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Zooplankton Population Variations, Chlorophyll-A and Nutrients in Anchar Lake, Kashmir

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Abstract:

In order to understand trophic status of lake Anchar, seasonal pattern of zooplankton, chlorophyll-*a* and nutrients level in water column was examined from June 2010 to May 2011. Average 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 in Anchar lake. The sequence of dominant species of zooplankton was *Rotifera* > *Cladocera* > *Protozoa* >*Copepoda*> *Ostracoda* in this lake. Correlation between zooplankton species and nutrients level was established. The Chlorophyll- *a* as an indicator of phytoplankton biomass peaks in colder periods. The ammonical-nitrogen ranged between 210.3 to 499.3 µg/l with mean of 336.3±21.60 µg/l. On the basis of nutrients and chlorophyll-a dynamics, the lake varied from mesotrophic to eutrophic in different seasons.

Keywords: Zooplankton, nutrients, chlorophyll

1.0 Introduction:

Anchar lake (1583 m.s.l) is the shallow basined lake in Kashmir valley. The lake water is used mainly for irrigation, drinking for cattle and other purposes. Zooplanktons are minute organisms which float in the water surface along with water current. They occupy an intermediate position in the food web. The importance of zooplankton as fish food both for adults and fry has been stressed by different workers (Fontaine and Revera 1986 and Geiger 1983). The presence and dominance of zooplankton species play very significant role in the functioning of fresh water ecosystems. The seasonal changes in zooplankton species are closely related to the physico-chemical and biological regime of the aquatic environments. Species of Rotifer and Cladocerans are suggested as indicators that can be used to identify different physical and chemical gradients (Branco *et al.* 2002). The relation of zooplankton to phytoplankton and other physical and chemical gradients are well described. So, seasonal variation of zooplanktons may be a key factor to understand the lake ecosystem. A considerable number of studies have been done on zooplanktons dynamics in this lake. However, the relation between nutrient dynamics and abundance of zooplankton has not been studied in Anchar lake. Therefore, this paper deals with spatial and temporal distribution of nutrients and zooplankton in Anchar lake. The relation between nutrients and secondary trophic level in the lake and their significance for the lake ecosystem management is also discussed.

2.0 Materials and Methods:

Water samples for physical, chemical and biological parameters were collected on monthly basis from June 2010 to May 2011. Water samples were taken from different water depths in Anchar lake for each parameter except zooplankton. All the samples were collected using Vandorn water sampler of 3 liter capacity. The parameters examined were dissolved oxygen, pH, temperature, transparency, total phosphate phosphorous, sodium, nitrate and nitrite. Water temperature and pH were measured at the sites using thermometer and SIBATA pH kit, respectively. Chl-a samples were obtained from 1000 ml integrated samples and 300 ml filtered through GF/c (whatman 47 mm) filter paper. This filtered water was used for the NH_4-N, Total phosphate phosphorous and NO_3-N determination. The

chlorophyll concentrations were determined according to methods by Lorenzen (1977). The water transparency was measured with a 20 cm diameter black and white secchi disc. Zooplankton samples were obtained by passing 50 l water through plankton net in each depth. Zooplankton samples were preserved in 4% formalin. Enumeration of zooplankton and analysis were done by the methods in laboratory manual of water quality analysis by Welch (1952)

3.0 Results and Discussion:

The annual range of water quality parameters are presented in Table 1.

Table 1: Annual mean and range of limnological parameters.

Parameters	Mean ± SE	Range
Temperature (^{o}C)	16.3 ±2.22	3.1-25.6
Transparency	0.64±0.05	0.27-0.93
pH	8.0±0.02	7.96-8.39
D.O. (mg/l)	4.2±0.30	2.0-6.9
Chlorophyll-a (mg/m^3)	34.3±21.3	0.0-99.1
NH_4-N (µg/l)	336.3±21.60	210.3-499.3
NO_3-N (µg/l)	252.5±9.89	137.3-323.4
TPP (µg/l)	394.1±21.42	287.7-512.4
OPP (µg/l)	117.3±12.11	51.4-179.6

± Standard Error

The pattern in water temperature was typical in this lake. With increasing day length from spring to summer water temperature increased at surface layer. Similar results were recorded by Chinnaiah *et al.* (2011) on Khanjana and Darmasagar lake in Adilabad, Andra Pradesh. The maximum mean water temperature at surface layer was 24.0 ^{0}C in July 2010 while lowest was 3.2 ^{0}C in January 2011. Water temperature started to decline after September and reached about 5.7 ^{0}C in December at both layers during the holomixing at the water column. Contrastingly, in winter the water temperature was almost similar in all depths from November-February. The transparency from August to November was inconsistent however, after November visibility decreased consistently throughout the winter. The mean transparency during the study period was 0.64 m. Comparing the two layers, the dissolved oxygen was always higher at the surface layer. The highest variations between two layers were observed from Sept. 2010 to January 2011 during the lake stratification periods. The lowest dissolved oxygen (DO) in upper layer was 2.9 mg/l in May, while highest was 6.2 mg/l in January, 2011, in the bottom layer the minimum reached to 3.1 mg/l in August and maximum was 5.2 mg/l in November, 2010. After December, the dissolved oxygen in the upper layer declined gradually till May and fluctuated from December to February. It was December when both layers had equal value of dissolved oxygen. The pH value was higher in upper layer and almost closest value found from December to February at both layers.

The Chlorophyll-a peak was found in November at both layers of water column. The highest concentration in upper layer was 29.5 mg/m^3 and that of bottom layer was 17.8 mg/m^3 in November. The lowest Chlorophyll-a concentration at upper layer was 16.5 mg/m^3 in July and in bottom layer it was 8.9 mg/m^3 in January. The upper layer has higher concentration of Chlorophyll-a from January-May. The concentrations of Chlorophyll-a were higher in both layers from April-June and September-November. The average of both layers showed lower concentration of chlorophyll a during June to September. Comparing both layers, bottom layer had higher concentration of ammonium (NH_4-N). The concentrations of nitrite and nitrate fluctuate during the lake stratification period from July to September and remain consistent from October to January. Concentration of total phosphorus (TP) was higher in bottom layer of lake from May to October when lake was stratified. In upper layer, higher concentration of TP was found in January-February and in November. In December, when holomixing of water column in lake takes place, same amount of TP concentration occurs in both layers. The peak of total phosphorus concentration was observed in January at upper layer and at bottom layer highest concentration was found in March. The lowest concentration of TP was in both layers in August.

Twenty five species of zooplanktons were recorded throughout the study period, out of which 08 species were from class Rotifer, 08 species from class Cladocera, 02 species belong to class Copepoda, 01 species from Ostracoda and 06 species from Protozoa. Comparison of the results obtained with those of earlier investigations performed in during 2001 showed that changes have occurred in the interval (Ahangar *et al*. 2012). Although 25 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; Davis, 1961; Pejler, 1964 and Kaul *et al.,* 1978). Average 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.

Table 2. Seasonal abundance of zooplanktons (dominant species) in lake Anchar.

Zooplankton Species	Summer	Autumn	Winter
Keratella sp.	+++	+++	+++
Brachionus sp.	+++	+	++
Euglypha sp.	+	++	+++
Synchaeta sp.	-	-	++
Chydorous sp.	+	++	++
Polyarthra sp.	+	+	+
Bosmina sp.	++	+	++
Daphnia sp.	++	+++	++
Centropyxis sp.	-	++	+
Nauplius sp.	+	++	++
Cyclops sp.	++	+++	++

0 absent (-), 1-10 N/L low (+), 10-40N/L medium (++), over 40 N/L highest (+++)

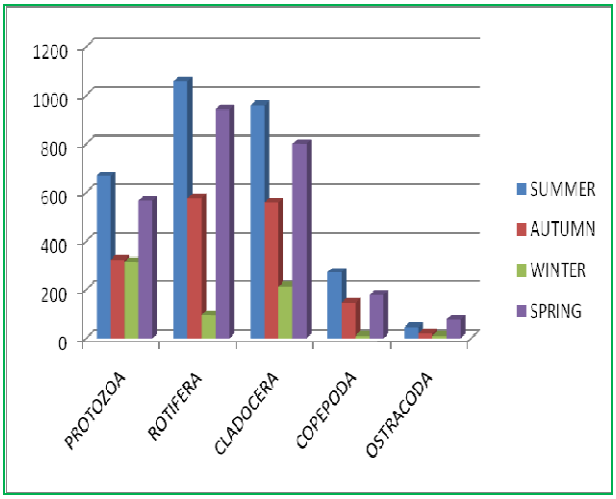

Fig.1: Seasonal variation of zooplankton classes in lake Anchar

The abundance of zooplankton in the lake follows a sequence as under:
Rotifera > Cladocera > Protozoa > Copepoda > Ostracoda

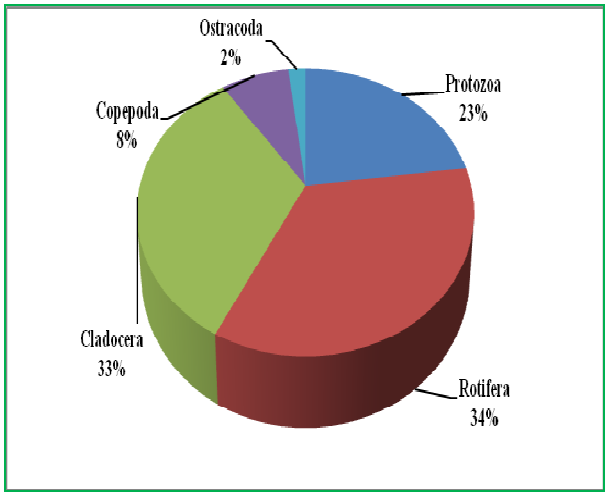

Fig 2: Showing percent composition of zooplankton in Anchar lake .

The patterns of most dominated species of zooplanktons were different (Table 2). The *Nauplius* showed their peaks in March while lowest density was found in June. *Keratella* species peaked in November and lowest density was observed in August. Cyclops attained maximum density in July and minimum density in January. *Daphnia* species density was highest in January and lowest in June. Regression analysis was done to find out relationship of zooplanktons with other variables. Rotifer was inversely co-related to water temperature. *Filinia* and *Daphnia* species were inversely correlated to transparency and *Keratella* species was positively correlated to total phosphorus. *Keratella* species was associated with temperature. Inverse correlation found between *Brachionus* species and temperature. Rotifer was positively related with decline of chlorophyll-a. The seasonal change in zooplankton species was closely related to the physico-chemical and biological regime of the aquatic environments.

Total zooplankton density peak showed bimodal pattern in Anchar lake. The density of zooplanktons declined in June once throughout the year. Vassiht and Sharma (1975), Gophen (1972), and Wangaeno (1980) reported bimodal pattern of zooplanktons

peak in freshwaters. The lower density of zooplanktons during the spring to summer coincides to Plankton Ecology Group model (Sommer *et al*. 1986) cited by Bronmark and Hanssen (1998). The reason stated PEG model that in summer herbivorous zooplanktons face food limitation and fish predation increases due to higher temperature and development of young fish, leading to a reduction in size and abundance of zooplanktons. Transparency was low in November, associated with blooms of phytoplankton. The decline of chl-a in March is explained by PEG model, Sommer *et al*. (1986) showed that in spring, grazing rate exceeds phytoplankton's production rate, leading to a reduction in algal biomass. The chl-a amount depends upon the phytoplankton available but directly affected with rainfall and water flush out. The chlorophyll-a concentration was low in winter months (December to January). Despite of lengthy photoperiod and summer irradiation, chlorophyll-a concentration was lower during the summer. This evidently suggests the flushing of lake water, preventing phytoplankton's growth density. Bottom Layer showed higher concentration of ammonium than upper layer might be due to low level of oxygen in bottom layer.

Species of Rotifer and Cladocerans are suggested as indicator that can be used to identify different physical and chemical gradients in reservoirs (Branco *et al.* 2002). The relation of zooplanktons to phytoplanktons and other physical and chemical gradients are well described.

3.1 Trophic Condition of Lake:

Presently, lake is facing severe environmental problems as a result of nutrient loading from agriculture, landslides, and rapid urbanization in the surrounding areas. In the present study, lake showed eutrophic condition. According to the classification of Wetzel (1983), Chlorophyll-a concentrations of Anchar Lake range 0-99.1 mg/m^3 with average 13.5 mg/m^3 is under eutrophic. Anchar lake having transparency in the range 0.27-0.93 m with average value 0.64±0.05 m, is under eutrophic condition. According to Mackie *et al.,* 2000 and Mackie 2004, total phosphorus range, Chlorophyll-a range and Secchi disc depth range (Table 1) indicate Anchar lake in eutrophic condition.

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