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Full Length Research Paper

Ecology and biodiversity in Pangong Tso (lake) and its inlet stream in Ladakh, India

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Pangong Tso is a land locked lake situated in eastern part of Ladakh (Indian Tibet), at an altitude of 4,266 m A.S.L. and remains frozen for about three months during winter. There is no outlet to the lake and loss of water is only through evapotranspiration. The lake was found to be highly alkaline (pH ≤ 9.0) with high conductivity (≥ 1639 μS) and nutrients (NH4-N ≥ 54 μg/L; NO_3-N ≥ 299 μg/L; TP ≥ 464 μg/L) as compared to its inlet Cheshul stream. The progression of the cations in the lake was $Mg^{++} > Na^{+} > K^{+} > Ca^{++}$ while as in the stream it was $Ca^{++} > Mg^{++} > Na^{+} > K^{+}$. Mg^{++} content in the lake was higher than the Ca^{++} and Na^{+} due to its more solubility. The lake belonged to cold monomictic group of lakes. Twenty-three identified and some unidentified taxa of phytoplankton were recorded in the lake while as the periphytic community in the stream was represented by 34 taxa. Zooplankton in the lake was represented by only red coloured copepods, *Diaptomus* spp. and their larvae. No fish was observed in the lake while as in the stream three fishes *Schizopygopsis stoliczkae, Triplophysa stoliczkae* and *Triplophysa gracilis* were recorded. The low biodiversity in the lake was found due to high salinity and harsh environmental conditions prevailing in the lake. The inorganic nitrogen in the lake was recorded in very low concentration, Phosphate, on the other hand was present in very high concentrations. It seemed that instead of phosphate, nitrogen may act as a limiting factor for the aquatic community in the lake.

Key words: Pangong Tso, Ladakh, phytoplankton, *Diaptomus* spp., biodiversity, Cheshul stream.

INTRODUCTION

The Himalaya is home to numerous lakes and wetlands of many shapes and sizes, which make it a unique ecosystem that fulfils an important function in the overall water cycle of the basins. High altitude lakes of Himalaya located above timber line represent a relatively common ecosystem in mountain ranges in general; however, they remain less intensely studied than lowland lakes, mainly because of their remoteness and the short summer open-water period. Nevertheless, high altitude lakes are sensitive reference systems of global climatic change and other human impacts (Schmidt and Psenner, 1992). In fact, although remote high altitude lakes are in general protected from direct human impacts, in the last few decades they have been increasingly affected by airborne contaminants, such as acids and nutrients (Marchetto et al., 1995; Rogora et al., 2006), organic pollutants and heavy metals (Carrera et al., 2002). Due to the extreme environmental conditions (low temperature, strong radiations, mostly low buffering capacity and low nutrient level) these ecosystems have a relatively simple food web and react more rapidly and more sensitively to environmental changes than other lakes (Psenner, 2002). Even minor impacts are able to significantly affect the physical and chemical properties of soft water high altitude lakes, to induce changes in species composition and abundance of the biota and to cause accumulation of trace substances in higher trophic organisms (Hofer et al., 2001).

In spite of the socio-economic and ecological importance of high mountain lakes, better knowledge of

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several ecological aspects (especially regarding species distribution patterns and biogeography, diversity and functional interaction among the different components of the food web) is needed for better understanding of their relationships with the environmental variables. These wetlands and lakes have received little attention so far in terms of their limnology, diversity, conservation and water management, but they are becoming increasingly important due to the possible consequences of the global climate change. Conservation of these unique systems needs special efforts and some of these lakes and wetlands are trans - boundary extending into more than one country, while in other places the catchments are shared by more than one country.

Ladakh is a dry land of rugged mountains and open plains in the north of the main Himalaya and south of Karokarum mountains, the two mountain ranges which enclave the Ladakh. The region is peculiar in having a number of salt water lakes, which receive snow, melt water from the catchment but lack an outlet. These include Pangong Tso, Tso Moriri, Tso Khar and Tso Rul and many more. Most of the Ladakh waters, including these peculiar saltwater habitats, have so far received very little attention from scientific community except for few short reports such as Hutchinson (1933, 1936, 1937); Mir and Suri (1975); Gopal et al. (2002), Rashid and Pandit (2005) and Bhat (2009). Pangong Tso is a long, narrow, brackish lake spanning the Indian/ Chinese border, in a valley in the upper drainage basin of the Indus river, at the east end of the Karakoram Range. Only the westernmost one-third of the lake lies in Indian territory. The lake has been suggested as a Ramsar site due to its biological, cultural and geological values (Chatterjee et al., 2002). It is the largest and most brackish wetland in the cold desert ecosystem of the Trans-Himalaya. It is with this background that the present Lake and one of its important streams (Cheshul stream) was analyzed for various physico-chemical and biological characteristics in order to generate a base line data. The data obtained during the present study is presented in the present communication.

STUDYAREA

Pangong Tso is one of the trans-boundary lakes, major part of which, about two third lies in Tibet (China) while its remaining part is located in Ladakh (Jammu and Kashmir, India). The Lake is situated in eastern Ladakh with a catchment area of about 2000 km^2. It is about 134 km long, bisected by the international border between India and Tibet (China). Lake is having a maximum width of 8 km in Indian side and the western bank of the lake which is more than 50 km in length in Indian side is accessible through a rough road, on which Jeep Safaris, trucks etc. are able to move. The lake remains cut off from the rest of the Ladakh for about six months (winter months) as the road leading to lake across the Changla pass (Alt. > 5300 m ASL) remains closed for more than six months. The lake remains frozen for more than three months from the last week of December to first week of April.

Four sampling sites on the basis of length of the lake in Indian side were selected during the study period (during October, 2004, September, 2005 and September, 2006), one located in the Cheshul stream (RS) and three in the Pangong Tso (LS 1 to LS 3) (Figure 1). The geographical coordinates of selected sites are given in Table 1.

MATERIALS AND METHODS

The surface water samples were collected in one litre polyethylene bottles after 11 a.m. at all sites during the period of investigation. Temperature, pH and conductivity were recorded on the spot using Hg thermometer, digital pH meter-1011E and portable conductivity meter - DB104 model respectively. Water samples were collected in 250 ml glass bottles for estimation of dissolved oxygen following the modified Winkler's methods (APHA, 1998). Collected water samples were brought to the laboratory for immediate estimation of total hardness, total alkalinity, chloride, calcium, sodium, potassium, magnesium, total phosphate phosphorus, ammonium nitrogen, nitrate nitrogen following the Mackereth et al. (1978), CSIR Pretoria (1974) and APHA (1998).

For the quantitative and qualitative estimation of phytoplankton and zooplankton 20 L of the lake water was sieved through a plankton net made of nylobolt (mesh size 64 µm) and the filtered samples were then preserved in 4% formalin solution. Periphytic community was collected by scratching 1 cm^2 of the substratum (bottom stones) in inlet stream only. The scratched material was preserved in 4% formalin solution. Enumeration of the samples was done by taking 1 ml of the sub-sample in Sedgwick rafter chamber in triplicate and counting its entire contents under microscope to obtain the statistical accuracy after their identification with the help of standard taxonomical works (Edmondson, 1959; Heurek, 1896; Randhawa, 1959; Pal et al., 1962). The results have been expressed as units per litre for phytoplankton, individuals per litre for zooplankton and taxa per cm^2 for periphytic algae.

Species diversity index was calculated by using the Shannon diversity index (1963):

$$H' = - \Sigma \, pi \log^2 pi$$

Where H´ = Shannon diversity index; pi = the importance of probability of each species (n*i*/N), N = total no. of individuals in "S" species and ni = number of individuals in *i*th species.

Similarity analysis between the sites was calculated by using Jaccard similarity index (J):

$$J = (100 \times c) / (a + b - c)$$

Where 'a' is the number of species in community A, 'b' is number of species in community B, while 'c' is the number of species common to both communities.

RESULTS AND DISCUSSION

The physico-chemical features of the lake are given in Table 2. In the Lake, water temperature and air temperature were found close to one another due to the standing feature of the water. In the stream the water

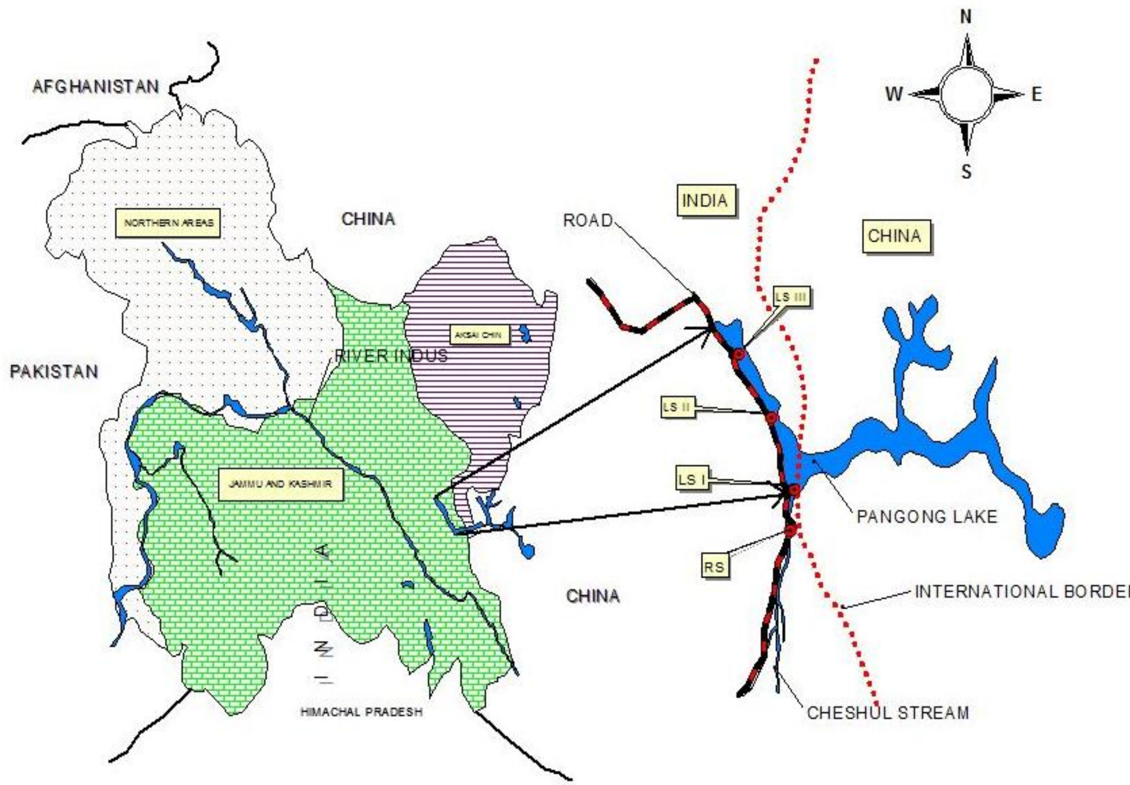

Figure 1. Location map of Pangong Tso Lake showing Study sites.

Table 1. The geographical coordinates of selected sites.

	RS	LS I	LS II	LS III
Latitude	33º 44' 16.3" N	33º 45' 06.3" N	33º 50' 32.4" N	33º 50' 50.5" N
Longitude	78º 38' 12.1" E	78º 38' 08.1" E	78º 34' 19.4" E	78º 39' 11.5" E

temperature showed much variation with respect to the air temperature, due to the running nature of the water (Hynes, 1979; Bhat, 2003). Dissolved oxygen in the lake was present with a mean value of 6.17 mg/L as compared to stream which was having a mean value of 8.67 mg/L. There was not much variation in dissolved oxygen in different sites of the lake and the little variation seemed due to mixing of atmospheric air by high waves

Table 2. Physico-chemical characteristics of Pangong Lake (LS I – LS III) and Cheshul Stream (RS I).

	RS	LS I	LS II	LS III
Parameter	**Range(Mean ± SD)**	**Range (Mean ± SD)**	**Range(Mean ± SD)**	**Range (Mean ± SD)**
Air temp.(°C)	11 – 26(21±8)	11 – 28(22 ± 10)	10 – 28(22±10)	9 – 27(21±10)
Water temp.(°C)	8 – 12(10±2)	12 – 16(14 ± 2)	13 - 16(14±2)	12 – 15(14±2)
pH	8.42 – 8.44(8.43 ±0.01)	8.74 – 9.05(8.89 ± 0.16)	8.92 – 9.08(9.00±0.08)	8.76 – 9.11(8.98±0.19)
D. O_2 (mg/L)	8 – 9(9 ± 1)	6 – 6.5(6 ± 0)	6 – 6(6±0)	6 – 6.5(6±0)
Conductivity (µS)	140 – 162(153 ± 12)	1524 – 1577(1550 ± 27)	1582 – 1621(1598±21)	1621 – 1639(1631±9)
Total alkalinity (mg/L)	240 – 268(257 ± 15)	1500 – 1866(1663 ± 186)	1640 – 2302(1909±348)	1700 – 2196 (1902±260)
TDS (ppm)	60 – 82(73 ± 12)	410 – 431(420 ± 11)	370 – 534(438±86)	452 – 564(524±62)
Total hardness (mg/L)	340 – 388(365 ± 24)	1988 – 2140(2049 ± 80)	2122 – 2420(2234±162)	2198 – 2344(2251±81)
Calcium (mg/L)	26 – 28(27 ± 1)	26 – 38(33 ± 6)	22 – 32(28±5)	21 – 30(27±5)
Magnesium (mg/L)	14 – 18(15 ± 2)	404 – 437(418 ± 17)	456 – 480(470±12)	488 – 520(509±18)
Chloride (mg/L)	14 – 16(15 ± 1)	1500 – 1700(1626 ± 109)	1600 – 1700(1638±54)	1500 – 1530(1517±16)
Sodium (mg/L)	6 – 11(9 ± 3)	182 – 264(230 ± 43)	227 – 246(239±10)	218 – 260(249±27)
Potassium (mg/L)	2 – 4(3 ± 1)	118 – 132(127 ± 8)	138 – 144(141±3)	98 – 140(125±24)
Nitrate (µg/ L)	260 – 288(275 ± 14)	244 – 310(281 ± 340	266 – 344(315±42)	251 – 330(302±44)
Ammonia (µg/ L)	42 – 56(48 ± 7)	55 – 68(61 ± 7)	47 – 64(56±9)	44 – 46(45±1)
Total phosphate phosphorus (µg/ L)	140 – 166(156 ± 14)	390 – 451(420 ± 31)	370 – 584(465±109)	452 – 580(507±66)

and due to little temperature difference of air and water. In the study area there are always howling wind afternoon and it sometimes even becomes difficult to collect the samples. However, LS II showed low DO values as compared to other two sites, the reason being that this site is located in the centre of the lake in the Indian territory with no inlet in its vicinity as compared to other two sites.

The pH of the stream ranged from 8.42 to 8.44 while as that of the lake ranged from 8.74 to 9.11. The lake was found devoid of any macrophyte, even on its littoral sides and the photosynthetic rate does not seem to be responsible for the higher pH value, instead the geological features of the catchment as well as that of basin and the evaporation pattern of water from the lake surface seem to be responsible for the high pH. Odour et al. (2003) have related the loss of solutes through underground seepage to low pH in Lake Baringo (Kenya). Ebel and Koski (1969) and Hannon et al. (1979) reported that the higher total alkalinity in the bottom waters is related to the release of carbonates from sediments and their subsequent convergence to the bicarbonates by carbonic acid is formed due to decomposition of organic matter. However, in the present lake due to negligible quantities of organic matter present (absence of macrophytes), decomposition does not seem to have much influence on the release of carbonates from sediments and their subsequent convergence to the bicarbonates is insignificant.

According to Hutchinson (1967) carbonates appear in water only when pH exceeds 8.34 and with increase in the concentration of carbonates, pH value also shows an increasing trend. This seems to be true for the present lake as well as its tributaries. Total alkalinity, which is taken as temporary hardness of $CaCO_3$ mg/L in the lake on the average was 1825 mg/L (1988 to 2420 mg/L). Freiser and Fernando (1966) stated that when total alkalinity is higher than HCO_3^- system, $CO_3^=$ system prevails and pH is usually found on the higher alkaline side. This is true for the present system as CO_2 was altogether absent in all the sampling sites.

Conductivity in the lake ranged from a minimum of 1524 µS at LS I during October 2004 to a maximum of 1639 µS at LS III during September, 2006 and the mean concentration was 1593 µS. Zutshi et al. (1980) reported that the conductivity of a water body decreases with the increase in altitude but in the present lake such phenomenon was not found to prevail, though the lake is located at a very high altitude. Compared to Kashmir Himalayan lakes it was observed that the values are quiet high which can be related to its non open type lake, which over the geological period of time has concentrated much salts mostly due to evaporation of water (Zutshi et al., 1980; Yousuf and Qadri, 1981; Zutshi et al., 1984). Kiplagat et al. (1999) asserted that conductivity and alkalinity are strongly influenced by the nature of the incoming water and its periodicity. It has also been observed that the geological character of rocks and subsoils not only in the catchment area but that of the lake basin (Hutchinson, 1937, 1967) as well influences the conductivity of the lake water. The snowmelt water of the stream (RS) of the Pangong Tso recorded generally very low conductivity, the average value being 153µS, however, the conductivity of the lake water (mean = 1593 µS) was much higher than that of the incoming water, which may be due to the landlocked nature of the lake which over the geological time period has accumulated the salts mostly due to evapotranspiration.

Water source in high altitude Himalayan lakes is mostly snow melt and rain water, which is usually low in ionic content. As this surface flow reaches a lake, the latter inherits the water type of these inflow waters before salts are deposited in the lake (Mianping, 1997). Total hardness and TDS in the lake and stream were found with a mean value of 2178 and 462 mg/L and 365 and 73 mg/L respectively. Total hardness in the lake was not only due to the calcium and magnesium but other salts contributed substantially to it. Calcium content in the lake was less in concentration as compared to magnesium and the mean value of calcium in the lake and stream was 29 and 27 mg/L respectively. The mean magnesium concentration in the lake and stream was 466 and 15 mg/L respectively. Sodium concentration was comparatively higher as compared to potassium in the lake as well as stream. Sodium and potassium on average in the lake and stream were present with a mean value of 239 and 131 mg/L and 9 and 3 mg/L respectively. The cation progression in the lake was as; $Mg^{++} > Na^{+} > K^{+} > Ca^{++}$. Comparison of the data clearly revealed that Na^{+} and K^{+} recorded a similar pattern in the lake water as well as tributaries but the concentration of Ca^{++} and Mg^{++} in the inflows and lake water showed a reverse trend, thus the calcium concentration in the lake was lower than magnesium although in incoming stream calcium was always higher than magnesium. Zutshi et al. (1980) have reported that in Kashmir lakes calcium is generally the dominant cation because of the predominance of lime rich rocks in the catchments areas. But in the present study the predominance of magnesium over calcium may be explained on the grounds that calcium, which is brought in large quantities in the incoming water, gets quickly precipitated as calcium carbonate in the highly alkaline lake water and therefore settles at the bottom. Magnesium salts, on the other hand, being more soluble in water, get concentrated in the water column due to the evaporation of water from the lake surface (Hutchinson, 1933; Mianping, 1997).

Chloride like that of magnesium was too high in the main lake. Mean concentration of chloride in the lake and stream was 1594 and 15 mg/L respectively. The high chloride content in the lake may be contributed to the land locked nature of the lake. Nitrate - nitrogen, Ammonium– nitrogen and Total phosphate concentration in the lake were recorded with a mean concentration of 299, 54 and 464 µg/L respectively. Their concentrations in the stream were 275, 48 and 156 µg/L respectively. Ammonium – nitrogen, Nitrate - nitrogen and total phosphate which are good indicators of anthropogenic pressures (Zutshi et al., 1984) but the human pressure in the vicinity of the lake being negligible but still these were higher in the lake. Vass (1980) and Zutshi et al. (1980) reported the distribution of the main plant nutrients like nitrate, ammonia and phosphate to be governed by physical factors such as input source to the lake (catchment characteristics), changes in mixing depth during stratification and complete mixing during isothermal conditions and by biological processes such as algal photosynthesis. The nitrogenous compounds in the water bodies are derived to an appreciable degree from the atmosphere, whereas ammonia is the chief product of decomposition of plant and animal proteins (Schmittou et al., 1988; Sharma, 2000). As the decomposition of plant and animal proteins is negligible in the lake, catchment characteristics (geological features) and atmosphere and closed nature of the lake seem to be responsible for their higher concentration.

Bhat (2009) while working on Tso Moriri, a similar land locked lake in Ladakh, with same altitude and a depth of 72 m, reported that after the melt of ice cover during summer the maximum surface water temperature reached up to 19°C while the maximum bottom temperature during the same month was 8°C and after words the temperature again started to decrease till the lake gets frozen during late December. The same condition seems to prevail in the present lake also and thus one can easily keep the lake Pangong under the cold monomictic group of lakes (Hutchinson, 1937; 1967; Bhat, 2009).

Biological measurements provide direct information on the condition of groups of biota resident in the water resources and also on the conditions of the resource. They address management issues, more directly and can provide a more sensitive time-integrated assessment of a water body than physical or chemical variables directly. In the lake a total of 23 taxa of phytoplankton and some unidentified taxa were recorded, which belonged to four classes. Out of 23 taxa, 17 belonged to

Bacillariophyceae, 3 to Chlorophyceae, 2 to Cyanophyceae and 1 to Xanthophyceae (Table 3). The dominant genera among the phytoplankton species in the lake were: *Gomphonema germinatum, Navicula* spp. *Achnanthes ovalis, Nitzschia* spp., *Diatoma elongatum, Caloneis* spp., *Fragilaria* spp., *Schaeroplea annulina, Spirulina major* and *Arachnochloris minor* and these were found throughout the lake. The distribution and density of other taxa varied significantly from site to site. Some of the species were found site specific; *Achnanthes ovalis*, *Amphora* spp., *Schroederia anchora, Lyngbya* spp. were recorded only at LS I while as *Cyclotella* spp. was present at LS III only. LS II and LS III showed almost the same pattern of taxa formation having 14 taxa and 12 taxa respectively while as the LS I showed comparatively maximum (23 taxa) number of taxa (Figure 2). The LS II and LS III showed the maximum Jaccard similarity index of (73.33) followed by LS I and LS III (70.57) (Table 4). In the lake on the average, Bacillariophyceae contributed 71% to the total taxa followed by Chlorophyceae (13%), Cyanophyceae (8%), Xanthophyceae (4%) and unidentified taxa (4%) (Figure 3).

In the stream (RS), the density and diversity of periphyton was higher and a total of 34 taxa were recorded, which belonged to five classes. Bacillariophyceae in the stream was represented by 22 taxa, Chlorophyceae by 7 taxa, Cyanophyceae by 2 taxa, Xanthophyceae by one 1 taxa and Rodophyceae by 2 taxa (Figure 2). On the average in the stream Bacillariophyceae formed 65% of the total taxa while as Chlorophyceae, Cyanophyceae, Xanthophyceae and Rodophyceae formed 21, 6, 3 and 7% of the total taxa respectively (Figure 4). Twenty two (22) taxa recorded in the stream where present in the lake also, though planktonic in nature. The dominant taxa of Bacillariophyceaea in the stream were *Cymbella tumida, Diatoma anceps, Eunotia* spp., *Liomophora anglica, Meriodon* spp., *Stauroneis* spp., *Tabellaria fenestrate,* the dominant taxa of Chlorophyceae were *Closteriopsis irregular, Desmidium aptogonum, Hormidium subtile, Tetraedron spp*. *Zygnema spp*., Cyanophyceae was represented by *Lyngbya* spp. and *Spirulina major.* Rodophyceae was present in the stream only and was represented by two taxa, *Thorea ramosissima* and *Batrachospermum boryanum*. The Jaccard similarity index between the stream site (RS) and lake sites was low as compared among the 3 sites of the lake. However, the lake site which was near to the mouth of the stream, that is, LS I showed maximum similarity of 50 with the RS , while as the LS II and LS III showed a similarity of 33.33 and 31.42 respectively with the RS I. The maximum Shannon diversity of algal taxa in the lake was recorded at LS I (mean, H´ = 1.282) followed by LS II (mean, H´ = 0.967) and LS III (mean, H´ = 0.928) Figure 5. The average Shannon Diversity Index value of lake was 1.059 while that of the stream site was 2.434. Zooplankton in the lake was represented by red coloured adult *Diaptomus* species and their larval stage Nauplius larvae. Their density varied between the sites and the dominance pattern of zooplankton in the studied sites was; Site LS I (mouth of the Cheshul stream) > LS II > LS III. The more density of zooplankton in the studies sites was recorded during the September, 2005. No fish was recorded from the lake; however, the fishes were present in the stream. Three species i.e. *Schizopygopsis stoliczkae, Triplophysa stoliczkae* and *Triplophysa gracilis* were recorded from the stream.

The low biodiversity in the lake is considered due to its high salinity and harsh environmental conditions prevailing in the lake as the lake remains frozen for about more than three months (Bhat, 2009). The biotic life during the frozen period is expected to have decreased further as it is only during the warmer period the phytoplankton are being reported to be dominant in such water bodies. Khan (2003) and Bhat (2009) reported that physico–chemical parameters like light, temperature and nutrient concentration, lake currents, and grazing by zooplankton control the phytoplankton growth and reproduction. Williams (1992) and Kipriyanova et al. (2007) reported that the diversity and density of phytoplankton decline with increase in salinity. Similar observations were also found in the present lake as the maximum density and diversity was recorded near the mouth of the stream, where due to dilution of the stream water, salinity is low as compared to other sites, which is also confirmed by the high Jaccard similarity index between the mouth site (LS I) and the stream site (RS) as compared to other lake sites. Tuchman et al. (1998) and Alocer and Hammer (1998) also found species richness in the saline lake ecosystems of Mexico to be decreasing with increase in salinity.

The extreme conditions which influence the Pangong Tso are reflected in all groups of life forms mostly in zooplankton. One of the effects of harsh environmental conditions is also the absence of fishes from the lake. Hansson et al. (2007) reported on the effect of UV radiation on the zooplankton at high altitudes and found that to save the body from any damage zooplankton commonly synthesizes photo protective compounds that function either as sun-screens or as scavengers of photo-produced radicals. Due to strong ultraviolet radiations all the species have developed the red colour due to pigmentation of carotenoids and melanin in their body surface to overcome the harmful effects of ultraviolet radiations. This phenomenon was exhibited by all the taxa (adult as well as juveniles) in the Lake and due to the pigmentation the individuals appeared reddish in colour, especially during bright hot day. The fishes as were recorded only from the inlet stream of the lake and were absent from the main lake, it is possible that in the past the fishes might have been present in the lake but over the geological period of time as the salinity of lake increased due to evaporation, these might have ventured into the inlet stream and have adapted themselves well

Table 3. Distribution pattern of periphyton, phytoplankton, zooplankton and fishes in Cheshul stream (RS) and Pangong Lake (LS I – LS III).

Serial No.		RS	LS I	LS II	LS III
A	**Algal taxa**	**Periphyton**	**Phytoplankton**		
	Bacillariophyceae				
1	*Achnanthes ovalis*	++++	++	-	-
2	*Amphora sp.*	+++	+	-	-
3	*Caloneis sp.*	++	+	+	+
4	*Closterium* spp.	+	+	+	-
5	*Cyclotella sp.*	++	-	-	+
6	*Cymbella tumida*	+	-	-	-
7	*Diatoma elongatum*	+++	++	+	+
8	*Diatoma anceps*	+	-	-	-
9	*Diatoma hiemale*	+	+	-	-
10	*Epithemia zebra*	++	+	+	-
11	*Eunotia* spp.	+	-	-	-
12	*Eupodiscus argus*	-	+	+	-
13	*Fragillaria sp.*	+++	+	+	+
14	*Gomphonema herculeanum*	++	+	-	-
15	*Gomphonema germinatum*	+++	++	+	+
16	*Liomophora anglica*	+	-	-	-
17	*Meriodon* spp.	+	-	-	-
18	*Navicula* spp.	+++	+++	++	++
19	*Navicula radiosa*	+	+	+	+
20	*Nitzschia sp.*	++	++	+	+
21	*Nitzschia lanceolata*	-	+	-	-
22	*Stauroneis* spp.	+	-	-	-
23	*Synedra* spp.	++	+	-	-
24	*Tabellaria fenestrata*	+	-	-	-
	Chlorophyceae				
25	*Closteriopsis irregulare*	+	-	-	-
26	*Desmidium aptogonum*	++	+	-	-
27	*Hormidium subtile*	+	-	-	-
28	*Schaeroplea annulina*	++	+	+	+
29	*Schroederia anchora*	++	+	-	-
30	*Tetraedron* spp.	+	-	-	-
31	*Zygnema* spp.	++	-	-	-
	Cyanophyceae				
32	*Lyngbya* spp.	+	+	-	-
33	*Spirulina major*	+	+	+	+
	Xanthophyceae				
34	*Arachnochloris minor*	+	+	+	+
	Rodophyceae				
35	*Thorea ramosissima*	+	-	-	-
36	*Batrachospermum boryanum*	++	-	-	-
37	Un identified algae	-	+	+	+
B	**Zooplankton**				

Table 3. Contd.

1	*Diaptomus* spp.	-	+++	++	-
2	Nauplius larvae	-	++	+	+
C	**Fishes**				
1	*Schizopygopsis stoliczkae*	++	-	-	-
2	*Triplophysa stoliczkae*	+++	-	-	-
3	*Triplophysa gracilis*	++	-	-	-

++++= Very dense, +++ = Dense, ++ = moderate, + = low - = absent .

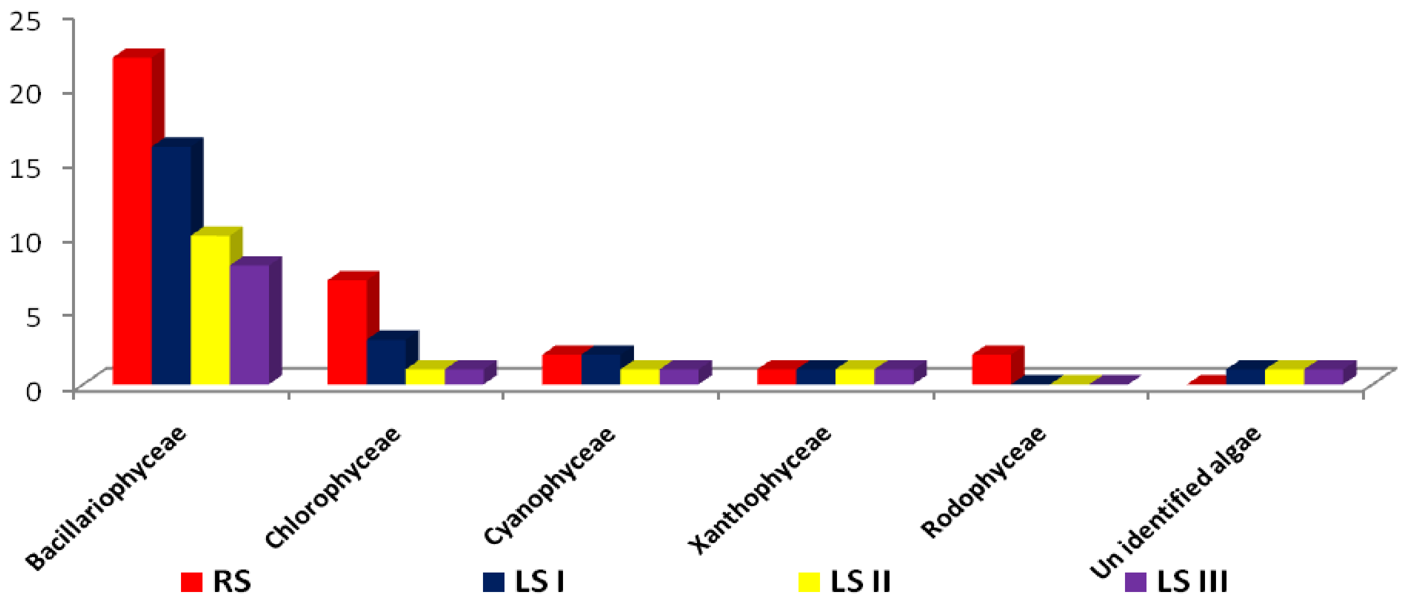

Figure 2. Dominance of different taxa to different algal classes at different sites.

Table 4. Jaccard similarity index (J) of algal taxa between the four sites.

	RS I	LS I	LS II	LS III
RS I		50	33.33	31.42
LS I			60.89	70.57
LS II				73.33
LS III				

there. The species recorded in the Pangong Lake are also reported from the other parts of the Himalaya, mostly from the fresh water lakes of Kashmir valley (Wanganeo and Wanganeo, 1991) as well from other parts of the world (Gunkel et al., 2002 and Tolotti et al., 2006) and some have also been reported from the saline lakes (Hodgson et al., 2001). This clearly points to the fact that only eurytopic species that have the capability of resisting wide range of fluctuations in environmental factors have been able to colonize this extreme ecosystem of the cold desert of Ladakh.

The low biodiversity in the lake is considered due to its high salinity and harsh environmental condition as the diversity and density of phytoplankton decline with increase in salinity as the maximum density and diversity was recorded near the mouth of the stream. Due to the extreme conditions and due to the effect of UV radiation at high altitudes, zooplankton to save the body from any

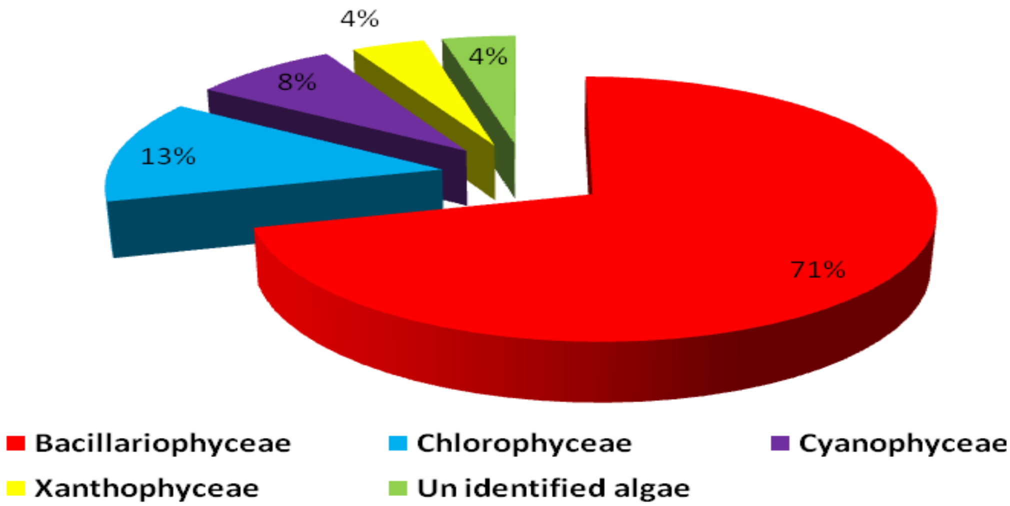

Figure 3. Mean percentage contribution of different classes to total phytoplankton taxa in the lake.

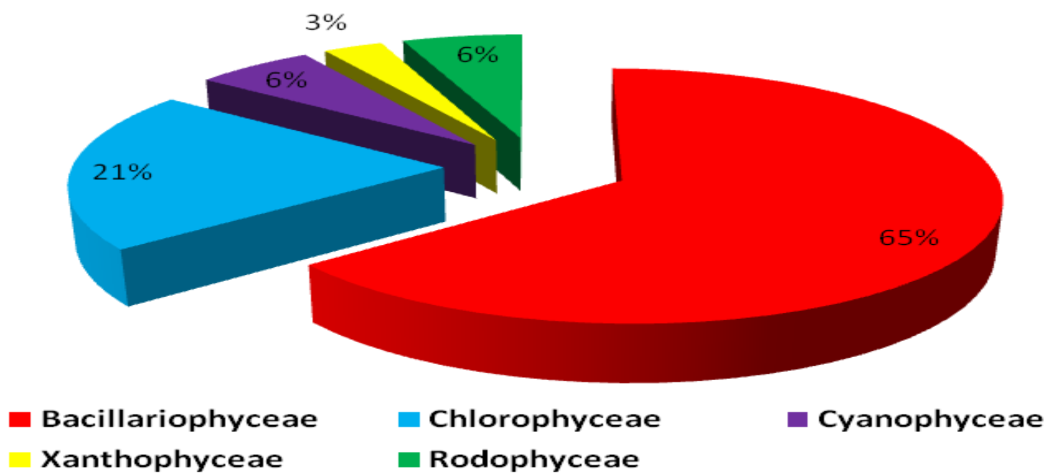

Figure 4. Mean percentage contribution of different classes to total periphyton taxa in the stream.

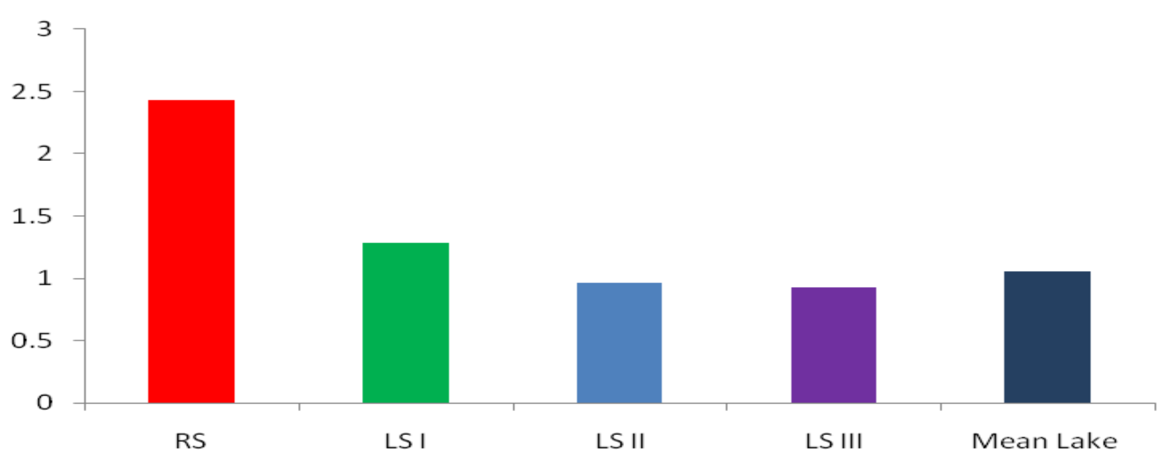

Figure 5. Mean Shannon diversity Index in the stream and different sites in Pangong Lake.

damage, commonly synthesize photo protective compounds that function either as sun-screens or as scavengers of photo-produced radicals. Due to strong ultraviolet radiations all the species have developed the red colour due to pigmentation of carotenoids and melanin in their body surface to overcome the harmful effects of ultraviolet radiations. The fishes as were recorded only from the inlet stream of the lake and were absent from the main lake. It is possible that in the past the fishes might have been present in the lake but over the geological period of time as the salinity of lake increased due to evaporation, these might have ventured into the inlet stream and have adapted themselves well there.

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