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RESEARCH ARTICLE

PHYCOLOGICAL STUDIES IN HIMALAYAN DAL LAKE ECOSYSTEM: SEASONAL COMPOSITION AND ROLE OF PHYSICO-CHEMICAL PARAMETERS

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ABSTRACT

A research study conducted on the Himalayan Dal Lake has shown that this lentic ecosystem is rich in microalgal flora. During the study, a total of 21 algal genera comprising of 39 species, 6 varieties were identified during the four seasons at six different sites of Dal Lake. Cyanophyceae with 16 genera, 29 species and 2 varieties were the largest class recorded, showed their peak abundance during summer and autumn seasons with the maximum standing crop at DLS-VI. Euglenophyceae includes 4 genera, 9 species and 4 varieties and show their appreciable numbers at DLS-VI during the autumn season. In case of Rhodophyceae only one genera and one species namely *Glaucosphaera vacuolata* was reported during the autumn season at DLS-IV and is a new record reported to the phycological studies of India. Blue green microalgae *Microcystis aeruginosa* was found abundantly at DLS-II indicating alarming toxic nature of water as this alga contains microcystins of neuro and hepato toxins. The water chemistry revealed the lake is undergoing tremendous cultural eutrophication, DLS-VI was the most polluted site of the lake with the highest chemical nutrient load observed in summer season exhibiting highest value of 3.95 ppm of nitrate and 1.80 ppm of phosphate.

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INTRODUCTION

Algae are a large and diverse group of simple plants ranging from unicellular to multicellular form. These are considered as the first autotrophic (photosynthetic) plants of the planet. Algae are ubiquitous, that occur in almost all habitats, ranging from marine and freshwater to desert sands and from hot springs to snow. The habitats occupied by fresh water algae are divided into lotic (running) and lentic (stagnant) water types. Due to the growth of algae in different habitats, they may be variable and highly diversified group of green plants i.e., phytoplanktonic (free floating), benthos (attached to sediments), epiphytic (on plants), epilithic (on stones), epipelic (on sand), endophytic (inside the plant), epizoic (on shells), and endozoic (inside sponge). They have enormous economic implications, not only as primary producers and pollution indicators but also as a source of several natural products, biofertilizers, fine chemicals and biofuels. (Prasad and Singh, 1996; Lone *et al*., 2013; Chisti, 2007) They are an inseparable associate of environment and also help in the purification of the environment. The early accumulation of oxygen in the earth's atmosphere was due to photosynthesis of ancient algal forms. It is estimated that, the algal photosynthesis contributes nearly 90 per cent of oxygen release in the earth's atmosphere. Globally algae are considered to fix 50 per cent of CO_2 and are the primary producers in aquatic habitat supporting rich food chains and oxygenate the aquatic systems. (Misra *et al*., 2004) Scientists have estimated the total number of algal species to over 50,000 in the world but only 30,000 species are identified and examined. (Frac *et al*., 2010) Even less species are really tried out biotechnologically for industrial purposes. Kashmir valley is one of the divisions of Jammu & Kashmir, India, which is bestowed with number of world famous lentic water bodies and Dal Lake is one such important temperate ecosystem. This urban lake is of fluviatile origin having been formed from the ox-bows of the river Jhelum situated towards the North-east of Srinagar, Kashmir at the foot of Zabarwan mountains. The lake lies between 34°6'N -34°10'N latitude and 74°50'E -74°54'E longitude at an altitude of about 1,584 m above mean sea level. (Najar and Khan, 2012) The main source of water for this lake

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is rainfall. (Khan *et al*., 2012) The lake is also mainly fed by a large perennial inflow stream *Telbal Nala* that contributes about 80% of the total inflow to the lake. (ENEX, 1978) Other small streams that bring water from the catchments into lake ecosystem are *Peshpaw, Shalimar, Merakhsha* and *Harshikul*. (Najar and Khan, 2012) However, water also springs out from its bed. The lake is divided into four basins: *Hazratbal, Boddal, Nagin* and *Gagribal* which differ markedly in their area, volume, depth and shoreline development indices etc. The total water surface area of the lake is 11.50 km², of which 4.1 km² is under floating gardens, 1.51 km² is submerged land and 2.25 km² under marsh lands respectively. Being an urban lake, the Dal lake is surrounded by developed land; most of the lakeshore is occupied by houses, hotels, restaurants, houseboats and is under tremendous anthropogenic pressure. The chemical analysis of water provides specific information about a particular compound, but the plankton composition reflects the overall health status of an aquatic system and its suitability for different uses. (Singh and Ahluwalia, 2013) Phytoplankton responds quickly to environmental changes and are considered good indicators of water quality and trophic conditions because of their short generation time and fast population renewal. (Singh *et al*., 2013) Several phycological studies have been carried out in Kashmir wetlands however, Khan carried out the documentation to consolidate the available data. (Kant and Kachroo, 1974; Zutshi *et al*., 1980; Mir and Kachroo,1982; Rather, 1994; Jeelani *et al*., 2008; Ganai *et al*., 2010; Khan, 2002) The fresh water algal flora especially Cyanophyceae, Euglenophyceae and Rhodophyceae of this temperate lake have not yet been systematically explored. In order to fill this gap, and to get the latest algal floristic data, present investigation has been carried out with special emphasis on Cyanophyceae, Euglenophceae and Rhodophyceae.

MATERIALS AND METHODS

Water and fresh algal samples were collected separately from the six different sampling sites (Dal Lake Sites (DLS): DLS-I (Nehru Park), DLS-II (Bren Laam), DLS-III (Char Chinar), DLS-IV (Hazratbal), DLS-V (Nagin) and DLS-VI (Ranawari) of Dal Lake between 8:30-13:30 in sample collection bottles made of polyethylene and polypropylene (100 ml for algal samples and 500 ml for water samples) with four replications for each sample. Sampling was done during the four seasons of a year i.e., spring (April), summer (July), autumn (October), and winter (January). Water samples were collected from the Lake between 15th and 20th of every seasonal month from January 2012 to December 2012. The fresh algal samples were collected with the help of sample collecting spoons, forceps etc and were immediately fixed by using suitable amount of preservative (7% formaldehyde) for the biodiversity studies. (Wetzel and Lickens, 2000) The physico-chemical parameters (pH, electrical conductivity, temperature, total dissolved solids, total hardness, total alkalinity, phosphate, nitrate, and silicate) of the surface water samples collected from six sites of Dal Lake were analysed as per "American Public Health Association". (APHA, 1995) The parameters including temperature and total dissolved solids were determined on spot. While as pH and conductivity were measured within 5 hours of sampling, the rest of the parameters were determined in the laboratory within 24 hours. The identification of microalgae was carried out by using advanced microscope (LEICA DM 500, U.K) connected with computer having digital image analyzer and software (LAS EZ 1.8.0) and microphotographs were taken with attached camera LEICA EC3. The identification of the microalgae was also authenticated based upon standard keys given by Desikachary, Tiffany, Prescott, Phillipose etc. for morphological characteristics. (Desikachary, 1959; Tiffany and Britton, 1952; Prescott, 1970; Phillipose, 1967) The attributes recorded for morphological parameters through microscopic examination were size and shape of vegetative cells, spines, flagella, heterocyst and colour of thallus. The Box-and-Whisker plots for each of the water parameter were carried out by using R- software.

RESULTS

In the present comprehensive research programme fresh water algal flora of Himalayan Dal lake ecosystem have been studied with the help of digital photo imagery and using advanced Leica software for measurements. A total of ninety six algal samples during the four seasons of the year were collected for biological studies from six different sites of Dal Lake. The taxa have been arranged in various orders of each class Cyanophyceae, Eugleanophyceae and Rhodophyceae. The diversity and distribution of each Class (Cyanophyceae, Eugleanophyceae and Rhodophyceae) at six different sites of Dal Lake during four seasons of a year are presented in the Tables 1 and 2. The Cyanophycean algae showed their peak abundance during summer and autumn seasons and were absent during winter months. The Euglenophyceae were best represented in autumn months and during summer season DLS-V and DLS-VI also showed dominance of some species. The species of each genus are alphabetically arranged and in some cases, only a variety of a particular species was encountered. The measurement has been given for each taxon and is followed by collection number.

Class: Cyanophyceae

Dactylococcopsis acicularis Lemmermann 1900, Ber. D. Deutsch: Cells 60.40 µm long, 4.71 µm in diameter. Collection No: DLS201258.

Gloeothece rupestris (Lyngb.) Bornet: Cells are 9.05 µm long, 6.56 µm in diameter and colonies 26.32 µm in diameter. Collection No: DLS201288.

Gloeothece samoensis Wille var. ***major*** Wille: Cell without sheath 10.90 µm long, 10.99 µm in diameter. Collection No: DLS201288.

Gloeocystis ampla Kuetzing: Cell 12.38 µm long, 10.34 µm in diameter. Collection No: DLS201288.

Gomphosphaeria naegeliana (Unger) Lemmermann, Kryptogamenflora der Mark Brandenburg: Cells 4.89 µm long, 4.43 µm in diameter and colony 47.84 µm in diameter. Collection No: DLS201272

Merismopedia glauca (Ehrenberg) Nag/ Kuetzing: Cells 4.99 µm / 4.53 µm / 4.34 µm in diameter and colony 39.25 µm in diameter. Collection No: DLS201273

Chroococcus minutes (Kutz.) Nag: Cell with sheath 12.38 µm in diameter and without sheath 9.60 µm in diameter. Colonies 22.72 µm long, 30.66 µm in diameter. Collection No: DLS201274

Chroococcus turgidus var. ***maximus*** (Kutz.) Nag: Cells without sheath 5.91 µm in diameter, with sheath 9.05 µm in diameter. Colonies 27.61 µm long, 35.83 µm in diameter. Collection No: DLS201272

Chroococcus tenax (Kirchn.) Hieron: Cell without sheath 13.76 µm in diameter, with sheath 23.83 µm in diameter. Collection No: DLS201280

Chroococcus schizodermaticus West: Cell without sheath 8.03 µm in diameter, with sheath 14.68 µm in diameter, colony 35.92 µm in diameter. Collection No: DLS201281

Coelosphaerium collinsii Drouet and Daily: Cells 5.26 µm long, 3.51 µm in diameter, and coloney 42.30 µm in diameter. Collection No: DLS201274

Microcystis aeruginosa Kutz: Cells 5.91 µm in diameter. Collection No: DLS201253

Trichodesmium lacustre Klebahn: Cells 6.46 µm long, 10.16 µm in diameter. Collection No: DLS201251.

Lyngbya birgei Smith, G.M: Cell 2.626 µm long, 20.36 µm in diameter. Collection No: DLS201248

Lyngbya contorta Lemm: Cell 4.57 µm long, 5.81 µm in diameter and colony 99.64 µm in diameter. Collection No: DLS201292

Phormidium purpurascens *(*Kutz.) Gomont: Cell 4.43 µm long, 2.49 µm in diameter. Collection No: DLS201289

Anabaena doliolum Bharadwaja: Cell 8.96 µm long, 7.48 µm in diameter. Collection No: DLS201294

Anabaena circinalis Rabenhorst ex Born. et Flah: Cell 7.02 µm long, 6.19 µm in diameter. Heterocyst 8.62 µm long, 9.02 µm in diameter. Collection No: DLS201278

Arthrospira jenneri (Kuetz.) Stizenberger 1852: Cell 3.71 - 3.87 µm long, 6.15 /-6.41 µm in diameter. Collection No: DLS201295

Aphanizomenon flos-aquae (Linn.) Ralfs ex Born. et Flah: Cell 2.83 - 3.60 µm long. Heterocyst 6.72 µm long, 4.87 µm in diameter and spores 22.86 µm long and 5.89 µm in diameter. Collection No: DLS201278

Spirulina meneghiniana Zanard. ex Gomont: Cell 7.92 µm long, 4.51 µm in diameter. Collection No: DLS201293

Oscillatoria chalybea Mertens in Jurgens 1822: Cells 8.60 µm in diameter, 4.95 µm long. Collection No: DLS201294

Oscillatoria limosa Ag. Ex Gomont: Cells 13.67 - 20.78 µm in diameter, 4.62 - 5.63 µm long. Collection No: DLS201294

Oscillatoria chlorina Kuetzing: Cells 6.10 µm long and 6.37 µm in diameter. Collection No: DLS201295

Oscillatoria curviceps C. A. Agardh 1824: Cells 3.78 µm long and 19.49 µm in diameter. Collection No: DLS201292

Oscillatoria irrigua (Kutz.) Gomont: Cells 6.74 µm long and 5.73 µm broad. Collection No: DLS201293

Oscillatoria formosa Bory 1827: Cells granular 4.16 µm long and 4.16 µm in diameter. Collection No: DLS201289

Oscillatoria granulate Gardner 1927: Cells 3.60 µm long and 4.71 µm in diameter. Collection No: DLS201292.

Class: Eugleanophyceae

Phacus anacoelus var. ***undulata*** Skvortzow 1928: Cells 103.90 µm long, 81.64 µm in diameter. Collection No: DLS201294

Phacus acuminatus Stokes 1855a: Cells 20.69 µm long and 16.53 µm in diameter. Collection No: DLS201264.

Phacus anacoelus Stokes 1888: Cells 35.19 µm long and 31.77 µm in diameter. Collection No: DLS201292

Phacus longicauda Ehrenb. Dujardin 1841: Cells 75.82 µm long and 38.42 µm in diameter. Collection No: DLS201269

Lepocinclis fusiformis (Carter) Lemmermann 1901: Cell 37.22 µm long and 25.21 µm diameter. Collection No: DLS201293

Lepocinclis fusiformis var. ***minor****:* Collection No: DLS201295

Trachelomonas hispida var. ***coronate*** Lemmermann: Test 32.60 µm long and 21.16 µm diameter. Collection No: DLS201290

Euglena acus var. ***rigida*** Huebner 1886: Cell 123.75 µm long and10.81 in µm diameter. Collection No: DLS201290

Euglena acus Ehrenberg 1838: Cell 114.79 µm long and 12.56 µm diameter. Collection No: DLS201289

Euglena proxima Dangeard 1902: Cell 66.12 µm long and 6.46- 17.92 µm diameter. Collection No: DLS201295

Euglena spirogyra Ehrenberg 1838: Cell 173.07 µm long and19.49 µm diameter. Collection No: DLS201294

Euglena deses Ehrenberg 1835**:** Cell 102.79 µm long and 12.10 µm diameter. Collection No: DLS201294.

Class: Rhodophyceae

Glaucosphaera vacuolata Korsh: Cells are solitary with numerous contractile vacuoles. Cells are uninucleate and the multiplication of cell is by vegetative division. Cell is 23.73 µm in diameter. Collection No: DLS201286.

Table 1. Diversity and distribution of Cyanophyceae at six different sites of Dal Lake during four seasons of a year

Phytoplanktons	Winter						Spring						Summer						Autumn					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Anabaena circinalis	-	-	-	-	-	-	-	-	-	-	-	-	-	+++	-	-	++	+++	+	+++	++	++	-	++
Anabaena doliolum	-	-	-	-	-	-	-	-	-	-	-	-		++	-	-	+	++	+		-	-	-	+++
Aphanizomenon flos-aquae	-	-	-	-	-	-	-	-	-	-	-	-	+	+++	-	-	-	-	-	-	-	-	-	-
Arthrospira jenneri	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	-	+	++	++	-	-	-	+	+++
Chroococcus minutes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++		-	-	-	-	-	-	-
Chroococcus schizodermaticus	-	-	-	-	-	-	-	-	-	-	-	-		-	++	-	-	-	-	-	+++	-	-	++
Chroococcus tenax	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+++	-	-	-
Chroococcus turgidus	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	++	-	++	+++	-	-	+	-	-
Chroococcus turgidus var. *maximus*	-	-	-	-	-	-	-	-	-	-	-	-	+	++	-	-	-	-	+++	-	-	-	-	++
Coelosphaerium collinsii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+++	-	-	-	-	-
Dactylococcopsis acicularis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	+	-	-	-	-	+++	-
Gloeocystis ampla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	-	-	+++	-
Gloeothece rupestris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	-	-	+++	-
Gloeothece samoensis var. *major*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	+	-	-	-	-	+++	+
Gomphosphaeria naegeliana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+++	-	-	-	-	+
Gomphosphaeria species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+++	+++
Lyngbya birgei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	+++	-	+	-	-	-
Lyngbya contorta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	-	-	-	+	-	+++
Merismopedia glauca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+++	-	-	-	-	-
Microcystis aeruginosa	-	-	-	-	-	-	-	-	-	-	-	-	++	++++	++	-	-	-	-	++++	++		-	++
Oscillatoria curviceps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	+		++	++	+	-	++		+++
Oscillatoria chalybea	+	-	-	+		+	-	-	-	-	-	+	-	-	+	+	+	++	+	+	-	++	+	+++
Oscillatoria granulata	-	-	-	-	-	-	-	-	-	+	-	++	-	-	+	++	+	++	++	+	-	++	+	+++
Oscillatoria chlorina	+	-	-	+		+	-	-	-	-	-	++	-	-	+	++	+	++	++	+	-	++	+	+++
Oscillatoria limosa	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+		+	+++	++	-	-	++		+++
Oscillatoria irrigua	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	++	+	-	-	++	+	+++
Oscillatoria formosa	+	-	-	+		+	-	-	-	-	-	+	-	-	++		+	++	++	+	-	++	+++	-
Phormidium purpurascens	-	-	-	-	-	-	-	-	-	+	-	-	+++	-	-	-	-	++	+++	++	-	++	++	+++
Spirulina meneghiniana	-	-	-	-	-	-	-	-	-	-	-	++	-	-	-	-	-	++	-	-	-	++	-	+++
Trichodesmium lacustre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	-	-	-	-

Table 2. Diversity and distribution of Eugleanophyceae and Rhodophyceae at six different sites of Dal Lake during four seasons of a year

Phytoplanktons	Winter						Spring						Summer						Autumn					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Euglena acus	-	-	-	-	-	-	-	+	-	+	-	-	+	-	-	-	++	+++	-	-	-	+	++	+++
Euglena deses	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	+	+++	-	-	-	+++	++	+++
Euglena proxima	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	++	+	++	-	-	+++	++	++
Euglena spirogyra	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	++	-	-	-	+++	++	++
Lepocinclis fusiformis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	+	+
Lepocinclis fusiformis var. *minor*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	+	+
Phacus acuminatus	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	+	+++	+	-	-		+	-	+++
Phacus anacoelus	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	++	-	-	-	-	+	+	+++
Phacus anacoelus var. *undulate*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	++	+	-	-	-	++	-	+++
Phacus longicauda	-	-	-	-	-	-	-	-	-	+	-	-	++	-	-	+	++	+++	++	-	-	+	-	+++
Trachelomonas hispida var. *coronate*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	+	-	+
Rhodophyceae																								
Glaucosphaera vacuolata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-

Abbreviations: Where I, II, III, IV, V and VI are Dal Lake Sites: DLS-I (Nehru Park), DLS-II (Bren Laam), DLS-III (Char Chinar), DLS-IV (Hazratbal), DLS-V (Nagin) and DLS-VI (Ranawari). **Frequency status:** (-, **0%**) Absent; (+, **< 20%)** Present and Rare; (++, **>20-50%)** Common; (+++, **>50%**) Dominant; (++++, **100%**) Abundant.

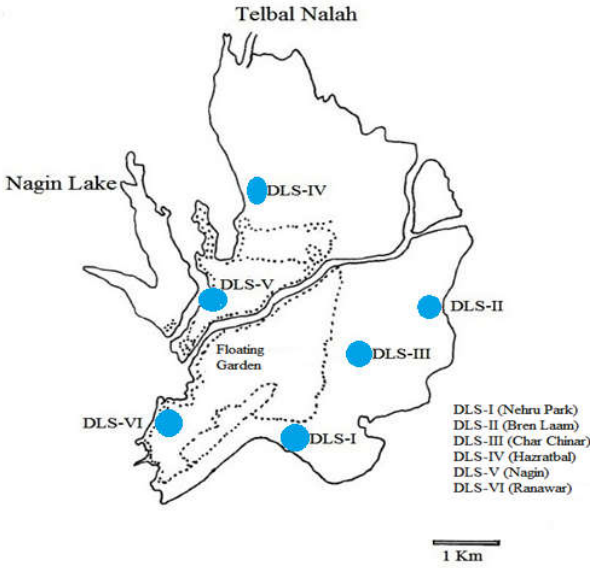


Figure 1. Map of Dal Lake, Srinagar, India and its sampling sites

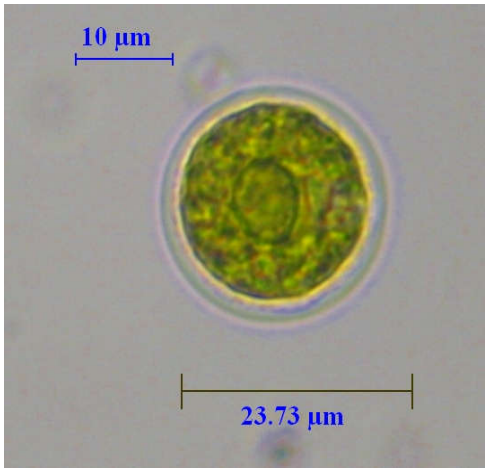
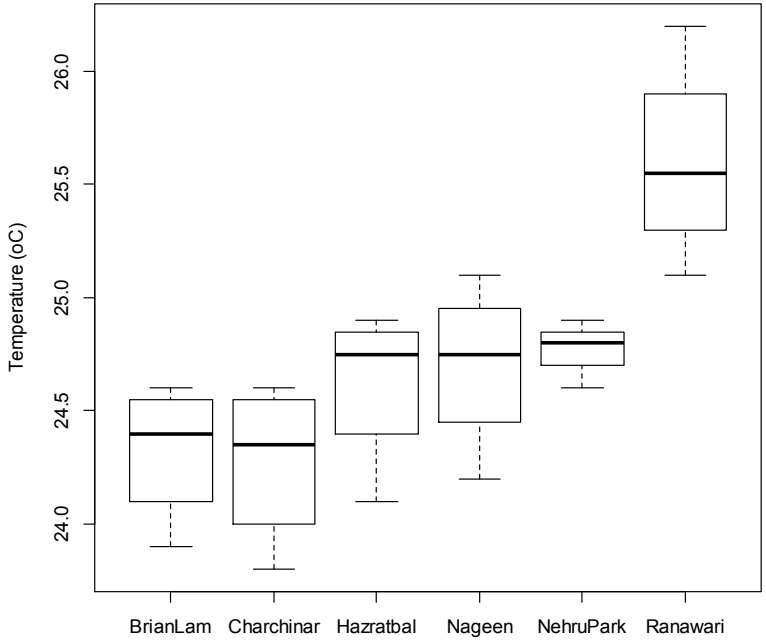
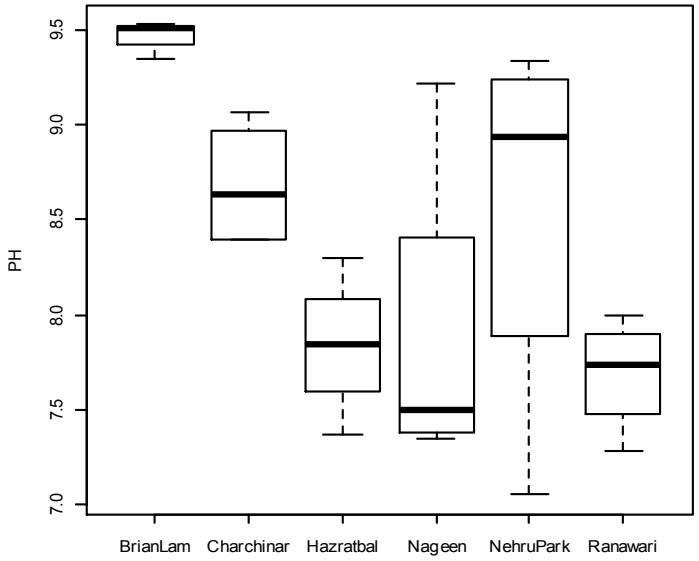


Figure 2. *Glaucosphaera vacuolata*

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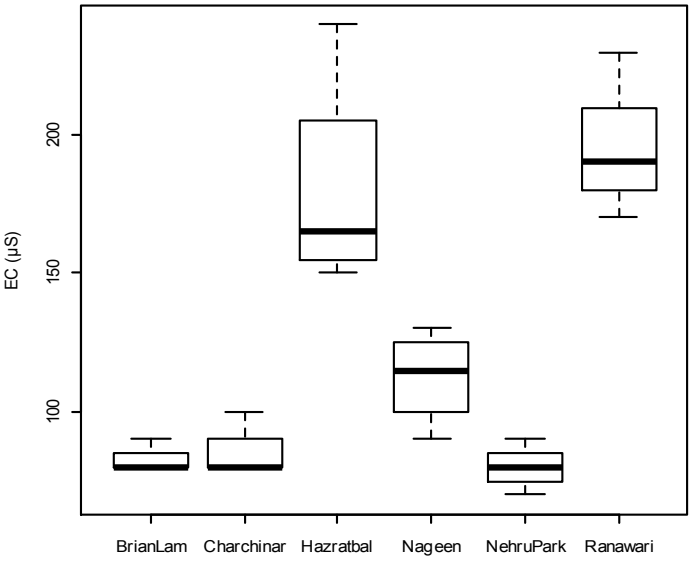
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Charchinar
Hazratbal
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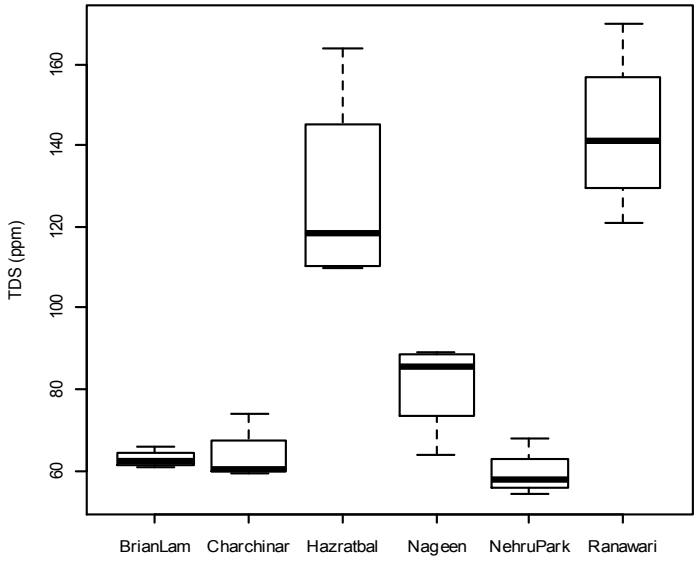
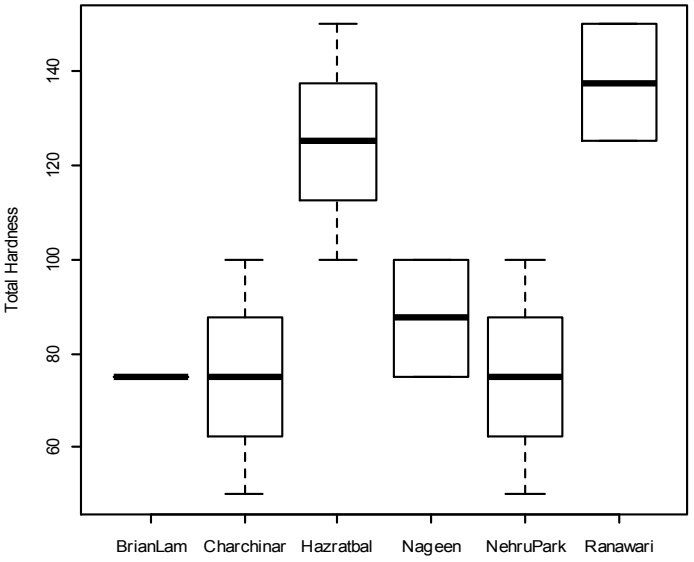
Ranawari


TDS (ppm)
160
140
120
100
80
60
BrianLam
Charchinar
Hazratbal
Nageen
NehruPark
Ranawari


Total Hardness
140
120
100
80
60
BrianLam
Charchinar
Hazratbal
Nageen
NehruPark
Ranawari

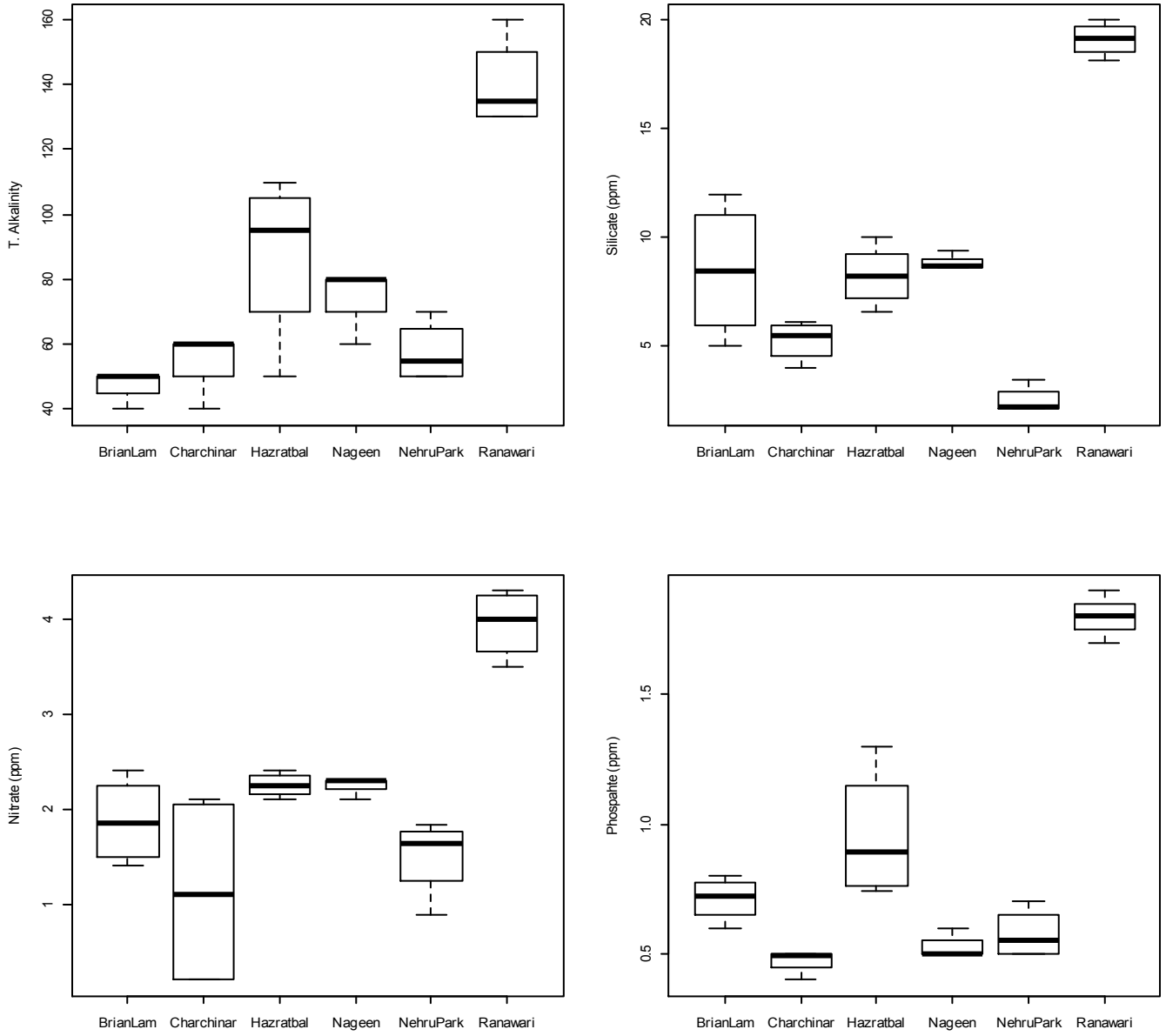


Fig. 3. Box-and-Whisker plots of water parameters (n=4) during summer season (July- 2012

DISCUSSION

Algal taxonomy with diverse families is of great diagnostic importance in floristic analysis as well as basic and applied aspects of research. (Medvedeva, 2001) Based on its geographical position Dal lake ecosystem also enjoys the richest and the most diverse biodiversity among the other fresh water lakes of Kashmir Himalayas and also in Indian subcontinent. In the present work morphotaxonomic characters, diversity and distribution of fresh water algae was carried out. The results show that a total of 22 algal genera, 39 species and 6 varieties were recorded in the fresh water ecosystem (Table 1 and 2). Cyanophyceae is the largest class with 29 species and 2 varieties. The abundance of cyanophyceae during the summer and autumn months indicates the eutrophic nature of water body. The cyanophyceae showed their peaks during summer and autumn seasons with the maximum standing crop especially at DLS-VI. The possible reasons behind this result may be the favourable temperature, alkaline pH, low water volume and availability of nutrients as shown in box-whisker plot analysis which created favourable condition for better propagation of this group of phytoplankton (Fig. 3). The dominant species of cyanophyceae was *Oscillatoria*. Ganai and Parveen also found *Osillatoria* spp. the most abundant amongst cyanophyceae in Wular Lake in their study during March, 2007 to February, 2008. (Ganai and Parveen, 2013) Presence of some pollution tolerant blue green algae like *Microcystis aeruginosa, Oscillatoria sp.* can be used as indicator species for polluted habitats, as these species were recorded from those sites having high concentration of pollutants especially nitrate and phosphate. These results are in accordance with the findings of Bhatnagar and Bhardwaj. (2013)

Microalgae *Microcystis aeruginosa* was found abundantly at DLS-II during the summer and autumn months indicating alarming toxic nature of water as this alga contains neuro and hepato toxins. The toxicity reports of *Microcystis aeruginosa* were reported by Bishop *et al.* Al-Jassabi and Khalil; Ahmed. (Bishop *et al*., 1959; Al-Jassabi and Khalil, 2006; Ahmed, 2009) Moreover, protenious algae *Spirulina* was common at sites of DLS-IV, DLS-VI which indicates that the algae is able to tolerate the high level of pollutants as these sites contains appreciable quantities of physico-chemical characteristics. The high tolerance limit of *Spirulina platensis* in various toxicants and pollutants was also reported by Lone *et al.,* which is in conformity with our results. (Lone *et al*., 2013) Euglenoid algae form a relatively large and diverse group but few species are truly planktonic. (Wetzel, 1983) Among the Euglenophyceae 4 genera, 9 species and with 4 varieties were recorded during the four seasons of the year. All these species were found in appreciable numbers at DLS-VI during the autumn season. Increasing temperature and accumulation of organic loads from catchment area, autothonous and allocthonus organic load, sewage, clear sun-shine, temperature may be the possible reasons for the dominance of euglenophyceae in autumn months. (Munawar, 1972)

Class Rhodophyceae was monotypic in its representation of having only one taxon namely *Glaucosphaera vacuolata* from DLS-IV during the autumn season having physico-chemical characteristics of temperature 21.1 ^{o}C; pH 7.59; EC 186.6 $\mu S\ cm^{-1}$; TDS 88.3 ppm; Total Hardness 93.8 ppm; Total Alkalinity 67.5 ppm; nitrate 1.92 ppm; phosphate 0.6 ppm. Khan, documented only one Rhodophyta *Betrachospermum* species from the wetlands of Kashmir. (Khan, 2002) *Glaucosphaera vacuolata* reported in the present study is a new record reported to the phycological studies of India and Kashmir Himalayas. The blue green algae showing their dominance at those sites receiving heavy load of pollutants from and within the catchment area. The water of this lentic fresh water body is a prime example of a natural ecosystem severely affected by pollution and class cyanophyceae can be used as indicator species for pollution. These algal assemblages can be regarded as 'models' that will be of great value in providing baseline data for future monitoring and for assessing the effects of anthropogenic pollution.

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