



Temporal and Spatial Variations in Rotifer Density with Environmental Factors of Three Kashmir Lakes, India

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ABSTRACT: The present study was carried out to examine temporal and spatial variations in three fresh water lakes of Kashmir, Dal, Anchar, Ahansar between 2012-2013. All these lakes are with different sizes and varying depths, located at same altitude 1583 m (a.s.l). Density of Rotifer was greatly influenced by various factors like variations in temperature, pH, conductivity, dissolved oxygen, carbon dioxide and alkalinity. Rotifer density was found abundant during summer months while as minimum numbers were recorded during winter months, *Notholca acuminata*, *Keratella hiemalis*, *K. valga*, *K. cochlearis*, *Trichocerca longiseta* were the main species found during the study period.

Keywords: Dal, Anchar, Ahansar, Rotifer community, Seasonal fluctuations

I. INTRODUCTION

Seasonal fluctuations of Zooplankton are a well-known phenomenon and exhibit a bimodal pattern with spring and autumn peaks in temperate lakes [1]. Variations in temperature mostly effect the fluctuation of rotifers besides other factors. Temperature along with other factors are essential for the rotifer assemblage and seasonal occurrence, and their behaviour is ultimately determined by these factors [2,3]. Primary Peaks of Zooplankton are observed during the early summers. The current study was carried out keeping environmental uncertainty under consideration, mainly those factors that regulate the diversity and density of Rotifer community in the study area. This type of study will lead to yield new insights into the occurrence and ecology of rotifers with respect to the prevailing conditions.

II. MATERIALS AND METHODS

A. Study areas

Dal Lake. Dal lake is a Shallow Urban water body Situated in the laps of Zaberwan at an altitude of 1583 m (a.s.l) along with geographic coordinates of North latitude $34^{\circ}05'0''$ - $34^{\circ}09'04''$ and East longitude $74^{\circ}49'55''$ - $74^{\circ}52'55''$ at a distance of about 12km to the North east of the summer capital of Jammu and Kashmir, with an area of 11.5km^2 and maximum depth of 1.5m. It is an open drainage type and is divisible in to five basins, 1.Gagribal basin in the South –east, 2. Lokut – Dal in the East with a small island called Rupa-Lank in the middle, 3. Hazaratbal basin in the north with a small Island called Sona –Lank in the middle.

This basin receives Telbal stream on its northside and is connected by a narrow channel at Ashaibagh with the 4th basin of the lake, the Nageen basin. On the western side the Gagribal basin is connected with the 5thbasin called Brarinumbal basin through the Nowpora channel (Fig. 1).

Anchar lake. Anchar lake, a semi urban shallow lake is a small sized water body. It is single Basined and drainage type lake with perennial inflow and outflow channel. Situated at an altitude of 1583 m (a.s.l) within the geographical coordinates of Northlatitude $34^{\circ}08'05''$ - $34^{\circ}10'50''$ and East longitude $74^{\circ}46'0''$ - $74^{\circ}48'0''$, at a distance of about 12 km to the north – west of Srinagar city. The lake has a total area of 6.80km^2 ,out of which 1.7km^2 at present represent the open water extent and rest has turned into marshland with maximum depth of 3.5m. The Sindh nalla is the main source of water for the lake (Fig. 2).

Ahansar Lake. Ahansar Lake is a small rural fresh water body situated at an altitude of 1585m (a.s.l) within the geographical coordinates of North latitude $34^{\circ}13'37''$ - $34^{\circ}3'56''$ and East longitude $74^{\circ}39'20''$ - $74^{\circ}39'54''$, about 30km north of Srinagar, at Sumbal (District Bandipora). The lake is semi drainage type with the maximum depth of 5m. It is surrounded by three villages, Ahanon is in north-eastern side, Waskuron is in southern and Nesbal on western side. It is surrounded by the Karewas. There is no perennial inflow channel and the supply is mainly maintained by underground springs spread over its basin and in its area of 0.8km^2 (Fig. 3).

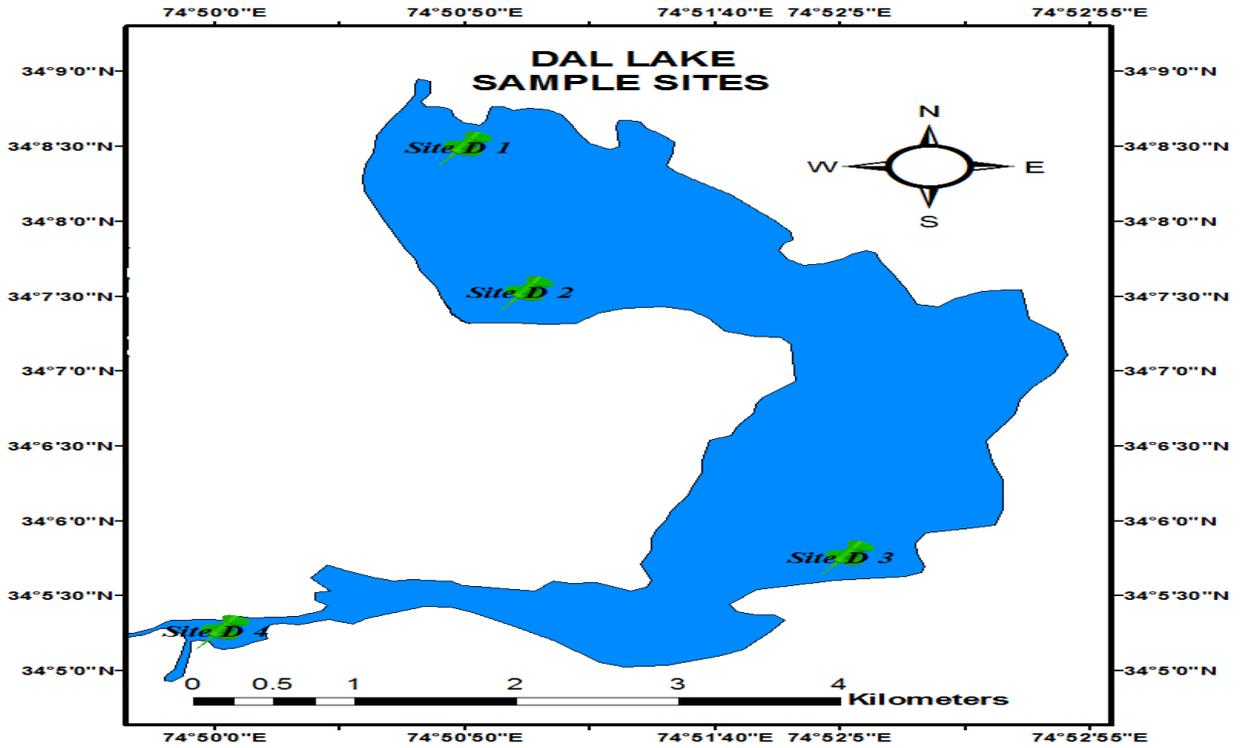


Fig. 1. Map of Dal Lake.

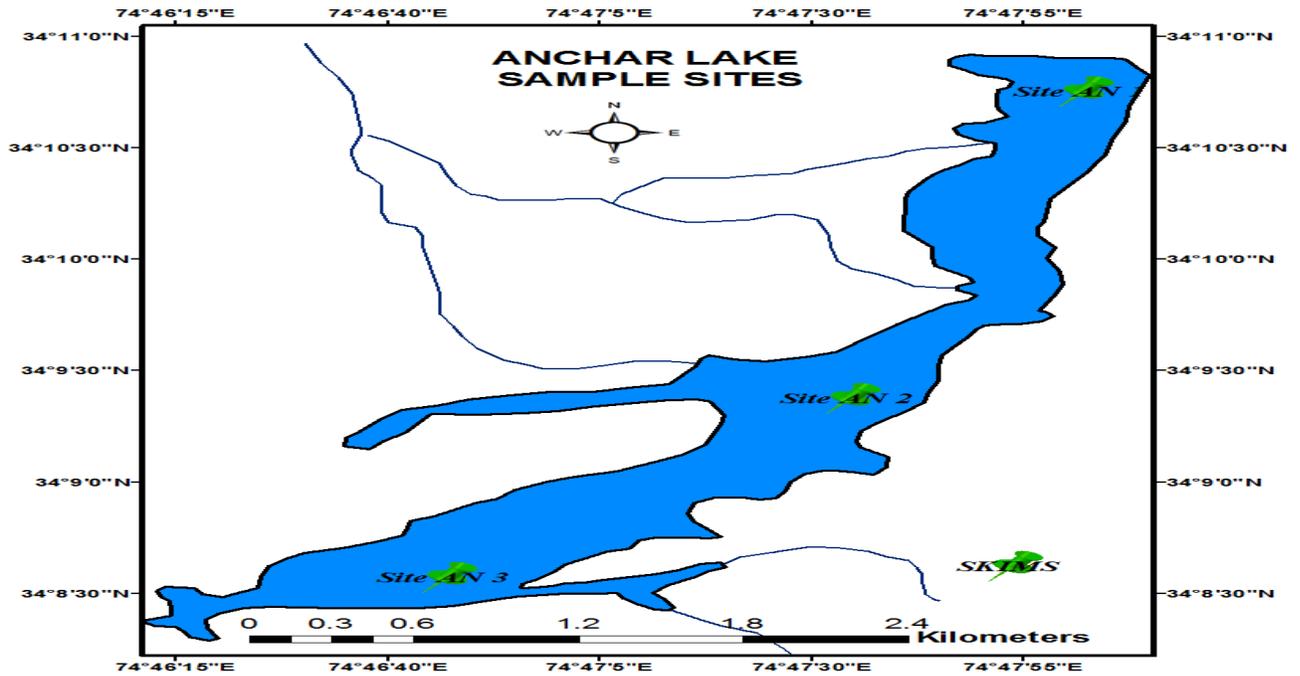


Fig. 2. Map of Anchar Lake.

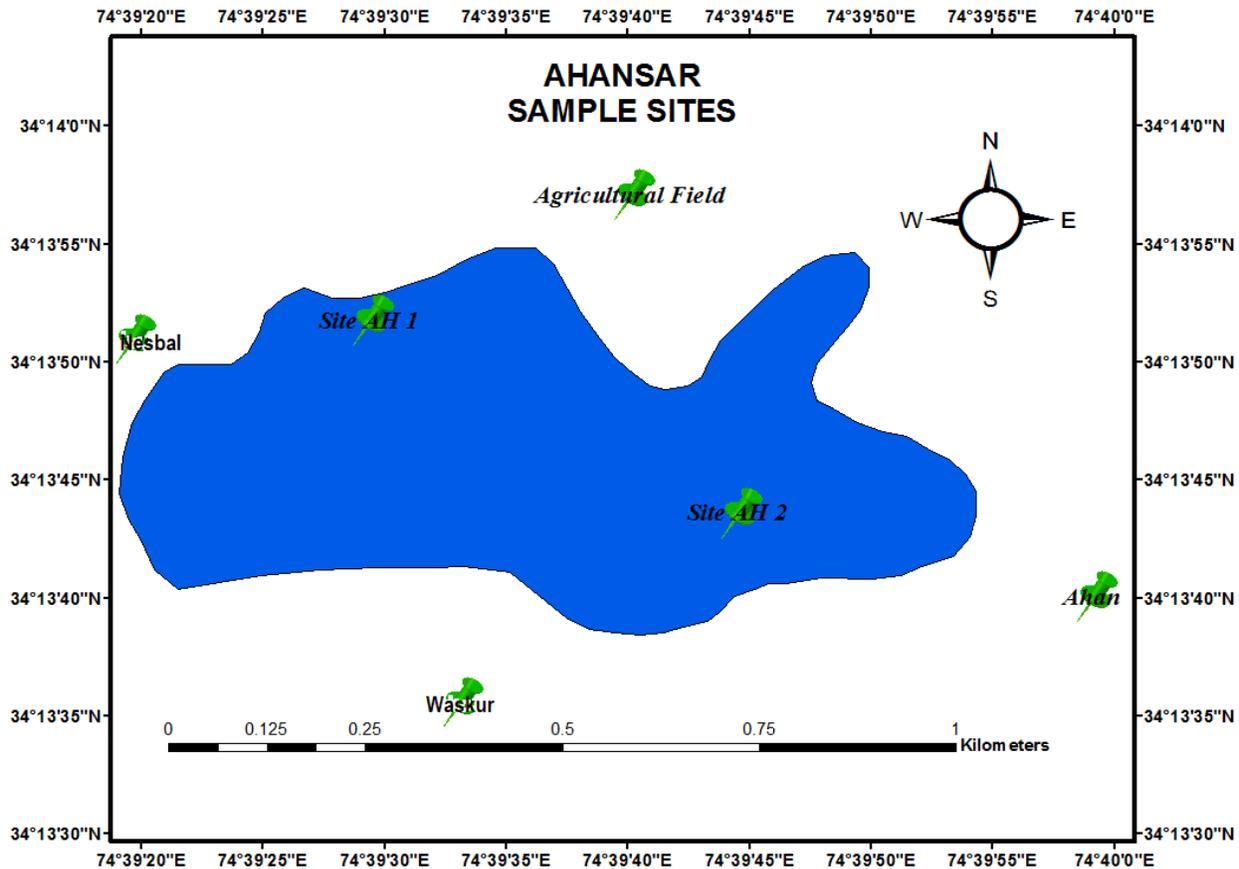


Fig. 3. Map of Ahansar Lake.

Water samples were collected between 9 am to 12 am, Physico-chemical parameters were measured as Temperature was measured by a graduated Celsius thermometer, pH was measured with the help of portable pH meter (HANNA Model –PHEP). Conductivity with the help of portable conductivity meter (HANNA Model – DIST-3). Dissolved oxygen was determined by Iodometric Azide method which is modified Wrinkler method. [4], Free carbon dioxide and alkalinity were determined by titremetric method [5]. Collection of the plankton for qualitative analysis was carried out by hauling plankton net through water in vertical and horizontal directions and preserved in 4% formalin. Detailed qualitative investigations was made under binocular microscope at 40X and 100X. Identification of Zooplankton was done with the help of standard taxonomic keys like [6,7]. For quantitative enumeration plankton samples were collected by sieving 10 litres of water obtained separately with the help of 2 litre Ruttner type sampler and preserved in 4% formalin and studied

under a binocular microscope. For accuracy counting of the subsamples was taken in triplicate and mean value was taken for calculating the number of organisms per cubic meter of the water by the formula [4]. The results were expressed in indi/m³. To study the relative effect of some environmental factors Pearson correlation between Rotifera and physico chemical parameters was calculated.

III. RESULTS AND DISCUSSION

During the study period, Forty Four, Twenty six and Twenty two species of Rotifera were recorded in Dal, Anchar, Ahansar (Table 1). Rotifers were influenced by water chemistry. In case of Dal Lake there was a positive correlation of rotifers with temperature, the values of co-efficient of correlation (r) between the two was (0.999) Table 2. During the study period highest temperature 31.2°C was recorded in July when rotifer density was 766,375ind./ m³ showing peak population (Table 3, Fig. 4).

Table 1: List of Rotifera recorded at three Study Lakes.

Dal Lake	Anchar Lake	Ahansar Lake
<i>Brachionus angularis</i>	<i>Brachionus angularis</i>	<i>Brachionus angularis</i>
<i>B. bidentata</i>	<i>B. quadridentata</i>	<i>B. bidentata</i>
<i>B. calyciflorus</i>	<i>Keratellacochlearis</i>	<i>B. calyciflorus</i>
<i>B. plicatilis</i>	<i>K. quadrata</i>	<i>B. quadridentata</i>
<i>B. quadridentata</i>	<i>K. hiemalis</i>	<i>Keratella cochlearis</i>
<i>Keratellacochlearis</i>	<i>Mytilina mucronata</i>	<i>K. quadrata</i>
<i>K. quadrata</i>	<i>M. ventralis</i>	<i>K. hiemalis</i>
<i>K. stipitata</i>	<i>Platiaspatulus</i>	<i>Mytilina mucronata</i>
<i>K. valga</i>	<i>P. quadricornis</i>	<i>Platiaspatulus</i>
<i>Mytilina mucronata</i>	<i>Notholca acuminata</i>	<i>P. quadricornis</i>
<i>M. ventralis</i>	<i>Lepadella ovalis</i>	<i>Notholca acuminata</i>
<i>Platiaspatulus</i>	<i>L. patella</i>	<i>Polyarthra vulgaris</i>
<i>P. quadricornis</i>	<i>Squatinellamutica</i>	<i>Lepadella ovalis</i>
<i>Trichotriatetractris</i>	<i>Monostyla bulla</i>	<i>L. patella</i>
<i>Euchlanis dilatata</i>	<i>M. lunaris</i>	<i>Monostyla bulla</i>
<i>Notholca acuminata</i>	<i>M. quadridentata</i>	<i>M. quadridentata</i>
<i>Kellicotia longispina</i>	<i>Cephalodella auriculata</i>	<i>Trichoceracylindrica</i>
<i>Lepadella ovalis</i>	<i>C. gibba</i>	<i>T. longiseta</i>
<i>L. patella</i>	<i>Trichoceracylindrica</i>	<i>T. porcellus</i>
<i>Colurella obtusa</i>	<i>Gastropus stylifer</i>	<i>Ascomorpha saltan</i>
<i>Squatinella mutica</i>	<i>Asplanchna priodonta</i>	<i>Filinia longiseta</i>
<i>Monostyla bulla</i>	<i>Polyarthra vulgaris</i>	<i>Philodina roseola</i>
<i>M. closterocerca</i>	<i>Filinia longiseta</i>	
<i>M. lunaris</i>	<i>F. terminalis</i>	
<i>M. quadridentata</i>	<i>Testudinella</i>	
<i>Lecaneluna</i>	<i>Philodina roseola</i>	
<i>Cephalodella auriculata</i>		
<i>C. exigua</i>		
<i>C. gibba</i>		
<i>Trichocera cylindrica</i>		
<i>T. longiseta</i>		
<i>T. porcellus</i>		
<i>Ascomorphellasp.</i>		
<i>Ascomorpha saltan</i>		
<i>Gastropus stylifer</i>		
<i>Asplanchna priodonta</i>		
<i>Proales</i>		
<i>Polyarthra dolicooptera</i>		
<i>P. vulgaris</i>		
<i>Filinia longiseta</i>		
<i>Testudinella</i>		
<i>Rotaria citrinus</i>		
<i>Philodina roseola</i>		
<i>Dissotrocha</i>		

Table 2: Correlation coefficient (r) between Rotifer density and various physic-chemical parameters in three lakes.

Study Area	Rotifer density	Temperature	pH	Dissolved oxygen	Carbon dioxide	Conductivity	Alkalinity
Dal Lake		0.999***	0.846***	0.099	-0.828***	0.999***	0.642
Anchar Lake		0.610	0.448	-0.363	-0.322	0.424	0.402
Ahansar Lake		0.763**	0.645	-0.542	-0.0418	0.798**	0.747

** =Correlation is highly significant at $p < 0.01$ level

Table 3: Showing the range of different physic-chemical parameters in three lakes.

Lake	Parameter	Range
Dal	Temp	9.2- 31.2°C
Anchar		9.2-26.3°C
Ahansar		8.8- 28.3°C
Dal	pH	7.2-9.6
Anchar		7.1-8.3
Ahansar		7.8-8.8
Dal	DO	2.6-10.1mg/l
Anchar		2.4-5.5mg/l
Ahansar		6.8-9mg/l
Dal	CO ₂	12-21mg/l
Anchar		17-38 mg/l
Ahansar		3-12 mg/l
Dal	Cond	176-229 μ S/cm
Anchar		289-434 μ S/cm
Ahansar		290-412 μ S/cm
Dal	Alkalinity	107-187 mg/l
Anchar		133-267 mg/l
Ahansar		145-298 mg/l

Thereafter the population experienced a short decline in August followed by second less peak in September with a population density of 57,125 ind./m³. During Summer there is rise in quantitative count of Rotifera and following species were mainly found *Brachionus calyciflorus*, *B. quadridentata*, *B. plicatilis*, *Mytilina mucronata*, *Keratella cochlearis*, *Trichocerca longiseta*, *Filinia longiseta*, *Philodina roseola*, *Rotaria citrinus*, while the September peak was dominated by *Brachionus bidentata*, *B. quadridentata*, *B. plicatilis*, *Mytilina mucronata*, *Colurella obtusa*, *Keratella cochlearis*, *Cephalodella gibba*, *Trichocerca longiceta*, *Rotaria citrinus*. The Rotifer community of winter was dominated by *Notholca acuminata*, *K. valga* and *Trichocerca longiseta* when water temperature was lowest 9.2°C in December. Similar results were found in Anchar and Ahansar Lakes ($r = 0.610$, 0.763) when water temperature in June was 26.3°C and 28.3°C respectively. In Anchar lake major peak density of 50,415 ind./m³ (Fig. 5) was contributed mainly by *Mytilina mucronata*, *Trichocerca longiseta*, *T. cylindrica*, *Lepadella ovalis*, *Monostyla quadridentata*. Second peak of 41,945 ind./m³ in

September were contributed by *Keratella cochlearis*, *Brachionus quadridentata*, *Trichocerca longiseta*. In Ahansar Lake Rotifers were observed to be maximum with population density of 40,250 ind/m³ (Fig. 6) in June which was mostly dominated by *Brachionus calyciflorus*, and second less peak in September was dominated by *Brachionus calyciflorus* and *Keratella cochlearis*. Winter community was dominated by *Notholca acuminata*, *Keratella hiemalis*, *K. cochlearis* both in Anchar and Ahansar when water temperature was 9.2°C and 8.8°C in December respectively.

Higher density of Rotifera were recorded during summer months while minimum during winters. This seasonal fluctuations may be due to changes in environmental factors. Temperature has been considered to be the main factor to cause fluctuations in the abundance of rotifera in fresh water [8,9,10,11]. Highest density of rotifer during the month of June and July probably was due to increasing temperature which stimulates the growth of phytoplankton population, resulting in the population increase of rotifer due to hastening of their growth rate [12].

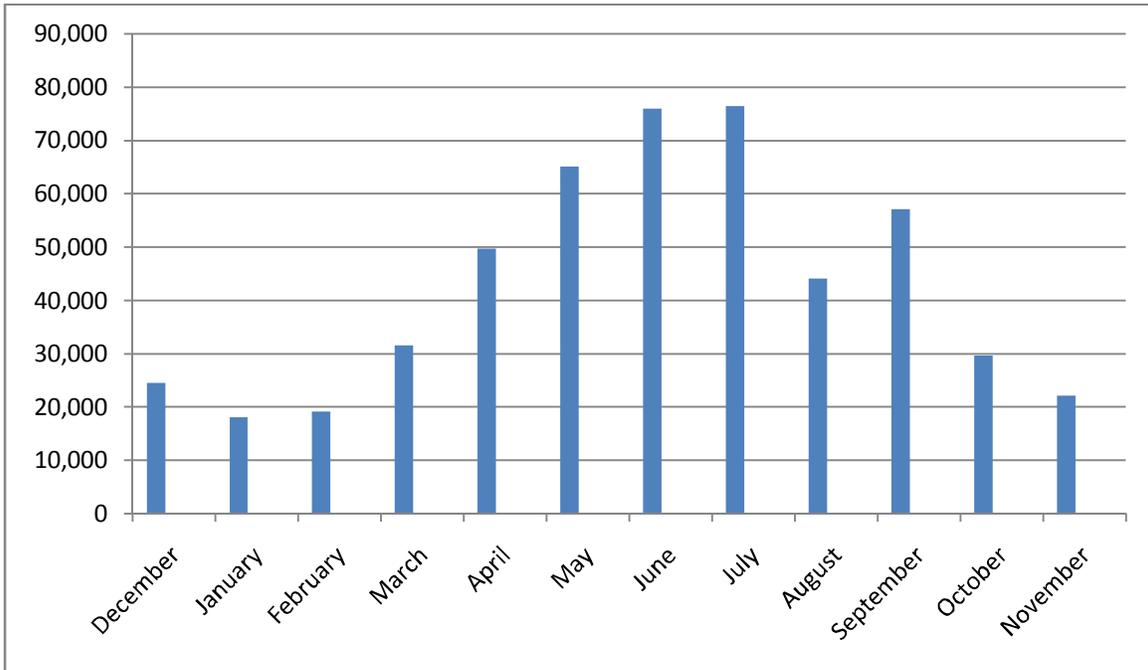


Fig. 4. Monthly fluctuations in Rotifera (ind./m³) in Dal Lake.

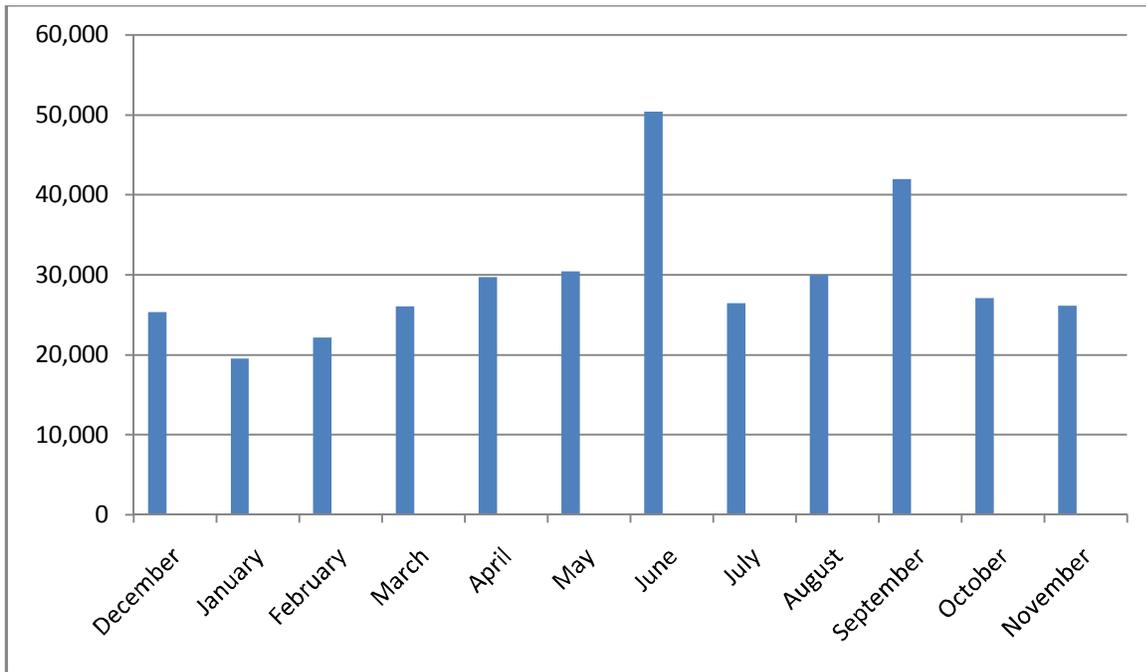


Fig. 5. Monthly fluctuations in Rotifera (ind./m³) in Anchar Lake.

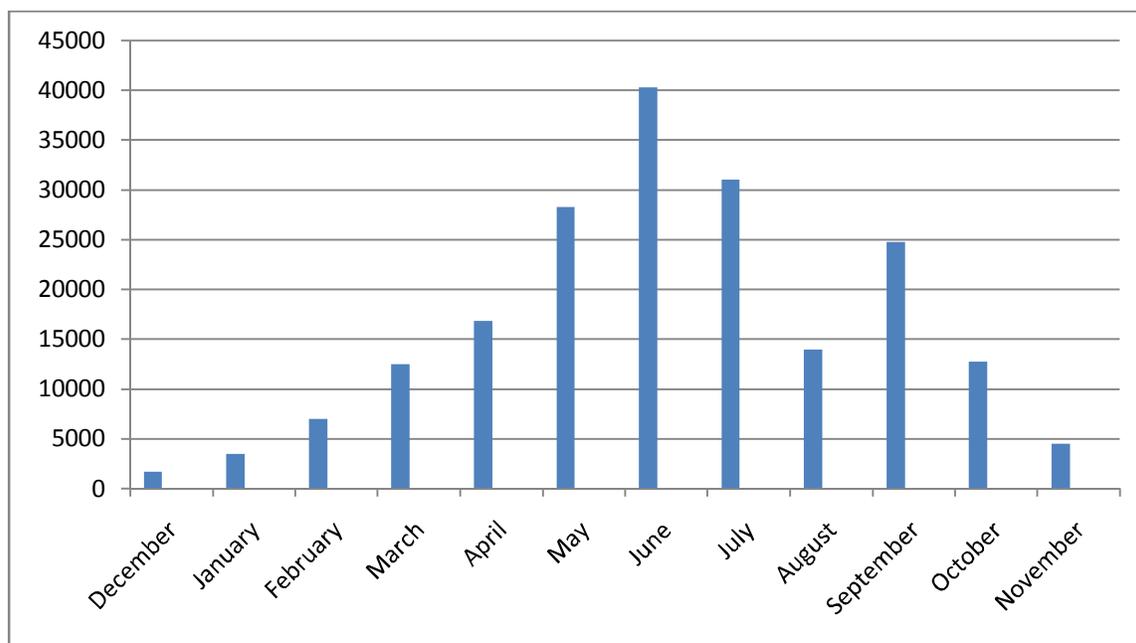


Fig. 6. Monthly fluctuations in Rotifera (ind./m³) in Ahansar Lake.

Rotifers have been reported to prefer alkaline waters with a pH range of 6.5 to 8.5 [13] and same appears true for present lakes as it showed a positive correlation with rotifer density 0.846, 0.448 and 0.645 in respective water bodies. Hydrogen ion concentration increases with increase in water temperature indicating a positive correlation [14] due to high photosynthetic activity which is accelerated by increasing temperature and prolonged photoperiod leading to an increase in alkalinity of water. Both pH and alkalinity are directly influenced by primary production and carbon dioxide [15]. A positive correlations was recorded between alkanity and density i.e 0.642, 0.402, 0.747. Density of rotifer showed insignificant positive correlation with dissolved oxygen in Dal Lake (0.099). However this result was contrary to Anchar and Ahansar when rotifer density exhibited negative correlation (-0.363 and -0.542). The lowest dissolved oxygen 2.6 mg/l (July), 2.4 mg/l (June) and 6.8 mg/l (June) were recorded in three water bodies respectively. This decline in the dissolved oxygen seems due to high decomposition by high temperature, releasing large quantities of carbon dioxide which adversely effect on density of rotifers as negative correlation was found between carbon dioxide and rotifer density (-0.828, -0.322, -0.0418). Similarly conductivity showed positive correlation 0.999, 0.424 and 0.798 in Dal, Anchar and Ahansar Lakes. The highest conductivity values were recorded when water temperature was high. Similar results were observed by [16] and related it with

lower solubility, high temperature and high decomposition of organic matter.

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