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Species composition and diversity of phytoplankton in some crenic habitats of district Anantnag, Kashmir

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ABSTRACT

Seven crenic habitats from district Anantnag were evaluated for composition and diversity of phytoplankton over a period of one year extended from September 2010 to August 2011. A total of 67 species were recorded during the entire study which belonged to four classes of algae namely Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. Class Bacillariophyceae was found to be dominant throughout the study period. Utmost diverse genera encountered in the present study belonged to *Nitzischia, Synedra* and *Oscillatoria*. Amongst the reported taxa, *Binucleara tatarana, Hormidium subtile, Cerotonis arcus, Diatomella balfouriana. Gommphonema gracile, Navicula* sp. and *Microspora amoena* were found almost throughout the study period. Further, springs showed greater species richness, composition in summer and autumn seasons.

Keywords: Phytoplankton, Crenic habitats, Springs, Species diversity, Chlorophyceae, Bacillariophyceae, Cyanophyceae, Euglenophyceae.

INTRODUCTION

Springs result from water table intersection with the earth's surface, or groundwater rise under hydrostatic pressure to the surface through rock faults, fractures or depressions (Death *et al.* 2004). They are widely distributed over the landscape, but vary greatly in morphology and size, ranging from minor seepages from bedrock faces, to alluvial springs in braided river landscapes, to resurgences in karst upto very large vents discharging many thousands of litres per second. Springs represent a triangular interaction between groundwater, surface water, and terrestrial ecosystems.

Springs are also represented with distinctive flora and fauna, with high levels of local endemism (Knott and Jasinska 1998). Phytoplankton succession is a well-investigated phenomenon in aquatic ecology and several studies have described the patterns and underlying mechanisms of the seasonal dynamics (Rothhaupt, 2000). However, the knowledge of the composition and abundance of phytoplanktonic organisms constitutes an indispensable feature for the assessment of the trophic status in springs and for the evaluation of the possible or optimal utilization of different water resources. Phytoplankton form the basis of the food chain in openwater resources and acts as an indicator of the water quality. Some phytoplankton species especially belonging to cyanophyceae are known to be harmful to humans on account of their capability to release toxic substances. Up-to-date there have been only occasional studies of the springs in Kashmir and little is known about their limnological aspects and possible, appropriate, management strategies (Soylu *et al.*, 2007). Thus, the present study was aimed at evaluating the seasonal variation in the diversity and composition of the phytoplankton to cover the existing gap in the knowledge about the phytoplanktonic assemblages in these crenic habitats of Kashmir valley.

Study area and study sites

Kashmir valley is one of the most beautiful and gratifying state so is called Switzerland of Asia.God has bestowed this valley with all the charm and scenery by which it is also called paradise on earth. Kashmir is one of the three administrative divisions in Jammu and Kashmir state and consists of Anantnag, Baramulla, Budgam, Bandipore, Ganderbal, Kupwara, Kulgam, Pulwama, Shopian and Srinagar districts. The study was carried out in Anantnag district as it possesses limitless springs which is reflected from its name viz, 'anant' meaning limitless and 'nag' meaning springs.

Seven springs in three tehsils of district Anantnag were choosen for carrying out the study viz., Himalinag and Malakhnag in Anantnag tehsil; Kirkadalnag and Parinag in Bijbehara tehsil; Dubnagin, Naranag, and Batnagin in Pahalgam tehsil. The coordinates of the study site and map is given in Table1 and Fig.1.

Table 1: Description of selected sites of district Anantnag

Sites	**Latitude** (N)	**Longitude (E)**	**Location**	**Bottom substrate**
Himalinag	33^{0}44´01.6´´	75^0 09´42.4´´	Anantnag tehsil	Boulders
Malakhnag	33^{0}43´44.6´´	75^0 09´15.6´´	Anantnag tehsil	Boulders &sand
Kirkadalnag	33^{0}47´52.6´´	75^0 07´09.7´´	Bijbehara tehsil	Flattened stones
Parinag	33^{0}47´34.8´´	75^{0}08´19.8´´	Bijbehara tehsil	Muddy
Dubnagin	33^{0}52´54.3´´	75^{0}14´59.6´´	Pahalgam tehsil	Mud & sand
Naranag	33^{0}51´10.2´´	75^{0}14´15.8´´	Pahalgam tehsil	Muddy
Batnagin	33^{0}51´11.2´´	75^{0}14´15.3´´	Pahalgam tehsil	Small boulders

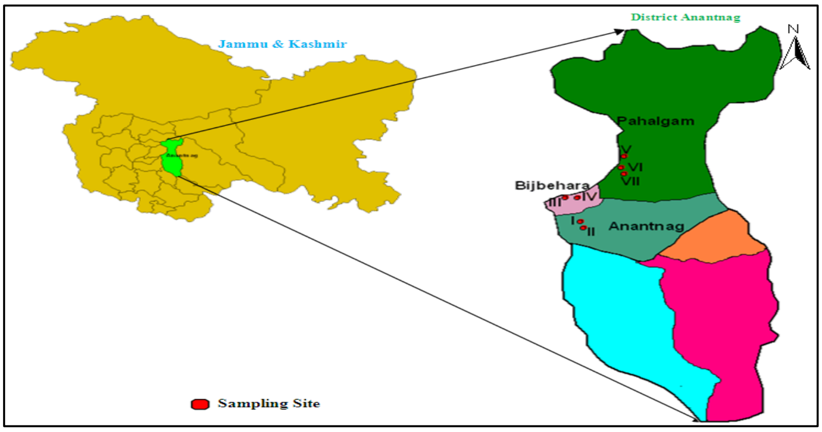

Fig.1: Map showing location of seven springs in District Anantnag of Kashmir in J&K state.

MATERIALS AND METHODS

Plankton samples for both qualitative and quantitative analysis were collected by sieving 10 litres of water through a plankton net (No. 25, mesh size 64 µm) in the vertical direction. Part of the sample of plankton population thus obtained was examined live while the other aliquot was preserved by fixing in 4% formalin and Lugol's solution (10gm pure iodine + 20gm potassium iodide+200cc distilled water to 200cc glacial acetic acid).

Identification of the plankton was done with the help of standard works of Prescott (1939), Nygard (1945), Smith (1950), Edmondson (1959), Cox (1996), and APHA (1998).

RESULTS AND DISCUSSION

A total of 67 species of phytoplankton belonging to Chlorophyceae (25 species), Bacillariophyceae (24 species), Cyanophyceae (17 species), Euglenophyceae (1 species) was recorded across seven different springs during the entire study (Table 2).

Among the springs the highest number of algal species was registered at Dubnagin (65), followed by Himalinag (63), Naranag (60), Parinag (50),Malakhnag (40), Kirkadalnag (21) and decreasing to the lowest of 11 species at Batnagin (Table 2). Qualitatively, Chlorophyceae and Bacillariophyceae were the most dominant algal classes in all the springs as against Cyanophyceae. Amongst the reported taxa, the most common species reported from the seven springs were *Binucleara tatarana, Hormidium subtile, Cerotonis arcus, Diatomella balfouriana. Gommphonema gracile, Navicula sp.* and *Microspora amoena* being found almost throughout the study period. The greater species diversity of algal flora in springs like Dubnagin and Naranag is likely due to the presence of organic matter (Smith, 1990; Watson *et al.,* 1997) and also due to the application of fertilizers in the agricultural fields causing nutrient enrichment at Dubnagin.

The majority of algal taxa in the present study (e.g. *Cocconeis*, *Synedra, Gomphonema, Fragillaria, Melosira*, *Cymbella*, *Cladophora, Oedogonium, Rhizoclonium, Ulothrix*, *Spirogyra, Closterium*, etc.) which has also been reported from springs elsewhere (Whitford, 1956; Bhat and Pandit, 2010) do not display marked seasonal variations as they live under similar ecological conditions. The majority of the diatoms encountered from the springs under study are reported to be cosmopolitan in distribution rendering them unsuitable as ecological indicators (Lowe, 1996). Though, there was no detectable change in dominance or species composition throughout the year in any of the spring communities, yet species richness was found comparatively higher in summer and autumn while as it decreased during the winter and early spring which could be attributed to decreasing water temperature. Though most of the springs hardly exhibited any discernible peak, yet by and large most of the algal groups multiplied profusely in summer-autumn seasons in all the springs (Fig. 2-5).The restricted distribution of certain taxa to given habitats probably reflects the peculiarity of the different habitats or microhabitats (Watson *et al*., 1997).

Diatoms occupy a wide range of ecological niches (Brook, 1959, 1965; Moss, 1972) which probably accounts for their occurrence in all the studied springs. The greater species diversity of algal flora in springs like Dubnagin, Himalinag and Naranag can be attributed to the different but suitable micro-environments or habitats within these springs and also greater water discharge, area and good water quality, an observation also made by other workers (Cantonati*et et al*., 2006; Scarsbrook *et al*.,2007; Staudacher and Füreder, 2007; Bhat and Pandit, 2010).

The Bray Curtis cluster analysis yielded the results of the study sites into three groups having certain similarity with each other (Fig. 6). Himalinag had less than 50% similarity with rest of the springs while as Malakhnag, Parinag, Naranag, and Dubnagin had more than 50% similarity with each other. Similarly Kirkadalnag and Batnagin had nearly 50% similarity with each other.

Table 2: Composition of different species of phytoplankton at different sites

Species	Himalinag	Malakhnag	Kirkadalnag	Parinag	Dubnagin	Naranag	Batnagin
Chlorophyceae							
Binuclearia tatarana	+	+	+	+	+	+	+
Chara globularis	+	_	+	+	+	+	_
Chlormormidium rivularie	+	+	_	_	+	+	_
Chlorochytrium lemnae	_	+	_	+	+	+	_
***Chlorococum* sp.**	+	+	_	_	+	+	_
***Cladophora* sp.**	+	+	_	+	+	+	_
***Closterium* sp.**	+	+	+	_	+	+	+
***Cosmarium* sp.**	+	+	_	_	+	+	_
Draparnaldia glomerata	+	_	_	+	+	+	_
Gonalozygon kinahani	+	_	+	_	+	_	+
Hormidium subtile	+	+	+	+	+	+	+
Hydrodictyon indicum	+	_	_	+	+	+	_
Lamnea annulata	+	_	_	+	+	+	_
Oedogonium cripsum	+	_	_	_	+	+	_
Protococcus virdis	+	+	_	_	+	+	_
Rhizoclonium hieroglyphicum	+	+	+	_	+	+	+
Sphaeroplea annulina	+	_	_	+	+	+	_
***Spirogyra* sp.**	+	+	+	+	+	+	_
Spirogyra bullata	+	_-	-_	+	+	+	_-
Straurastrum chactoceras	+	_	+	+	+	_	_
Straustraum dilatum	+	+	_	+	+	+	_
Ulothrix cylindricum	+	_	_	+	+	_	_
Ulothrix zonata	+	+	_	+	+	+	_
Uronema elongatum	+	_	_	+	+	+	_
Zygnema stellinum	+	_	_	_	+	+	_
Bacillariophyceae							
Caloneis amphisbaena	+	+	_	+	+	+	_
Cerotoneis arcus	+	+	+	+	+	+	+
Cocconeis placentula var.	+	_	_	+	+	+	_
Cylotella opercalata	+	+	_	_	+	+	_
Cymatopleura elliptica	+	_	_	+	+	+	_
Cymbella cistula	+	_	+	+	+	+	_
Diatomella balfouriana	+	+	+	+	+	+	+
Diatomella tabelleria	+	+	_	+	+	+	_
Diploneis eliptica	+	_	_	+	+	+	_
***Fragillaria* sp.**	+	+	_	+	+	+	_
Gramatophora marrina	+	_	+	+	+	_	_
Gymphonema gracile	+	+	+	+	+	+	+
Liemophora angliea	+	_-	+	+	+	+	_-
Melosira granulata	+	_	_	_	+	+	_
Meridion circulare	+	+	_	+	+	+	_
Navicula cincta	+	+	+	+	+	+	_
***Navicula* sp.**	+	+	+	+	+	+	+
Nitzchia angularis	+	+	+	+	+	+	_
Nitzchia microcephala	+	_	_	_	_	+	_
Nitzchia travicularis	+	+	+	+	+	+	_
Synedra voucheria	+	_	_	+	+	+	_
Synedra acus	+	+	_	+	+	+	_
Synedra ulna	+	+	_	+	+	+	+
***Tabellaria* species**	+	+	_	+	+	+	_
Cyanophyceae							
Anabena affinis	+	+	_	+	+	+	_
***Anacystis* species**	+	_	_	+	+	+	_
Gleotrichia pisum	_	+	_	_	+	+	_
***Lyngbya* sp.**	+	+	_	+	+	+	_

Cont. Table 2

Lyngbya subtulis	+	+	_	+	+	_	_
Merismopodia elegans	+	_	_	+	+	+	_
Merismopodia tenuissima	_	_	_	_	+	_	_
Microspora amoena	+	+	+	+	+	+	+
***Microspora* sp.**	+	+	+	+	+	+	_
Nodularia laxa	+	_	_	_	_	+	_
Nostoc linckia	+	+	_	+	+	+	_
Nostoc verrucosum	+	+	_	+	+	+	_
Oscillatoria limosa	+	+	_	+	+	+	_
Oscillatoria redeki	+	+	_	+	+	+	_
Oscillatoria linkia	+	+	_	_	+	+	_
Oscillatoria tenuis	+	+	+	+	+	+	_
Phormidiuma utumnale	_	_	_	_	+	+	_
Euglenophyceae							
Euglena acus	+	_	_	+	+	_	_
TOTAL	**63**	**40**	**21**	**50**	**65**	**60**	**11**

Present = + ; Absent = -

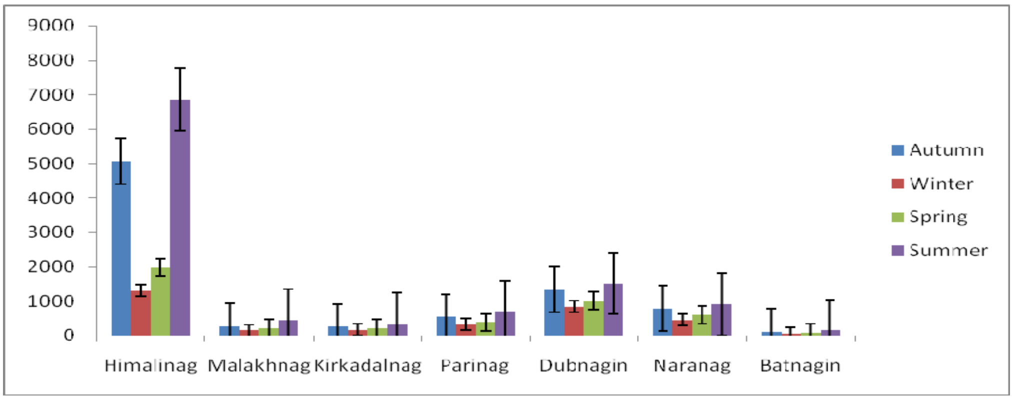

Fig. 2: Seasonal variation in density (No. of ind.cm^{-2}) of Chlorophyceae (phytoplankton) during different seasons

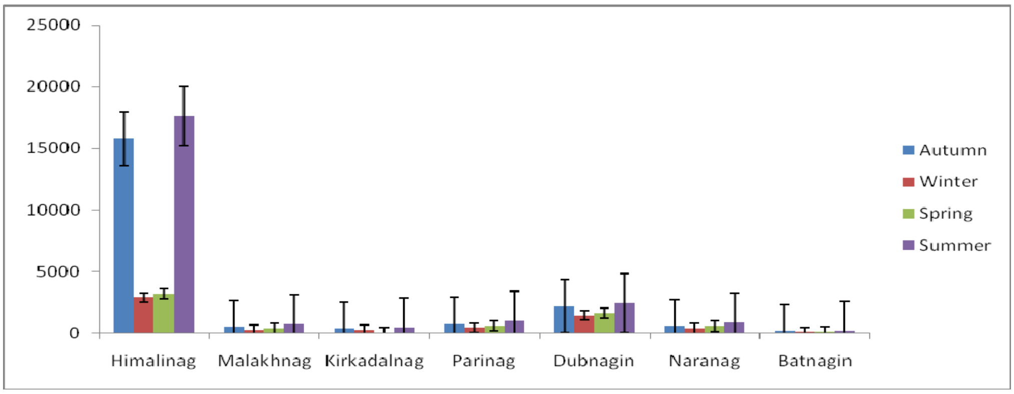

Fig. 3: Seasonal variation in density (No. of ind.cm^{-2}) of Bacillariophyceae (phytoplankton) during different seasons

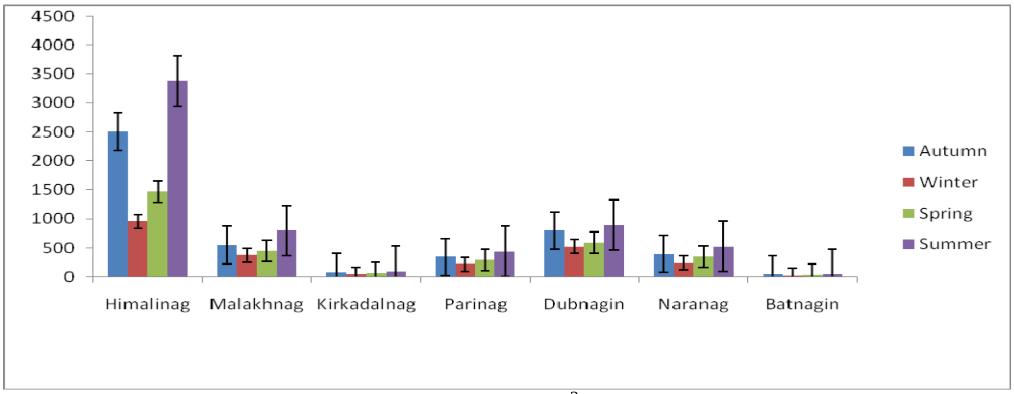

Fig. 4: Seasonal variation in density (No. of ind.cm^{-2}) of Cyanophyceae (phytoplankton) during different seasons.

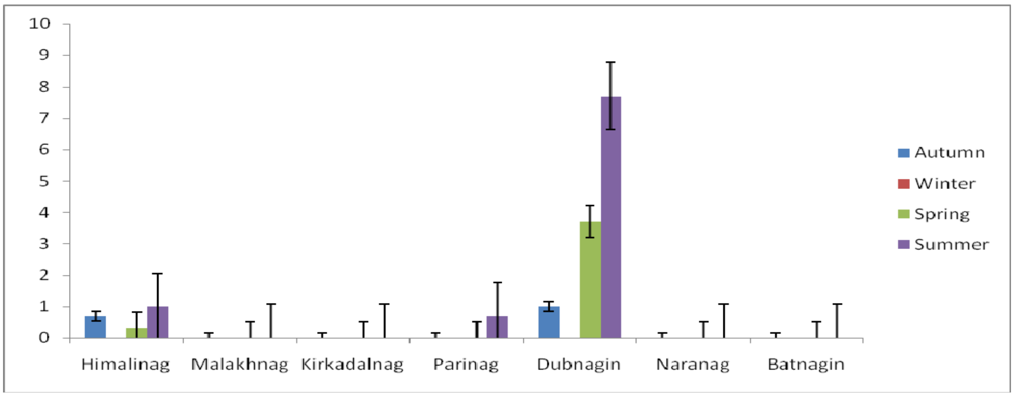

Fig. 5: Seasonal variation in density (No. of ind.cm^{-2}) of Euglenophyceae (phytoplankton) during different seasons.

The three diversity indices viz. Shanon, Margalef and Alpha were maximum at Naranag and minimum at Batnagin (Table 3) which might be due to shading effect (Padisak *et al.*, 2006; Kalff, 2002). The low value of indices at Batnagin is because of it being a rheocrene type of spring (water gushes out directly outside) while as other springs are limnocrene (water oozes from bottom). This might be also a reason that the former maintains the lower value of diversity indices. High species diversity values usually reflect diverse and well-balanced communities, while low values indicate stress or impact (Bode *et al.*, 2002). Naranag thus exhibits diverse and well balanced communities than the other springs where low values indicate very little of pollution as evidenced by stress or impact (Bode *et al.*, 2002). The most important stresses in these springs are through organic enrichments, nutrients, pesticides, herbicides and washing clothes.

Table 3: Diversity indices of phytoplankton species at different studied sites

	Himalinag	**Malakhnag**	**Kirkadalnag**	**Parinag**	**Dubnagin**	**Naranag**	**Batnagin**
Taxa_S	63	40	20	49	65	60	11
Individuals	15759	1288	651	1489	3803	1659	271
Shannon_H	3.578	3.488	2.88	3.794	3.88	4.01	2.173
Margalef	6.415	5.446	2.933	6.57	7.764	7.958	1.785
Fisher_alpha	8.352	7.829	3.904	9.727	11.14	12.19	2.303

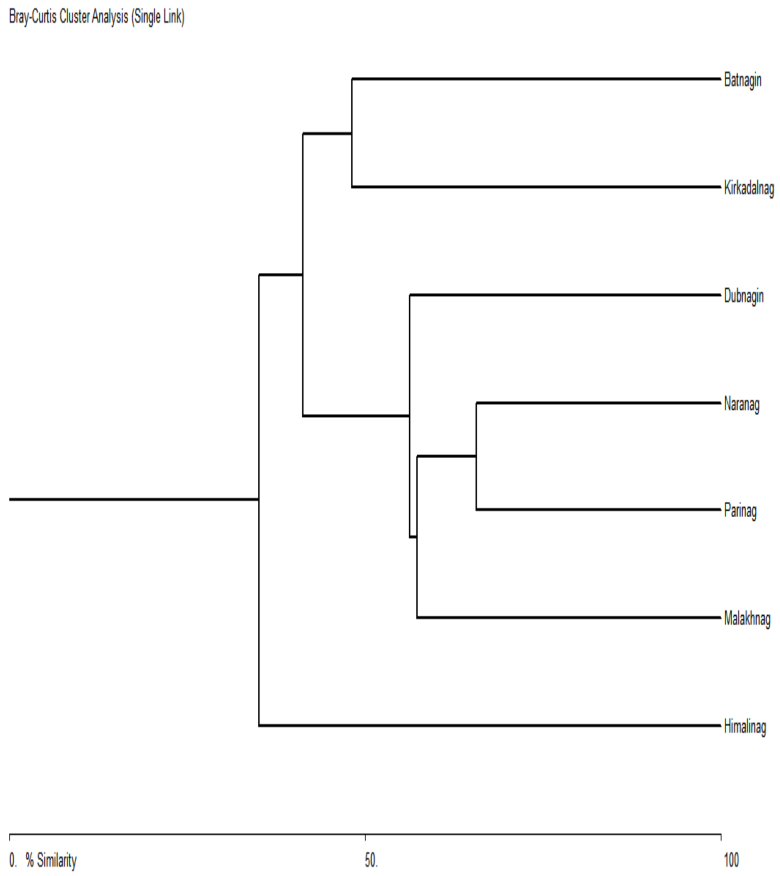

Fig. 6: Dendrogram showing clustering in the respective study sites

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