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Ecological understanding of Anchar Lake, Kashmir

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Abstract

As all of us are well aware that limnology plays an important role in water use and distribution. It also helps to maintain the aquatic habitat intact. For any managerial practice/'s of lake as an ecosystem, it is very important to understand the formation and history of the lake. Also to understand its structure, physical, chemical and biological conditions. For the present study, how Anchar lake was formed, its size and shape, drainage, topography, watershed, regional climate and biological communities of the lake will be discussed. In addition activities of humans during the past and at the present time will also be discussed. It will also be discussed how more and number of people who although are not well aware of the ecology of the Anchar lake but are associated; will be involved for better understanding of this beautiful aquatic ecosystem.

Keywords: *Ecological* | *Anchar Lake* | *Kashmir* |

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Introduction

The Anchar lake is fluviatile in its origin; shallow basined and is situated 12 kms to the northwest of Srinagar city within the geographical coordinates of 34° 20´-34° 26´ N latitude and 74°82´ and 74° 85´ E longitude at 1584m a.s.l. The lake is mono basined with its main catchment comprising Srinagar city and a number of bordering villages. A network of channels from the river Sind enters the lake on its western shore and serves as the main source of water. The littorals of the lake are surrounded by a thick canopy of trees, willows and popular trees providing the base material for the manufacture of baskets, cricket bats, wood carvings, wicker work, etc. Besides numerous values of the lake in meeting human needs for survival and socio-economic development. According to Lawrence (1895), the area of the Anchar lake during 1893-1894 was 19.54 km2 and since then there has been a considerable decrease in the surface area of the lake. The area of the lake was 6.5 km2 in the year 2004. On the northwest side of the lake

the catchment is under cultivation and used mainly for raising multiple crops. The lake is heavily infested with thick macrophytic growth and the littorals of the lake are dominated by *Phragmites* sp., *Typha* sp., *Sparganium* sp. and *Nelumbium nucifera*(Lotus). As a result of heavy anthropogenic pressures as they use resources of the lake like fishes, nelumbo, trapa etc. without any consideration to the lake ecology, negligence on part of the people as well as by the government. The Anchar lake has shrinked to a large extent in the recent past (Fig.1). With the result the water quality has also deteriorated posed the threat not only to the biotic life of the lake, but also to the humans who reside on the periphery of this lake. During the last one to two decades, human population has expanded manifold in the catchment area of the lake. In addition natural siltation accompanied by anthropogenic siltation has further deteriorated the lake. This lake is situated in the low lying area and flood plain of river Sind, the deposits of silt is a nonstop process. Towards the north-east of the lake is situated the hospital. At this site, the enrichment of lake water has advanced so badly thus causing excessive growth of water macrophytes particularly on the littorals with mucky waters towards centre accompanied by bad smell. Since the lake is located at the terminus of a drainage basin, it receives water with excessive inflow of Phosphorus and the pollutants that are carried in it from the entire drainage basin, the lake acts as a "BOWL FOR POLLUTANTS" entering it. Thus the present study was undertaken for ecological understanding of the Anchar lake, and also to find out information of the lake in the recent past; its management and problems. The strategies and actions taken to address the problems of the lake. Any lesson learned from the management of other lakes as it can provide guidance on how to effectively apply the management practices in action.

Materials and Methods

Three sampling sites were selected in the lake that represents different environmental features. The site-I is located at the point where a channel from the river Sind enters the Anchar lake. It is characterized by flowing water. The site-II is located in the centre of the lake where water is standing while the site-III is located close to the point where lake receives wastes from the peripheries, where there is human habitation living. Several sewerage outlets from the catchment area and the peripheries discharge their contents into water at this site. This site is also close to the point where hospital is located. In fact these studies were undertaken in two different periods of time and on this basis comparative studies were carried out.

The earlier sampling was carried out for a period of two years extending from September 2000 to August 2002. The recent sampling was carried out for a period of only one year from

March 2011 to February 2012. The physico-chemical analysis of water samples were carried out according to standard methods of Golterman and Clymo (1969) and APHA (1989). For biological study, the samples were preserved in 5% formalin (zooplankton) and Lugols solution (phytoplankton) and further concentrated through centrifugation and studied under phase contrast inverted microscope (Nikon) in a Sedgwick-Rafter cell. Hauling samples collected were also studied to obtain representative individuals. Identification of phytoplankton was done by using standard monographs and with the help of keys given in the books of Heurk (1896), Smith (1950), Disikachary (1959), Randhawa (1959), Philpose (1967), Round (1973), Prescott (1978) and Palmer (1980). The identification of zooplankton was done with the help of keys given by Pennak (1978), Ward and Whipple (1959), Mellanby (1963), Tonapi (1980), Koste and Sheil (1980) and Sharma (1980). For the collection of Macrozoobenthos (previous studies only-Sept'2000-Aug'2002), sampling was carried out by Ekman's grab. The series of sieves used for zoobenthos are in the size range of 0.5, 0.6, and 0.2mm while as for the collection of phytoplankton and zooplankton, a standard plankton net with 64nm pore diameter was used.

Results and Discussion

The physico-chemical features of water are summarized in Table-1. The water temperature in general showing usual seasonal trend with maximum values in summer and minimum values in winter. The pH values indicate that the water is well buffered. The dissolved oxygen values were recorded minimum at site-III and maximum at site-I in both the studies. The conductivity values of Anchar lake indicate high ionic concentration. As per Oslen (1950), the water of the lake can be categorized as of β-mesotrophic type. In the latest studies (March 2011 – February 2012), the ionic concentration is on the increasing trend.

S.No	Parameter	Unit	Range-I	Range-II
1	Temperature	^{0}C	3.0-28	Same as recorded in the previous study
2	pH	-	6.9-8.6	Same as recorded in the previous study
3	Conductivity	µS/cm	205-580	375-650
4	Dissolved oxygen	mg/L	0.4-9.5	Zero-4.5
5	Calcium	mg/L	9.0-43.0	20-42
6	Magnesium	mg/L	4.3-28.5	25-65
7	Total alkalinity	mg/L	59-315	75-450
8	Chloride	mg/L	9.0-95	25-215
9	Nitrate-nitrogen	µg/L	245-611	514-845
10	Total phosphate	µg/L	200-505	316-745

Range-I: September, 2000-2002; Range-II: March, 2011-Feb'2012

Table 1: Range in physico-chemical characteristics in Anchar lake

The calcium and magnesium values indicate that the lake water is nutrient rich. Total alkalinity values also indicate that the lake water is nutrient rich. Philipose (1960) suggested that a water body with alkalinity values more than 100mg/L is nutrient rich. The chloride content of water in both the studies indicates that the water is polluted with sewage. Krenkel (1974) also observed increase in chloride contents in water receiving sewage waste. The nitrate nitrogen and phosphate phosphorus values in both the studies indicate that the lake water is nutrient rich. Sawyer (1947) has set phosphate phosphorus concentration of 300 µg/L as the critical level beyond which eutrophicated status can be expected. In the latter studies, a considerable and alarming increase particularly in phosphate phosphorus and nitrate nitrogen has been recorded.

S.No	Taxa	Site-I	Site-II	Site-III
	Bacillariophyceae			
1	Acanthes sp.	-	++	+
2	Coconeis placentula	++	+++	+
3	Cymbella sp.	+	+	+
4	Diatoma sp.	++	++	+
5	Fragillaria sp.	-	++	+++
6	Gomphonema sp.	++	++	++
7	Melosira sp.	++	++	+
8	Navicula sp.	+	+++	+++
9	Nitzschia sp.	+	+++	+++
10	Synedra ulna	-	+++	++
	Chlorophyceae			
11	Ankistrodesmus sp.	+	+	-
12	Cosmarium sp.	++	++	-
13	Pediastrum sp.	++	++	
14	Sphaerocystis sp.	+	+	
15	Staurastrum sp.	+	+	
	Cyanophyceae			
16	Microcystis	++	++	++
17	Oscillatoria sp.	+	++	+++
	Euglenophyceae			
18	Euglena sp.	-	++	+++
	Chrysophyceae			
19	Dinobryon sp.	+	++	++
	Dinophyceae			
20	Peridinium sp.	++	++	

Table 2: Showing species composition and population density of Phytoplankton in Anchar lake September 2000 to August 2002.

S.No	Taxa	Site-I	Site-II	Site-III
	Bacillariophyceae			
1	Coconeis placentula	++	+++	+
2	Cymbella sp.	+	++	+++
3	Diatoma sp.	++	++	+
4	Fragillaria sp.	+	+++	+++
5	Gomphonema sp.	++	++	++
6	Melosira sp.	++	++	+
7	Navicula sp.	+	+++	+++
8	Nitzschia sp.	+	+++	+++
9	Synedra ulna	-	+++	++
	Chlorophyceae			
10	Ankistrodesmus sp.	-	+	-
11	Cosmarium sp.	+	++	-
12	Pediastrum sp.	-	++	
13	Sphaerocystis sp.	+	++	
14	Staurastrum sp.	+	++	
	Cyanophyceae			
15	Microcystis	++	++	-
16	Oscillatoria sp.	-	++	+++
	Euglenophyceae			
17	Euglena sp.	-	++	-
	Chrysophyceae			
18	Dinobryon sp.	-	++	-
	Dinophyceae			
19	Peridinium sp.	+	++	

Table 3: Showing species composition and population density of Phytoplankton in Anchar lake from March 2011 to February

S.No.	Taxa	Site-I	Site-II	Site-III
1	*Arcella mitrata*	+	+	
2	*A. discoides*	+	+	+
3	*A. megastoma*	+	+	+
4	*A. vulgairs*	++	+	-
5	*C. constricta*	+	+	+
6	*D. accuminata*	++	++	-
7	*D. aurela*	-	+	-
8	*D. corona*	+	+	+
9	*D. rubescens*	+	+	-
10	*Difflugia labostoma*	++	-	-
11	*D. oblonga*	++	+	+
12	*Euglypha ciliata*	-	+	-
13	*Lesquereusia modesta*	++	-	-
14	*L. spiralis*	+++	-	-
15	*Nebula sp.*	+++	-	-
16	*Paraeuglypha sp.*	+	+	+
17	*Paramecium sp.*	+++	+++	++

Table 4: Showing the population density and species composition of protozoa in the Anchar lake from March 2011 to February 2012.

S.No.	Taxa	Site-I	Site-II	Site-III
1	*Arcella mitrata*	+		
2	*A. discoides*	+	+	+
3	*A. megastoma*	+	+	+
4	*A. vulgairs*	+	+	+
5	*Bullinaria indica*	+	+	
6	*C. aerophila*	+	+	
7	*C. constricta*	+	+	+
8	*Centropyxis ecornis*	+	+	
9	*Centropyxis stellata*	+	+	+
10	*D. accuminata*	+	+	+
11	*D. tuberculata*			+
12	*D. aurela*	+		+
13	*D. corona*	+	+	
14	*D. rubescens*	+	+	
15	*Difflugia labostoma*	+	+	
16	*Difflugia lebes.*	+	+	+
17	*D. oblonga*			+
18	*Euglypha ciliata*	+	+	+
19	*Euglypha laevis*		+	
20	*Euglypha tuberculata*		+	+
21	*Lesquereusia modesta*	+	+	+
22	*L. spiralis*			+
23	*N. dentistoma*			+
24	*Paraeuglypha reticulata*	+	+	
25	*Paraeuglypha sp.*		+	+
26	*Paraquadrula irregularis*	+	+	+
27	*Paramecium sp.*		+	+
28	*Pyxidicula scutella*		+	+
29	*Trinema sp.*			+
30	*Wailesella sp.*		+	+

Table 5: Showing the population density and species composition of protozoa in the Anchar lake from September 2000 to August 2002.

S.No.	Taxa	Site-I	Site-II	Site-III
1	*Bdelloid Sp.*		+	+
2	*Brachionus quadridentata*	+		
3	*B. bidentata*			+
4	*B. calyciflorus*		+	+
5	*Cephalodella sp*	+		+
6	*Chromogaster ovalis*	+		
7	*Epiphanes sp.*		+	+
8	*Filinia longiseta*		+	+
9	*Gastropus sp*	+	+	
10	*Keratella cochlearis*	+	+	+
11	*Keratella valga*	+	+	+
12	*Polyarthra vulgaris*		+	
13	*Synchaeta sp.*		+	

Table 6: Showing the population density and species composition of Rotifers in the Anchar lake from September 2000 to August 2002.

S.No.	Taxa	Site-I	Site-II	Site-III
1	*Bdelloid Sp.*		+	+
2	*Brachionus quadridentata*	+		
3	*B. bidentata*			+
4	*B. calyciflorus*		+	+
5	*Chromogaster ovalis*	+		
6	*Filinia longiseta*	+++	+	+
7	*Gastropus sp*	+	+	
8	*Keratella valga*	+	+	
9	*Polyarthra vulgaris*		+	

Table 7: showing the population density and species composition of Rotifers in the Anchar lake from March 2011 to February 2012.

S.No.	Taxa	Site-I	Site-II	Site-III
1	*Alonella sp*	+	+	+
2	*Bosmina longirostris*		+	+
3	*Canthocamptus sp*		+	
4	*Ceriodaphnia*		+	
5	*Cyclops sp*	+	+	+
6	*Daphnia pulex*		+	+
7	*Macrocyclops*	+	+	+
8	*Mesocyclops sp*		+	+
9	*Moina affins*	+	+	
10	*Moina sp.*			+
11	*Pseudosida sp*	+	+	+
12	*Sida sp*		+	
13	*Diaptomus sp.*	+		

Table 8: Showing the population density and species composition of Crustaceaen in the Anchar lake from September 2000 to August 2002.

S.No.	Taxa	Site-I	Site-II	Site-III
1	*Ceriodaphnia*		+	
2	*Cyclops sp*	+	++	-
3	*Daphnia pulex*	-	++	-
4	*Macrocyclops*	+	+	-
5	*Mesocyclops sp*	-	+	-
6	*Moina affins*	+	++	+
7	*Moina sp.*	-	++	+
8	*Pseudosida sp*	+	++	-
9	*Sida sp*	-	+	-

Table 9: Showing the population density and species composition of Crustaceaen in the Anchar lake from March 2011 to February 2012.

The phytoplankton taxa collected at the three sites from September'2000 to August'2002 have been enlisted in the table-2. A total of 20 phytoplankton taxa were identified during the whole studied period. The maximum population density and species diversity of

bacillariophyceae was recorded during autumn. While as that of chlorophyceae and cyanophyceae was recorded during the summer period. No marked or definite seasonal trend was recorded for dinophyceae and chrysophyceae taxa. The population density and species diversity for *Euglena sp.* was recorded during the summer months. The phytoplankton taxa recorded for a period of only one year from March 2011 to February 2012 have been enlisted in the table-3. A total of 19 phytoplankton taxa were identified during this period of study. The overall distribution pattern of phytoplankton taxa indicates that the species composition is not much variable between the two periods of study. The density of *Fragillaria sp.* was recorded to increase in the later studies at site-II. David *et al.* (1981) opined that this species is favoured by highly enriched waters. Jarnfelt (1952) labeled it as indicator of eutrophy. Khan and Bhat (2000) recorded this species in Manasbal lake harbouring rich growth of aquatic weeds and water receiving multiple organic wastes from anthropogenic perturbations. The phytoplankton studies also reveal that at the site-III, the percent contribution of species diversity has reduced from 70% to 50% while comparing the two periods of study. However, the margin of this difference at site-I is little and there is no change at site-II.

The Protozoa taxa found to be distributed are given in the tables 4 and 5. In the studies carried out during September' 2000-August 2002, thirty protozoa taxa have been recorded in all. While as the studies carried out during March 2011 - February 2012, in all seventeen protozoa taxa were recorded. In both the studies, the maximum density of protozoa was observed during summer followed by spring season. The lowest density was recorded during winter. The percent contribution of protozoa in terms of species diversity at site-III is 70% in the earlier studies and 41% in the latter studies. While as at site-I it is 63% in the earlier studies and 88% in the latter studies. However, at site-II no marked difference was recorded in terms of species diversity. The literature survey on the protozoa revealed that they can live actively in nutrient poor to organically rich waters and fresh waters and also can thrive well in both aerobic and anaerobic environments. According to Beaver and Crisman, (1982), protozoa populations can thrive well in more productive lakes, although probably higher in absolute terms than those in oligotrophic lakes. The present study reveals that increase in the chloride, nitrate nitrogen and total phosphate contents might be responsible for decreased species diversity among the protozoa.

The rotifer fauna collected have been enlisted in the tables 6 and 7. In the studies carried out during September' 2000-August' 2002, a total

of thirteen rotifer species were identified during the whole studied period. While as the studies carried out during March'2011-February'2012, a total of nine rotifer species were recorded. In both the studies, seasonal peaks in species diversity as well as population density in the lake was revealed during the summer. From the data it is revealed that majority of rotifer species exhibited wide occurrence. The site-I located in the feeding channel of the lake shows the minimum rotifer fauna in terms of species diversity and population density in the studies carried out during September 2000 - August 2002. While as during March 2011- February 2012, the minimum species diversity and density was recorded at the site-III, where the water area of the lake is polluted by the sewage. It can be regarded that pollution added by sewage play a significant role in the dynamics of rotifers. The percent contribution of rotifer reveals that species diversity has reduced at site-III in the latter studies (44%) in comparison to the earlier studies (61%), while as it has slightly increased at the site-I from 46% to 55%.

The crustacean fauna collected have been recorded in the tables 8 and 9. Thirteen crustaceans belonging to the orders cladocera and copepoda were discovered. Out of these, 6 were found at site-I, 11 at site-II and 8 at site-III during the period September 2000 – August 2002. While as during the period March 2011 - February 2012, only 9 crustacean taxa were recorded. Out of these, 4 were recorded at site-I, 9 at site-II and 2 at site-III. The crustacean population in both the studies showed single peak in the population density during summer. In both the studies, it has been recorded that the species diversity was much variable at different sites. The population density was highest at site-II. The percent contribution of crustaceae revealed that in the studies which were carried during March 2011 to February 2012, the species diversity has reduced considerably at the site-III in comparison to the studies which were carried earlier (Sept 2000 – Aug 2002). While as at site-II it has shown an increasing trend and negligible change at site-I.

Qualitative and quantitative analysis of zoobenthic invertebrate fauna revealed three groups viz. Annelida (5.5%), Crustacea (16.6%) and Insecta (77.0%). Phylum annelida was represented by a single taxon, *Placobdella* sp. (Hirudinea) while class crustacean included *Gammarus* sp (Amphipoda) and class Insecta was represented by 4 taxa namely *Stenonema* sp (Ephemeroptera), *Enallagma* sp (Odonata), *Chironomus* sp. (Diptera) and *Micropsectra* sp (Diptera) thereby showing the dominance of insect fauna. Out of these, 3 were recorded at site-I, 4 at site-II and only 1 at site-III. The zoobentic taxa in general showed a single peak in terms of species diversity and population density which was observed during spring. On the basis of these studies, it can be concluded that there has been an increase in

calcium, magnesium, chloride, total alkalinity, nitrate nitrogen and total phosphorus contents in the lake which is due to addition of agricultural run-off from the agricultural fields, sewage discharges from the catchment human habitation. Due to high ionic concentration and presence of rich macrophytic growth, water at site-III is highly nutritive, more turbid, less transparent. The wastes which are discharged at site-III have resulted in considerable decrease in the dissolved oxygen. The site-II where water from site-I and site-III mixes up, is moderately nutrient rich zone. The overall conditions depict that sewage, agricultural run-off associated with other factors have deteriorated the lake ecology. The normal discourse of the species diversity and density is also affected.

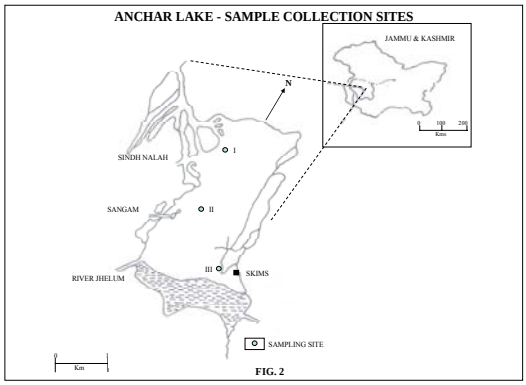

Figure - I

Management/issues associated with the Anchar lake:

There are several factors associated with which due to negligence has reduced the life span of this lake considerably.

1. Natural siltation of the lake associated with anthropogenic siltation.
2. Large scale encroachments in the catchment as well as in the lake itself.
3. The considerable inflow of sewage from the catchment areas.
4. Excessive macrophytic growth.
5. Increased levels of Phosphorus and nitrates.
6. In the close vicinity of the lake, the preliminary studies have shown that there are around 30-35 thousand people living. In addition there are several colonies around the lake in its catchment area.
7. The harmonious relationship between humans and the lake ecosystem is lacking.
8. Lake drainage basin management is totally lacking; therefore, no planning.
9. Preventive approach is lacking.
10. There is no policy for lake management.
11. Nobody comes to the front for resolution of conflicts if any with the people associated with this lake.

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