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DYNAMICS OF PERIPHYTIC ALGAE IN SOME CRENIC HABITATS OF DISTRICT ANANTNAG, KASHMIR

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ABSTRACT

The study pertains to the diversity patterns of periphytic algal assemblages of seven springs subjected to different anthropogenic stresses. The periphytic algal community during September 2010 to August 2011 revealed a total of twenty three species belonging to three algal classes: Chlorophyceae (6), Bacillariophyceae (12) and Cyanophyceae (5). The most dominant species in the algal community were *Rhizoclonium* sp., *Diatomella balfuriana, Navicula* sp., and *Oscillatoria limosa.* During the present study maximum number of species was obtained at Dubnagin (23), followed by Naranag (19), Parinag (17), Himalinag (15), Malakhnag (10), Batnagin (10) and decreasing to the minimum of 9 species at Kirkadalnag. Among the various periphytic classes, Bacillariophyceae dominated qualitatively both in diversity and density at each spring being followed by Chlorophyceae and Cyanophyceae.

Key words: Springs, periphyton, algae, Chlorophyceae, Bacillariophyceae, Cyanophyceae

INTRODUCTION

Crenic vegetation is typically composed of a mixture of vascular plants and bryophytes, with the former prevailing in shaded sites at lower altitudes and the latter dominating the communities of open habitats from the subalpine to alpine vegetation belts (Zechmeister and Mucina 1994). Vegetation diversity in springs is primarily determined by a combination of interacting physical and chemical factors. Of the physical factors, solar radiation, water temperature and current flow velocity play a major role in determining floristic diversity and structure in crenic vegetation (Hinterlang, 1992).

In natural landscapes springs have a propensity to control diversity, not only by allowing diversification of submerged fauna and flora but also because of their significance for terrestrial communities developing around them. The degree to which the presence and variety of inland waters shape natural diversity in an area varies considerably depending on the climatic conditions. Under various hydro-chemical profiles and anthropogenic stresses these springs tend to display, in a diversified manner, in the form of diversity and richness of species.

Due to their particularly stable physico-chemical conditions, crenic habitats play a key role in this scenario (Cantonati *et al.,* 2006). Springs fed by larger, deeper aquifers are very stable, and are particularly appropriate and useful for long-term observations (Cantonati and Ortler, 1998; Cantonati *et al.,* 2006). However, crenic habitats are very heterogeneous environments and, despite being mostly small, are numerous and widespread in many areas. There is ample variability in the main morphological, physical, and chemical determinants (permanent/temporary, fast current/still water etc.) and their combinations to

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generate a highly diverse set of conditions which might be responsible for the overall existence of periphytic algae in the springs. In this context an attempt was made study the dynamics of periphytic algae of hydrochemically different set of springs in the Anantnag district of Kashmir Valley.

STUDY AREA

Seven springs in district Anantnag of Kashmir valley were chosen for carrying out the present study. The name Anantnag by itself means countless springs and the name fits the district suitably. The district hosts a large number of beautiful springs that add to its pristine beauty, by bringing life to many rivers, rivulets, nallahs and streams, besides providing clear water all over the district. Most of the springs have been extensively modified by man because of housing development and as such three out of seven springs under investigation are affected, hiding their original form of resurgence which makes the detailed study somewhat difficult. Seven springs in three tehsils of district Anantnag were selected for the study: two in Anantnag tehsil (Himalinag and Malakhnag), two in Bijbehara tehsil (Kirkadalnag and Parinag) and three in Pahalgam tehsil (Dubnagin, Naranag and Batnagin). The coordinates of sites are given as below (Figure 1) (Table 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

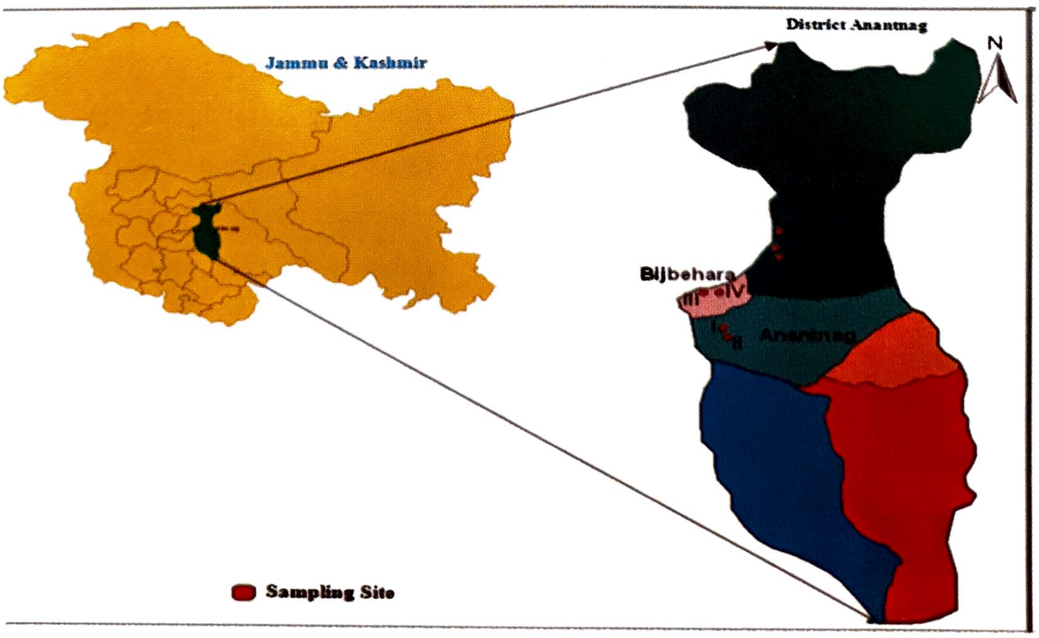

Fig.1. Map showing location of seven springs in District Anantnag of Kashmir in J&K state.

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MATERIAL AND METHODS

The stones of different sizes were picked up from the bottom of springs and a desirable definite area was marked on the stones. The periphyton from the marked area was scraped with the help of scalpel and brushes and mixed with small amount of water and then labeled into the container. Periphyton samples were preserved in 5% formalin or Lugol's solution (10gm pure iodine + 20gm potassium iodide+200cc distilled water to 200cc glacial acetic acid).

The identification of the samples was carried out with the help of taxonomical works of Prescott (1939), Nygard (1945), Smith (1950), Edmondson (1959), Cox (1996) and Biggs and Kilroy (2000).

For counting the population of periphytic algae the preserved samples were either diluted or centrifuged in 100 ml or other suitable volume depending on the ease of counting process. 1 ml of aliquot was transferred to a Sedgwick Rafter cell and analyzed under compound microscope; the organisms were then counted within a known number of strips. The unicellular algae were counted as individuals while for filamentous Cyanophyceae 100μm length of the filament was taken as one individual. Similarly filamentous Chlorophyceae were counted as cells.

RESULTS AND DISCUSSION

During the entire study on seven springs only 23 species of periphytic algae belonging to Chlorophyceae (6 species), Bacillariophyceae (12 species), Cyanophyceae (5 species) were found. Among the various periphytic classes Bacillariophyceae dominated qualitatively at each spring, followed by Chlorophyceae and Cyanophyceae. However,among the various springs the maximum number of species was obtained at Dubnagin (23), followed by Naranag (19), Parinag (17), Himalinag (15), Malakhnag (10), Batnagin (10) and decreasing to the minimum of 9 species at Kirkadalnag(Table 2). The presence of maximum taxa at Dubnagin might be due to low discharge of the spring. The statement is supported by the findings of Reisen (1976) and Albay and Aykulu (2002). This diversity pattern of periphytic algae in most of the springs is the result of substrate homogeneity, inviting less number of taxa for colonization. The characteristic diversity and distribution pattern of periphytic algae in the springs also seems related to terrestrial canopy coverage along the shoreline areas of spring-fed ecosystems that may reduce the incident light to a level that restricts the abundance and distribution of algae. The visual study of terrestrial canopy coverage was found to be more in Naranag, Kirkadalnag, Parinag, Malakhnag and Himalinag than others but we could not find any categorization of springs on the basis of shading effect on the periphytic algal diversity pattern. However, Naranag having relatively higher flow rates was dominated by Bacillariophyceae as these mucilaginous diatoms are resistant to sloughing unlike the long filamentous algal species thriving at low flow rates (e.g., Dubnagin), a fact also revealed by Biggs *et al*. (1998). The constancy in the dominance pattern of certain taxa like *Rhizoclonium* sp., *Diatomella balfuriana, Navicula* sp., and *Oscillatoria limosa* provides the clue about the relatively constant environmental conditions at these seven springs.

On temporal basis also, the dominance pattern of different taxa was almost identical throughout the year. The composition of periphytic community varied to a little extent among different springs and it is expected to vary temporarily due to seasonal differences in light availability and also to very little by substrate composition. This is well illustrated by the density data of different springs during various seasons. Thus, Malakhnag showed less density (No. of ind./cm^2) of Chlorophyceae (17) and Bacillariophyceae (66) during winter as compared to Dubnagin (150) and Naranag (442) for Chlorophyceae and Bacillariophyceae classes respectively during summer. Similarly, Malakhnag showed high density of Cyanophyceae (183) during summer as compared to Kirkadalnag which showed minimum density (24) of blue greens during winter (Tables 3-5). The overall dominance of Cyanophyceae at Himalinag and Dubnagin may be due to relatively higher nutrient status of the springs as a result of pollution loads through agriculture wastes, and input of sewage from domestic usage of water like washing of clothes and bathing.

The growth and development of periphytic algae in the present study revealed the peak growth during summer and autumn seasons in accordance to other studies (Oleksowicz, 1982; Laugaste and Reunanen, 2005).This is quite expected as optimum temperature is known to enhance the reproduction of organisms in aquatic biotopes. The same very reason explains the summer maximum of periphytic density being related to higher water temperature and life cycle, a view point also held by Muller (1994) and Bhat and Pandit (2010).

Table 2. Composition of different species of periphyton at different sites

Sites	Himalinag	Malakhnag	Kirkadalnag	Parinag	Dubnagin	Naranag	Batnagin
			Chlorophyceae				
Cosmarium formasulum	+	+	–	+	+	+	–
***Cladophora* sp.**	–	–	–	+	+	+	–
***Rhizoclonium* sp.**	+	+	+	+	+	+	+
***Spirogyra* sp.**	–	–	–	+	+	+	+
Ulothrix *rorida*	+	–	–	–	+	–	–
Ulothrix zonata	+	–	+	+	+	+	+
			Bacillariophyceae				
Certoneis arcus	+	–	+	+	+	+	+
Cyclotella opercalata	–	–	–	–	+	–	–
Diatomella balfouriana	+	+	+	+	+	+	+
***Fragillaria* sp.**	–	–	–	+	+	+	–
Gymphonema gracile	–	–	–	+	+	+	+
***Navicula* sp.**	+	+	+	+	+	+	+
Nitzischia angularis	+	+	+	+	+	+	–
Nitzischia							

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travicularis	+	+	+	+	+	+	–
Synedra voucheria	+	+	–	–	+	+	–
Surirella ovata	+	–	–	–	+	+	+
Synedra acus	+	+	+	+	+	+	–
Synedra ulna	+	–	–	+	+	+	–
			Cyanophyceae				
Lyngbya subtulis	–	–	–	–	+	–	–
Microspora amoena	–	–	–	+	+	+	+
***Nostoc* sp.**	–	–	–	–	+	+	–
Oscilatoria redekei	+	+	–	+	+	–	–
Oscillatoria limosa	+	+	+	+	+	+	+
No of species	**15**	**10**	**9**	**17**	**23**	**19**	**10**

+ = present; - = absent

Table 3. Seasonal variation in density (No. of ind.cm^{-2}) of Chlorophyceae in different springs

Sites	Autumn	Winter	Spring	Summer
Himalinag	81.0	51.0	66.0	102.7
Malakhnag	24.3	17.0	21.0	30.7
Kirkadalnag	29.0	21.0	22.7	31.3
Parinag	76.3	57.7	92.7	139.7
Dubnagin	127.7	91.7	113.0	150.0
Naranag	90.0	68.3	98.3	129.7
Batnagin	32.3	25.3	28.7	38.0

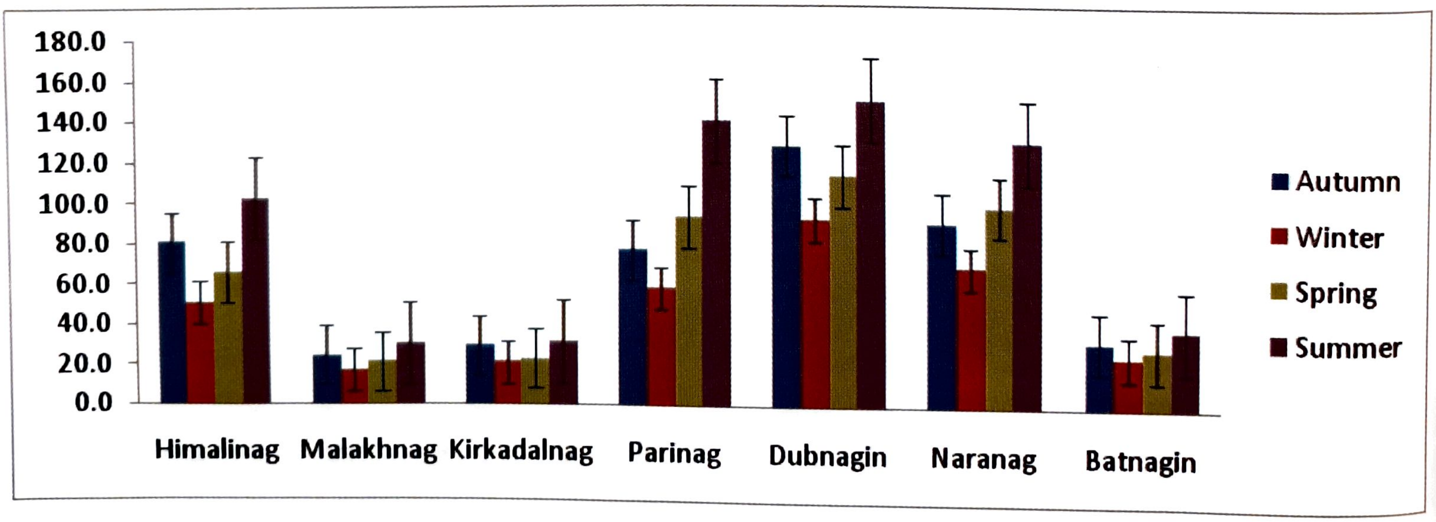

Fig.3. Seasonal variation in density (No. of ind.cm^{-2}) of Chlorophyceae in different springs

Table 4. Seasonal variation in density (No. of ind.cm^{-2}) of Bacillariophyceae in different springs

Sites	Autumn	Winter	Spring	Summer
Himalinag	342.0	234.3	284.0	387.0
Malakhnag	105.7	66.7	69.3	125.3
Kirkadalnag	109.0	75.0	89.3	130.3
Parinag	167.0	119.3	175.0	266.0
Dubnagin	348.3	261.7	317.3	437.0
Naranag	379.0	276.7	323.3	442.7
Batnagin	122.0	85.7	103.7	151.3

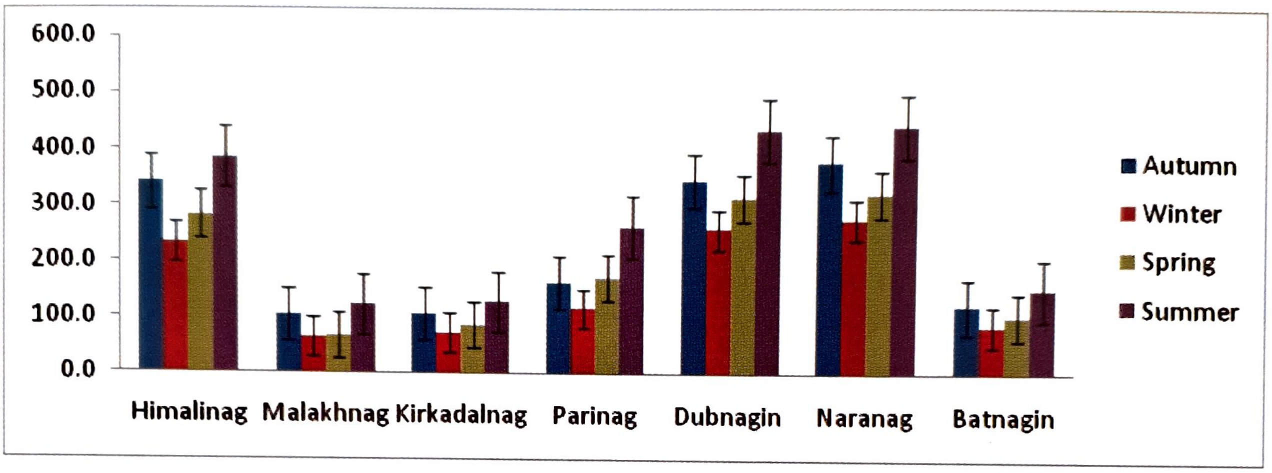

Fig.4. Seasonal variation in density (No. of ind.cm^{-2}) of Bacillariophyceae in different springs

Table 5. Seasonal variation in density (No. of ind.cm^{-2}) of Cyanophyceae in different springs

Sites	Autumn	Winter	Spring	Summer
Himalinag	107.3	113.3	126.7	183.3
Malakhnag	72.0	48.7	53.7	80.0
Kirkadalnag	32.3	24.3	34.7	48.3
Parinag	74.0	54.0	68.7	94.0
Dubnagin	106.3	74.0	94.7	140.3
Naranag	78.0	58.7	66.0	90.7
Batnagin	38.0	28.3	31.3	38.7

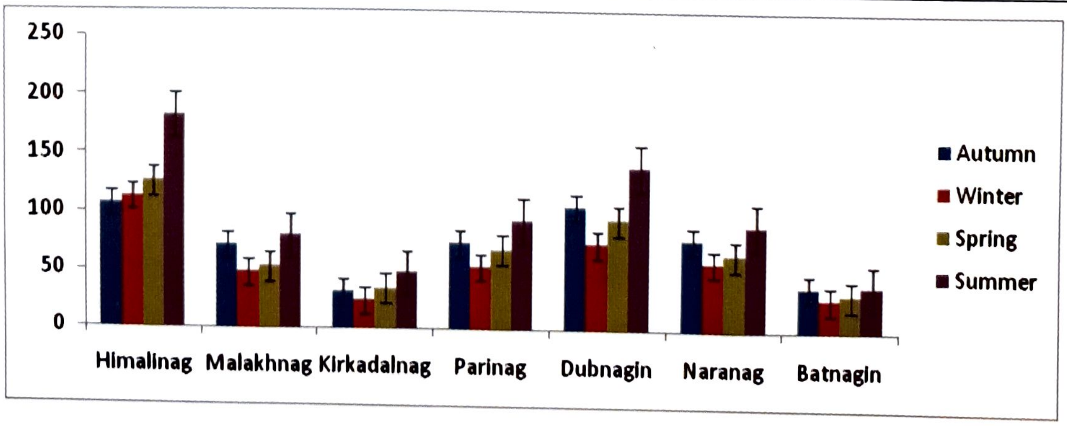

Fig.5. Seasonal variation in density (No. of ind.cm^{-2}) of Cyanophyceae in different springs

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