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Seasonal Variation in Zooplankton Community Structure of Anchar lake, Kashmir

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Abstract:

Anchar Lake was studied for a period of one year from June 2010 to May 2011 for regular physico-chemical parameters and zooplankton community structure. The study was designed to estimate zooplankton abundance qualitatively and quantitatively. Collections were taken on monthly basis. Biodiversity of zooplankton has been calculated using Shannon- Weiner index. The zooplankton community was composed of 08 species of Rotifera, 06 species of Protozoa, 07 species of Cladocera, 02 species of Copepoda and 01 species of Ostracoda. Numerically Crustacea was the dominant Class throughout the study period. Although 24 species have been identified at various stations in the Anchar lake but *Centropyxis aculeata, Keratella cochlearis, K. Valga, Alona affinis, Daphnia magna, Chydorous sphaericus, Macrothrix rosea* and *Cyclops bicuspidatus* are common species at all stations. The abundance of zooplankton in the lake follows a sequence as: Rotifera > Cladocera > Protozoa > Copepoda > Ostracoda. Correlation between various physico-chemical parameters and zooplankton density was calculated according to Karl- Pearson's formula. Some of the changes in zooplankton community structure was found associated with seasonal changes in temperature and nutrient content of water.

Keywords: Physico-chemical parameter, zooplankton, Correlation, biodiversity and Shannon-Wiener index.

1.0 Introduction:

Zooplankton plays an important role in aquatic ecosystem. They link the primary producers, phytoplankton with higher trophic level organisms. Zooplankton communities respond to a wide variety of disturbances including nutrient loading (Dodson, 1992) and play a key role in the aquatic food chains (Sharma, 1998). Nearly all fish depend on zooplankton for their food during their larval phases and some fishes continue to eat zooplankton in their entire lives (Madin *et al*., 2001).The importance of zooplankton as fish food both for adults and fry has been stressed by different workers (Fontaine and Revera,1986).The presence and dominance of zooplankton species play a significant role in the functioning of freshwater ecosystems. Therefore, zooplanktons are considered indicators of water quality (Geiger, 1983). Zooplankton respond quickly to aquatic environmental changes (e.g., water quality characteristics, such as pH, colour, odour and taste, etc.) for their short life cycle and are therefore used as indicators of overall health or condition (Carriack and Schelskek, 1977). During the study period, our aim was to analyze zooplankton population both qualitatively and quantitatively and the results are correlated with physico-chemical factors to get vital information for future references and better understanding of the structure and function of this important aquatic ecosystem.

2.0 Materials and Methods:

Kashmir valley is famous for water bodies, but most of them have lost their past grandeur and one of such water bodies is Anchar lake, which is a shallow basined lake with fluviatile origin, situated near Soura 12 km to the north west of Srinagar city at an altitude of 1583 m.s.l and lies within the geographical coordinates of 34° 20′- 34° 36′N latitude and 74°82′ - 74° 85′E longitudes in a semi urban conditions. Sprawled over a wide swathe of the area along the east side of Srinagar-Ganderbal road, Anchar Lake is in pathetic shape and waters of the lake are alkaline. The Anchar lake is considered an example of ecologically sick lake, mostly infested with weeds. On the Eastern bank, major portion of peripheral areas has been encroached by the locals. They have filled a large area within the lake and changed into vegetable gardens. Irony is that they have even turned it into residential plots and have raised concrete structures. The lake receives huge quantity of sludge from the areas of Soura, Buchpora, Ellahi-bagh and Awantabhawan and from the adjacent

areas of downtown through a chain of open drains. The wastes dumped into the lake have been continuously polluting its water quality which has become a menace for the population living on the lake side.

2.1 *Area of Sampling*:

Anchar lake has been selected for analysis of zooplankton from June 2010 to May 2011. Four sampling points were selected for this purpose from the four sides of the lake along the edge from the places of human activities such as bathing, washing and fishing etc (Fig: 1). The outlets, inlets, morphometric characteristics and aquatic weeds etc. were considered during the selection of the sites. Samples from the predetermined points were collected between 9.00 to 11.00 h IST (Indian Standard Time; + 5h 30 min GMT).

2.2 Sampling Period:

The sampling was done in the first week of every month in early hours of the day i.e, around 9.00 to 11.00 a.m.

2.3 *Water sample collection*:

The sub surface water samples were collected from Anchar Lake at four different sites with the help of bucket. Care was taken to avoid any kind of spilling of water or air bubbling at the time of sample collection.

2.4 *Collection of zooplankton samples*:

Zooplankton samples were collected from all four sites of the lake, which differ in water depth, vegetation and other characteristics. The samples were collected by filtering 50 litres of the subsurface lake water through nylon bolting cloth Birge conical zooplankton net. The content collected in the plankton tube attached to lower end of net were transferred to separate polyethylene tubes and after sedimentation, a subsample of 30 ml was taken. The zooplankton organisms were preserved in 4% formalin and also 4-5 drops of glycerine were added to the samples to ensure good preservation.

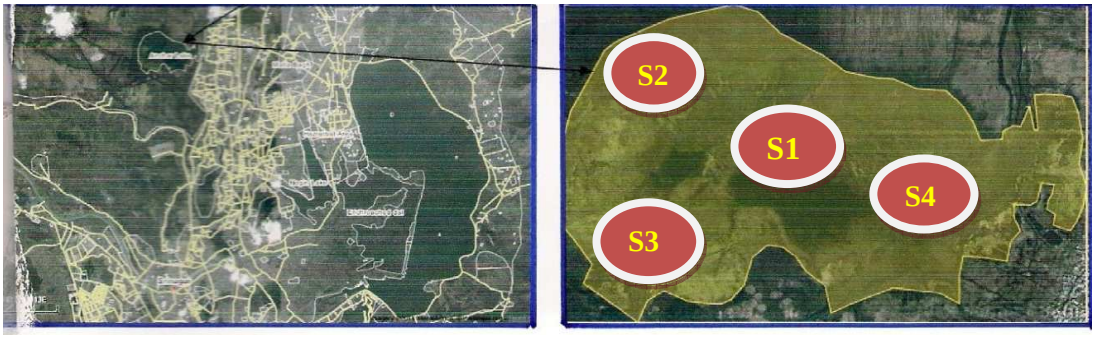

Figure 1: Google map of Anchar lake showing location of sampling stations

2.5 *Qualitative study of zooplankton:*

Preserved zooplankton samples were identified upto species level wise by observing them under a microscope. Systematic identification was done upto species level wherever possible by taking the help of (Edmondson, 1992, A. P. H. A, 1998) and several research publications.

2.6 *Quantitative study of zooplankton*:

For quantitative zooplankton study, a sedge-wick rafter cell was used which is 50 mm long, 20mm wide and 1mm deep. The samples were transferred to the cell with a dropper. The air bubbles were avoided while transferring the sample to the cell. Before counting the zooplankton, it was ensured that all the organisms have settled down. Every sample was counted for the zooplankton at least five times and an average was taken for the samples of each month for one year, i.e, during 2010-2011.The number of each species or genus was calculated by the following formula (Welch, 1948) and then total zooplanktonic forms were counted on monthly basis with the help of the following formula:

$$N\ (org\ L^{-1}) = \frac{a \times b}{V}$$

N= Number of zooplankton per liter

a= The average number of zooplankton in all counts in a counting cell of 1 ml capacity.

b= The volume of original concentrate in ml (30 ml)

V= Volume of original water filtered (50 litres)

All the organisms were represented numerically as organisms per liter. The correlation between various physico-chemical parameters and zooplankton groups was tested using the formula given below.

Correlation coefficient (r) = $$\frac{N \Sigma n^{x}y - \Sigma x - \Sigma y}{\sqrt{N\Sigma x^{2} - (\Sigma x^{2})\{N\Sigma Y^{2} - (\Sigma Y)^{2}\}}}$$

Diversity index H′ (Shannon and Reid, 2003) was calculated for zooplankton using the following formulae-

Shannon-Wiener index: $H' = -\sum pi \ln pi$

Pi = n/N
n = diversity of individual
N = total density

3.0 Results and Discussion:

3.1 Species composition, Species diversity and Seasonal fluctuation of Zooplankton:

In Anchar lake, Srinagar a total of 24 zooplankton species belonging to Protozoa, Rotifera and Crustacea were recorded for the lake during the investigation period. Rotifera (08), Cladocera (07), Protozoa (06), Copepopda (02) and Ostracoda (01) in a decreasing order. However, the stations experiencing severe sewage outfalls depicted very less number of species and thereby the diversity of zooplanktonic organisms. The species rich class Crustacea was represented by eleven species of Cladocera with *Alona affinis, Bosmina longirostris, B. coregoni, Daphnia magna, D. pulex, Moina brachiata*, *Chydorous sphaericus* and *Macrothrix rosea*, two species of Copepoda viz. *Cyclops scutifera* and *C. bicuspidatus* and only one species of Ostracoda i.e, *Cypris subglobosa* . Phylum Rotifera, being sub-dominant was represented by 08 species including *Brachionus bidentata, Brachionus calyciflorous, Brachionus quadridentata, Bryocamptus hiemalis, Keratella cochlearis, Keratella valga, Lecane luna and Notholca acuminata*. Phylum Protozoa, encompassing 06 species, was represented by forms like *Arcella mitrata, Centropyxis constricta, Centropyxis aculeata, Difflugia oblongata, Euglypha laevis* and *Euglypha ciliate* (Table 1).

Table 1: The distribution of zooplankton in Anchar Lake at various stations

Zooplankton Species	Site I	Site II	Site III	Site IV
P R O T O Z O A				
Arcella mitrata	+	-	+	+
Centropyxis constricta	+	+	-	+
Centropyxis aculeata	+	+	+	+
Difflugia oblongata	+	+	+	-
Euglypha laevis	+	+	-	+
Euglypha ciliata	+	-	+	+
R O T I F E R A				
Brachionus bidentata	+	+	-	+
Brachionus calyciflorous	+	-	+	+
Brachionus quadridentata	+	+	+	-
Bryocamptus hiemalis	+	+	-	+
Keratella cochlearis	+	+	+	+
Keratella valga	+	+	+	+
Lecane luna	+	+	-	-
Notholca acuminata	+	-	+	+
C L A D O C E R A				
Alona affinis	+	+	+	+
Bosmna longirostris	+	+	+	-
Bosmina coregoni	+	+	-	+
Daphnia magna	+	+	+	+
Daphnia pulex	+	+	-	+
Moina brachiata	+	-	+	+
Chydorous sphaericus	+	+	+	+
C O P E P O D A				
Cyclops scutifera	+	+	+	-
Cyclops bicuspidatus	+	+	+	+
O S T R A C O D A				
Cypris subglobosa	+	-	+	+

Table 2: Showing group wise total number of zooplankton forms (org. L^{-100}) at four stations in Anchar Lake, Kashmir

Groups	Site I	Site II	Site III	Site IV	Mean
Protozoa	2013	1572	1967	1977	1882
Rotifera	2827	2855	2514	2496	2673
Cladocera	1809	2663	2413	2658	2385
Copepoda	584	888	496	465	608
Ostracoda	82	0	350	191	155

Although 24 species have been identified at various stations in the Anchar lake but *Centropyxis aculeata, Keratella cochlearis, K. Valga, Alona affinis, Daphnia magna, Chydorous sphaericus, Macrothrix rosea* and *Cyclops bicuspidatus* were common species at all stations. The predominance of *Keratella sp., Brachionus sp., Bosmina longirostris, Daphnia sp., Chydorus sp., Alona sp., Cyclops sp.,* besides *Alona sp., Cyclops sp*., besides the group protozoa as a whole are clear signs of racing eutrophication (Jarnefelt, 1952; Rawson, 1956 and Davis, 1964).

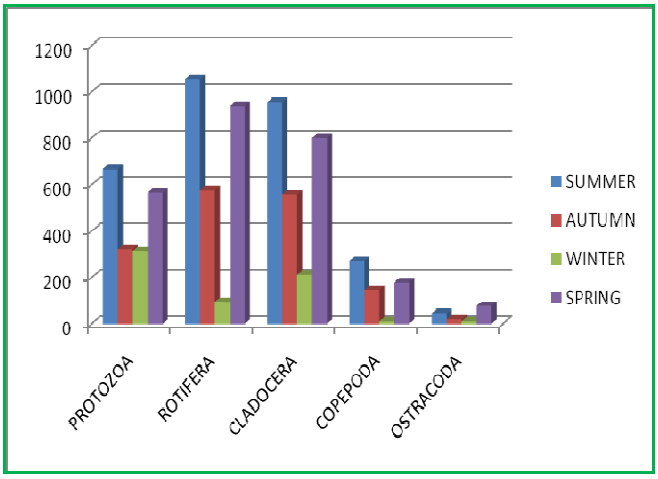

Fig.2: Seasonal variation of zooplankton classes in lake Anchar

Averages of all stations taken together have shown a bimodal peak, bigger peak was observed in spring months and the other smaller one was observed in summer months. The abundance of zooplankton at various stations followed a sequence:

Station I**: Rotifera > Protozoa> Cladocera > Copepoda > Ostracoda.**

Station II**: Rotifera > Cladocera > Protozoa > Copepoda > Ostracoda.**

Station III: **Rotifera > Cladocera > Protozoa > Copepoda > Ostracoda.**

Station IV: **Cladocera > Rotifera > Protozoa > Copepoda > Ostracoda**

The overall abundance of zooplankton in the lake follows a sequence as under:

Rotifera > Cladocera > Protozoa > Copepoda > Ostracoda

It was observed that the Protozoa exhibited maximum population density 665 org l^{-100} during summer season, 332 org l^{-100} during autumn season 314 org l^{-100} during winter season and 556 org l^{-100} during spring season. Rotifera showed peak density 1056 org l^{-100} during the summer season, 576 org l^{-100} during the autumn season, 960 org l^{-100} during the winter season and 961 org l^{-100} during spring season (Fig 2). Cladocera showed maximum density 957 org l^{-100} during summer season, 557 org l^{-100} during autumn season, 213 org l^{-100} during winter season , 800 org l^{-100} during spring season. Copepoda group exhibited maximum density 270 org l^{-100} during summer season, 145 org l^{-100} during autumn season, 11 org l^{-100} during winter season and 178 org l^{-100} during spring season. Ostracoda group showed maximum density 45 org l^{-100} during summer season, 20 org l^{-100} during autumn season, 11 org l^{-100} during winter season and 77 org l^{-100} during spring season in this lake as a whole.

3.2 Correlation of Physico-chemical parameters with zooplankton:

During the investigation period, Rotifers showed moderate positive correlation with sodium, nitrate and total hardness but high negative correlation with the electrical conductivity. Cladocerans exhibited moderate positive correlation with the transparency, chloride, total hardness, calcium and magnesium and high negative correlation with depth and silicates. Copepods displayed moderate positive correlation with the total hardness, total phosphate and nitrite and negative correlation were seen with depth. Ostracods had positive correlation with transparency, dissolved oxygen and silicates and negative correlation with total phosphate phosphorous.

Zooplanktons of an aquatic ecosystem are an essential component and their study together with other biotic components is an important tool to evaluate the trophic status of the system. During the last few decades, tremendous efforts have been made to understand their functional importance. (Pennak, 1946) suggested that annual and seasonal cycles of zooplankton vary from lake to lake and from year to year within the same lake. In general, zooplankton growth was registered

during moderate temperature conditions, which may be due to regeneration and availability of minerals, being an outcome of decomposition of organic matter in sediments, and the algal food during this period. These findings are in agreement with those of (Davis, 1964). The zooplankton population of Anchar lake , a shallow lake, was found to be composed of Protozoa, Rotifera, Copepoda, Cladocera and Ostracoda) of which Rotifers were dominant in terms of species diversity followed by Cladocera. Protozoa, Copepoda and Ostracoda. In general, Protozoa showed unimodal growth curve during warm water period thus indicating that the population is dependent on the temperature of the system. The quality and the quantity of the food available and the predation pressure due to the phytophagus species inhabiting the lake are also other vital factors controlling the growth and abundance of the group. The group Crustacea which included Cladocerans, Copepods and Ostracoda also showed unimodal curve for their population though present during moderate temperature conditions. The crustacean group showed maximum numerical surge during warm periods and minimum during colder periods, (Ahangar *et al*., 2012). Venkataraman *et al*., 2000, recorded a diversity of 70 species of zooplankton from freshwater wetlands of Wetlands. (Prameeladevi *et al*.,2006) delinated bioindicators of pollution indicators in Miralam Lake and *Daphnia* amoung rotifers were designated as most tolerant species. Zooplankton diversity of Sikandarpur reservoir with 08 species of rotifers and 04 species of each of protozoans cladocerans and copepods has been observed (Kumar *et al*., 2007).

Temperature has been considered as one of the primary factors to cause the abundance of zooplankton in freshwaters particularly so in shallow lakes or ponds where bottom exhibit considerable variations in temperature, especially with the progression of the warm season (Mecombie, 1953; Das, 1956; Bamforth, 1958 and Moitra and Bhattacharya, 1965). In the present study a positive correlation between zooplankton numbers and temperature was recorded. Temperature has been reported to affect zooplankton abundance in two ways. It acts directly to hasten growth rates resulting the increase of population densities; secondly it stimulates the growth of phytoplankton populations by providing nutrients and adequate light in the environment (Taylor, 1974). According to (Riley, 1941), Zooplankton shows a significant correlation only with temperature which appears to be the most significant, if not the only controlling factor. Highest zooplankton population was observed in summer season and lowest in the months of winter in Seetadwar lake, in Uttar Pradesh (Tripathi and Tiwari, 2006). In the present study, rotifers, copepods and cladocerans were abundant during early summer and summer seasons but protozoan were dominant during rainy season. The rotifers were the most dominant group with (35%) followed by Cladocera (31%), Protozoa (24%), Copepods (8%) and Ostracods (2%). The abundance of rotifers in general and brachionids in particular has been attributed to hard and alkaline water (Edmonson, 1959 and George, 1961). Previously in Gwalior region, (Saksena and Sharma, 1981a) have reported thirty species of rotifers from different water bodies. Eutrophication also affects the species composition, biomass and structure of zooplankton. At least during the initial phases, the biotic factors seem to be much more effective than the chemical factors, the changes being largely determined by alteration in the phytoplankton or the trophic conditions. In Anchar lake also rotifers, cladocerans and copepods showed moderate positive correlation with total hardness, free carbon dioxide and chlorides but high negative correlation was found with depth and electrical conductivity. In all 24 species of zooplanktonic organisms belonging to Rotifera (08), Cladocera (07), Copepods (02), Protozoa (06) and Ostracoda (01) were identified in Anchar lake. The distribution of various species of zooplanktonic organisms was not homogenous at all the stations, and there was clear cut seasonal variation of zooplankton and various physico- chemical characteristics influenced their occurrence. It may be concluded that the lake shows signs of accelerated cultural eutrophication. Climatic conditions, especially temperature also has a significant role to play in the dynamics of microscopic community.

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