid with low Secchi transparency (mean = 0.35 m). The water temperature fluctuated appreciably throughout the period. A minimum of 4.5°C was recorded in January and a maximum of 31°C in July. The lake waters are alkaline and well buffered. Mean pH of Trigamsar (8.7) was higher than that of Tilwansar (8.5). The specific conductivity was > 1000 μm oh cm^{-1} in both the lakes during most of the study. The dissolved oxygen concentration of the surface waters was above 100% saturation. Total alkalinity and chloride were higher in Trigamsar than in Tilwansar.

In Trigamsar, potassium was the dominant cation whereas in Tilwansar sodium was dominant. The equivalency order of the cations was K > Na > Ca > Mg in Trigamsar and Na > K > Ca > Mg in Tilwansar. Among the anions in both the lakes bicarbonate was dominant over chloride. In both the lakes the concentration of phosphorus and nitrogen were high but phosphorus was higher (143 μgl^{-1}) in Trigamsar than in Tilwansar (72 μgl^{-1}) whereas both nitrate-N and ammonium-N were high in Tilwansar. Silicate concentration was also higher in Tilwansar (10.4 mgl^{-1}) than in Trigamsar (4.7 mgl^{-1}) whereas iron had a mean concentration of 1 mgl^{-1} in both the lakes (Table I).

In both the lakes Rotifera constituted the numerically dominant group of zooplankton. Figure 1 shows the monthly fluctuations in numerical density during the study period.

In Trigamsar, low densities (150–800 $ind.l^{-1}$) of rotifera occurred during winter (Dec–Feb) but started increasing from early spring reaching the highest density (34.67×10^3 $ind.l^{-1}$) in July (mid-summer). The density waned to 2.2×10^3 $ind.l^{-1}$ in August rising again in September to 7.73×10^3 $ind.l^{-1}$ and subsequently declined averaging 200 $ind.l^{-1}$ during Oct–Nov. Thus, a distinct bimodal distribution was observed with peaks in July and in September.

In Tilwansar low numerical density was observed during winter though density increased in May (late spring) to 3.4×10^3 $ind.l^{-1}$. The density decreased to 2.0×10^3 $ind.l^{-1}$ in June but increased rapidly in July to a peak of 18.7×10^3 $ind.l^{-1}$ before decreasing in August and increasing again in autumn to 350 $ind.l^{-1}$. The density fluctuated during most part of the year with a single conspicuous maximum in July (mid-summer).

Keratella cochlearis was the most abundant species encountered during the present research. In Trigamsar the species exhibited pronounced summer (29.1×10^3 $ind.l^{-1}$) and an autumn maxima (8.9×10^3 $ind.l^{-1}$). In Tilwansar, *K. cochlearis* maxima were

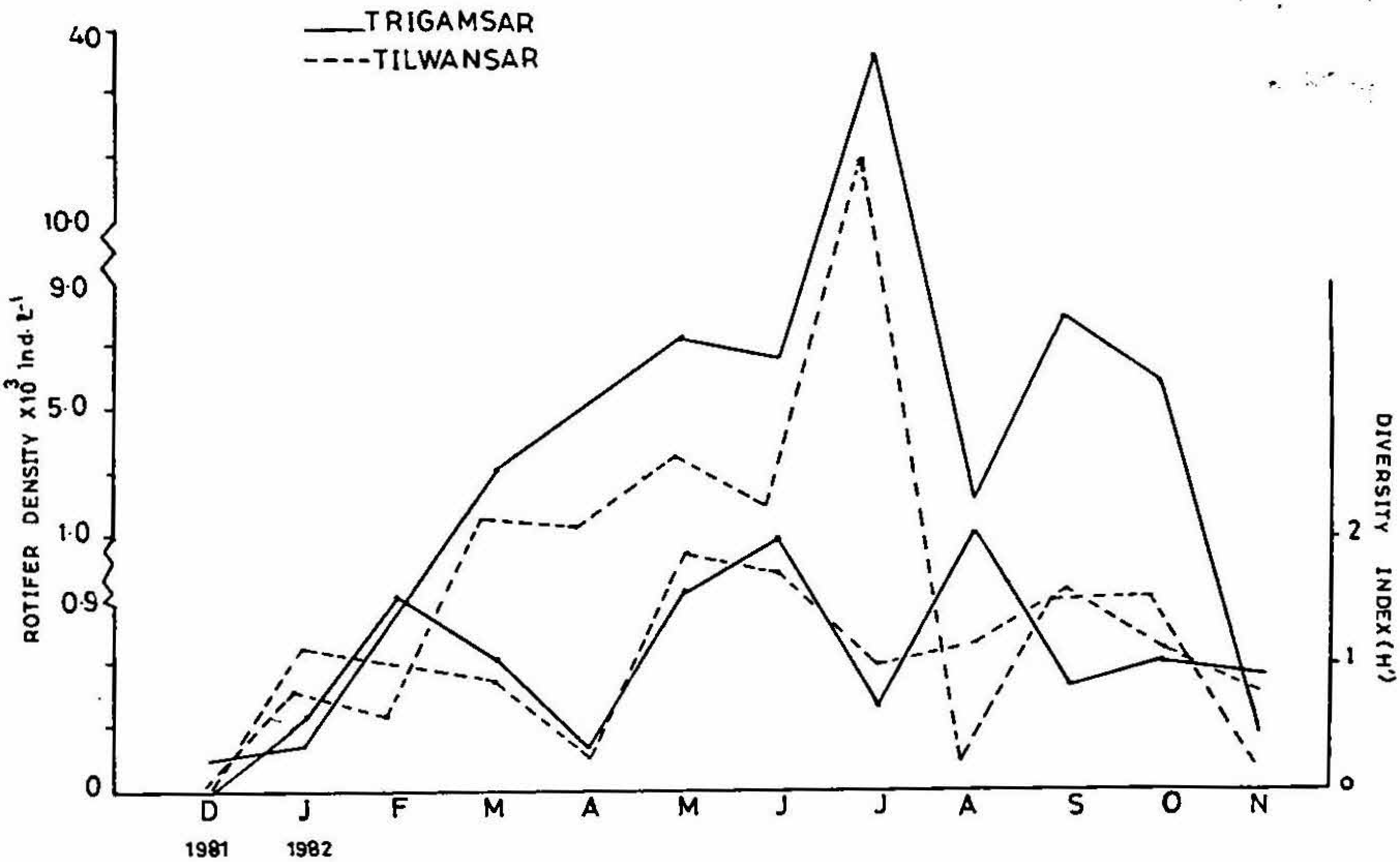

FIG. 1. Monthly fluctuations in the numerical density and diversity index of rotifer in the two lakes.

observed in spring (1.37×10^3 ind.l^{-1}) and summer (12.08×10^3 ind.l^{-1}). *Brachionus caudatus*, the second dominant species appeared in January, gradually increasing and reaching population maxima of 5×10^3 ind.l^{-1} (Trigamsar) and 6.3×10^3 ind.l^{-1} (Tilwansar) in July. *Polyarthra vulgaris* and *Trichocerca cylinderica* also contributed to the peak values of the rotifer density.

4. Discussion

The rotifer fauna formed the majority of the zooplankton community (90%) during the present investigations, with other zooplankton classes including Cladocera and Copepoda contributing little to zooplankton density (Table III). Rotifera are numerically dominant in the zooplankton of most of the shallow lakes of Kashmir[9, 10].

A small number of rotifer species (21 in Trigamsar and 17 in Tilwansar) were recorded during the present study (Table II) in comparison to 28 to 38 species reported by Yousuf and Qadri[3] and Subla *et al.*[4], in other valley lakes of Kashmir. The diversity index (H′) calculated for the two lakes showed low diversity values (Fig. 1) fluctuating between 0.3 and 1.96 in Trigamsar and 0.2 and 1.86 in Tilwansar. During the summer and autumn the indices for both the lakes were higher (except July) than in winter–spring. This decrease in diversity and increase in density of Rotifera may be attributed to high nutrient loading of the lake waters especially during the warm months. Brooks[11] suggested that eutrophication resulted in an increase in density and decrease in diversity of zooplankton. Both lakes show high trophic status as indicated by the water chemistry (Table II) and the *Brachionus: Trichocerca* (B/T) quotient[12]:

Table II
Seasonal abundance of Rotifera in the two lakes under study (Dec. 1981–Nov. 1982)

Taxa	*Trigamsar*				*Tilwansar*			
	Wi	*Sp*	*Su*	*Au*	*Wi*	*Sp*	*Su*	*Au*
Anuraeopsis fissa. Gosse	–	–	–	–	R	–	F	–
Asplanchna priodonta Gosse	–	R	R	–	–	–	R	R
Brachionus angularis Gosse	F	F	F	R	–	R	R	R
B. calyciflorus Pallas	F	F	F	R	–	R	R	R
B. caudatus Pallas	F	D	D	D	R	F	D	R
B. quadridentatus Hermann	–	R	R	–	–	R	–	R
Cephalodella gibba Ehrenberg	–	R	R	SD	–	F	R	F
Filinea longiseta Ehrenberg	R	F	F	F	F	R	R	R
F. terminalis Plate	–	R	F	R	–	R	–	–
Gastropus stylifer Imhof.	–	–	R	R	–	–	–	–
Hexarthra mira Hudson	–	–	R	R	–	–	–	–
Keratella cochlearis Gosse	F	D	D	D	F	D	D	SD
Lacane Luna Muller	R	–	–	–	–	–	–	–
Lepadella ovalis Muller	R	–	–	–	R	R	F	R
Monostyla bulla Gosse	–	F	–	–	–	–	R	–
Mytilina ventralis Ehrenberg	–	–	R	–	–	–	–	–
Notholca acuminata Ehrenberg	–	R	–	–	–	–	R	–
Philodina sp. Ehrenberg	–	R	R	–	–	–	–	–
Platyias patulus Muller	–	–	R	–	–	–	–	–
Polyartra vulgaris Carlin	R	SD	SD	SD	–	F	F	F
Trichocerca cylinderica Imhof	–	R	F	R	–	F	R	R
T. porcellus Gosse	–	R	R	R	–	R	–	R

R (Rare) = 1–20 ind. l^{-1}; F (Frequent) = 21–50 ind. l^{-1}; SD (sub-dominant) = 51–200 ind. l^{-1}; D (Dominant) > 200 ind. l^{-1}.
Wi = Winter; Sp = Spring; Su = Summer; Au = Autumn.

$$Q\frac{B}{T} = \frac{\text{Number of species of } Brachionus}{\text{Number of species of } Trichocerca}.$$

Values of Q B/T less than 1.0 indicate oligotrophy, between 1.0 and 2.0 mesotrophy and over 2.0 eutrophy.

A value of 2.0 places Trigamsar and Tilwansar in the meso-eutrophic category.

The bimodal seasonal density pattern of Rotifera in Trigamsar did not show any direct correlation with temperature or pH (Table II). However, rotifer density maxima were observed when water temperature was the highest. In Tilwansar, rotifer density waxed

Table III
Monthly fluctuations in the numerical density of other zooplankton groups (Cladocera and Copepoda recorded in the two lakes)

	1981 D	1982 J	F	M	A	M	J	J	A	S	O	N
Trigamsar	15	10	5	140	70	50	50	30	100	35	65	5
Tilwansar	–	5	2	15	5	50	15	15	30	20	35	20

and waned irregularly during the investigation period. After the July peak, a drastic fall in density was observed during August coinciding with cyanophycean blooms. A cyanophycean density of 3750.6×10^3 units l^{-1} (Wani[13]) occurred and constituted almost 100% of *Merismopedia* sp. Dumont[14] has suggested that toxic substance(s) released by Cyanophyceae can directly limit the abundance of rotifers. Also the excessive growth of Cyanophyceae inhibits the development of most sedimentators by eliminating most of the small algae which constitute the basic food of phytophagus sedimentators[14,15]. Since the correlation coefficient between Cyanophyceae and Rotifera was not significant ($r = 0.13$), it is presumed that the excessive growth of Cyanophyceae had an inhibitory effect on the production of small algae, bringing about drastic reduction in rotifer numerical density. The otherwise fluctuating density of Rotifera in Tilwansar may be attributed to water level fluctuations and human interference in the catchment.

Keratella cochlearis and *Brachionus caudatus* which formed the majority of the rotifer fauna in the study lakes have also been reported dominant in other water bodies of the region[2-4,10]. Being typical eutrophic species[16] their populations increase with an increase in nutrient level.

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