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RESEARCH ARTICLE

SEASONAL VARIATION IN PERIPHYTONIC COMMUNITY IN MOUNTAIN SPRINGS OF SAHASHRADHARA, GARHWAL HIMALAYAS

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ABSTRACT

Sahashradhara springs, a group of one thousand springs and one of the prominent tourist spot, is located in Doon Valley of Garhwal-Himalayas. The environmental monitoring of periphyton community of Sahashradhara springs was carried out for a period of one annual cycle (October 2011-September 2012). A total of 29 species belonging to three annual classes: Bacillariophyceae (14), Chlorophyceae (11) and Cyanophyceae (04) were recorded from different springs of Sahashradhara. Among the various periphyton community the dominance and density of Bacillariophyceae was found maximum followed by Chlorophyceae and Cyanophyceae. Members of Cyanophyceae were found absent during monsoon season.

INTRODUCTION

The stability of their chemical characteristics and temperature makes springs a unique class of habitat, distinct from any other freshwater ecosystem. Usually small in size, springs have high ecological value (Odum, 1971). Springs are considered to be ‘hotspots’ for aquatic biodiversity as these habitats are three way ecotone between groundwater, surfacewater and terrestrial ecosystem (Williams and Williams, 1998; Cantonati *et al.* 2006).

A voluminous literature on the limnology of springs at international level is available (Sabater and Roca 1990, 1992; Williams, 1991; Roca and Baltanes, 1993; Zechmeister and Mucina, 1994; Botosaneanu, 1998; Cantonati, 1998; Stoch, 2001; Di Sabatino *et al.*, 2003; Cantonati *et al.* 2006, 2012; Wojtal, 2006; Taxbock and Perisig, 2007; Cantonati and Spitale 2009; Glazier, 2009; Wojtal and Solak, 2009; Angeli *et al.*, 2010; Tomaselli *et al.*, 2011; Martin and Brunke, 2012; Abdelsalam and Tanida, 2013). But only few reports on some geological and limnological aspects of the springs of the Kashmir valley (Saha *et al.* 1978; Qadri and Yousuf, 1979, 1988; Pandit *et al.* 2001; Bhatt and Yousuf, 2002; Bhat and Pandit, 2010) in India are available. Unfortunately, no work has been done so far on the in-depth study of biodiversity and physico-chemical stability of springs of Garhwal Himalayas. It was, therefore thought worthwhile to investigate periphytonic community of mountain of Sahashradhara of Garhwal Himalayas.

Study Area

Sahashradhara (meaning cluster of thousand fold springs) is situated at 13 km away from the Dehradun city, the capital of Uttarakhand state, India. The Sahashradhara, a prominent place of tourists, is one of the most important clusters of helocrenes, limnocrenes and rheocrenes types of springs located in Doon Valley of Garhwal-Himalayas. It lies on 30°38’N latitude and 78°13’ E longitude. A total of five clusters of springs were selected as a representative subset (S_1, S_2, S_3, S_4 and S_5) of the area for study

MATERIAL METHOD

Regular monthly sampling for analyzing the biotic components of periphyton of the Sahashradhara springs was undertaken at each site (S_1, S_2 S_3, S_4 and S_5) for one annual cycle (October 2011- September 2012). Five replicates were obtained for each parameter and the results were integrated and recorded. Collection of periphytonic community in three replicates was done by scratching one cm^2 of the substratum (bottom substratum). The scratched material was preserved in 4% formalin. Counting of periphyton was done using the Sedgwick-Rafter counting chambers after their identification

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with the help of standard taxonomic works of Fassett (1997), Fritsch (1945), Prescot (1962), Patric and Reimer (1966), Cleve-Euler (1968), Palmer (1968), Wetzel, (1979), Ward and Whipple (1992) and APHA (1998).

RESULT AND DISCUSSION

The ecosystem of the Sahashradhara springs constitute of bottom substrate ranging from sand to big boulders but lack silt and clay. During the entire study only 29 species belonging to Bacillariophyceae (14 species), Chlorophyceae (11 species) and Cyanophyceae (04 species) were found. Among the various periphytic classes Bacillariophyceae dominated qualitatively at each site, followed by Chlorophyceae and Cyanophyceae respectively. On seasonal basis, the dominance patterns of different taxa at all the five sites were identical. During monsoon seasons the species of Cyanophyceae were found absent.

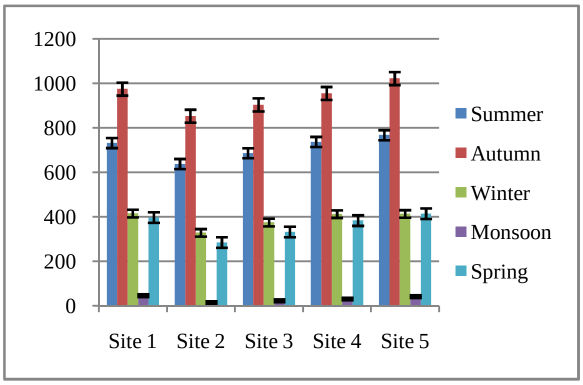
Table 1 List of periphyton in all the five sites of the Sahasradhara springs during study period

Periphyton	S_1	S_2	S_3	S_4	S_5
Bacillariophyceae					
Achnanthes minutissima Kützing, 1844	+++	++	++	++	+++
Amphora ovalis Kützing, 1844	+++	++	++	++	+++
Cocconeis placentula Ehrenberg 1838	++	++	++	++	++
Cymbella aequalis Fontell, 1917	++	+	+	+	+
Diatoma vulgaris Bory 1824	+++	++	++	++	+++
Fragilaria inflat, Pantocsek 1902	+++	+	+	+	+++
Frustulia rhomboides (Ehrenberg) De Toni 1891	+	+	+	+	+
Gomphonema geminate, (Lyngbye) C.Agardh 1824	+	+	+	+	+
Pinnularia interrupta W.Smith, 1853	++	+	+	+	+++
Navicula radiosa Kützing 1844	++	++	++	++	+++
Nitzschia diversa Hustedt 1959	+++	+	+	+	+++
Nodularia moravica Hindák, Smarda and Komárek 2003	++	+	+	+	++
Synedra ulna, (Nitzsch) Ehrenberg 1832	+++	+	+	+	+++
Tabellaria fenestrate (Lyngbye) Kützing 1844	+	+	+	+	++
Chlorophyceae					
Cladophora glomerata (Linnaeus) Kützing 1843	+++	+	+	++	++
Closterium longissima (Ehrenberg) Van Heurck 1885	+++	+	+	++	+++
Cosmarium granatum Fritsch 1921	++	++	+	+	+
Desmidium aptogonum Kützing 1849	++	++	+	+	++
Gonatozygon sp.	+	+	+	+	+
Hydrodictyon reticulatum (Linnaeus) Bory de Saint-Vincent 1824	+	+	+	+	+
Microspora sp.	++	++	+	+	++
Odegonium sp.	+	+	+	+	+
Spirogyra orientalis West and G.S.West 1907	+++	++	++	+++	+++
Ulothrix zonata (Weber and Mohr) Kützing 1843	++	+	+	+	++
Volvox sp.	+	++	++	+	+
Cyanophyceae					
Anabaena ambigua C.B.Rao 1937	++	+	+	+	+
Chroococcus urgidus (Kützing) Nägeli, 1849	+	++	++	+	+
Oscillatoria tenuis , C.Agardh ex Gomont 1892	+	++	++	++	+
Phormidium lucidum Kützing ex Gomont1892	++	+	+	+	+

+++ Abundant; ++ Common; + Rare

Table 2 Seasonal variations in density (No. of ind. m^{-2}) of Bacillariophyceae at different sites

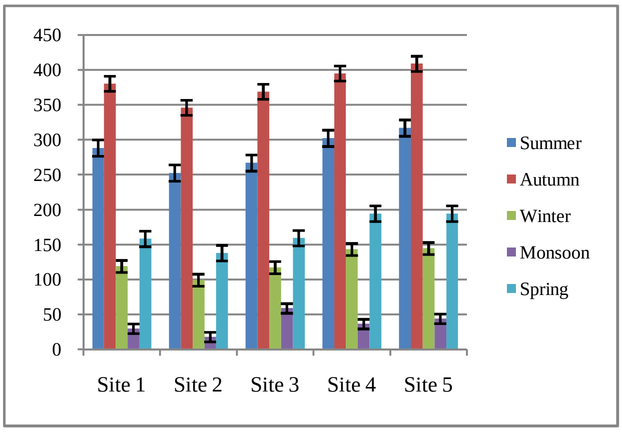
Site	Summer	Monsoon	Autumn	Winter	Spring
S_1	732.33	47	975	415.67	397.5
S_2	638	15	853	329	285.5
S_3	686.67	24	904	375.33	332.5
S_4	737.33	32	955	413	384
S_5	767.67	42.5	1022.5	413.67	415



Graph 1 Seasonal variations in density (No. of ind. m^{-2}) of Bacillariophyceae at different sites

Table 3 Seasonal variations in density (No. of ind. m^{-2}) of Chlorophyceae at different sites

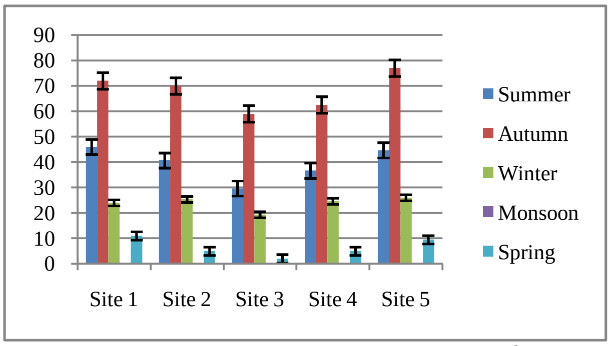
Site	Summer	Monsoon	Autumn	Winter	Spring
S_1	288.33	30	380.5	119	158.5
S_2	252.67	18	346	99.33	138
S_3	267	59	369	117.33	159.5
S_4	302.33	36.5	395	143.33	194.5
S_5	317	44	409	144.67	194.5



Graph 2 Seasonal variations in density (No. of ind. m^{-2}) of Chlorophyceae at different sites

Table 4 Seasonal variations in density (No. of ind. m^{-2}) of Cyanophyceae at different sites

Site	Summer	Monsoon	Autumn	Winter	Spring
S_1	46	0	72	24	11
S_2	40.67	0	70	25.33	5
S_3	29.67	0	59	19.33	2
S_4	36.67	0	62.5	24.67	5
S_5	44.67	0	77	26	9.5



Graph 3 Seasonal variations in density (No. of ind. m^{-2}) of Cyanophyceae at different sites

The springs are unique in their characteristics; specific aquatic microecosystems; the contact zone of the above ground and underground of hydrosphere, and refugia of rare and relict species of aquatic organisms (Takhteev *et. al.* 2010).

Presence of highest density of periphyton community at S_5 followed by S_1 may be due to low discharge of the springs at these sites. The statement may be supported by the findings of Reisen (1976) and Albay and Aykulu (2002). When compared to structurally simple substrates, such as a sand and bedrock, the physical substrate types (leaves, gravel, wood and macrophytes) generally support more diversity (Angradi 1996; Hawkins 1984). This can be a good explanation for the high abundance and diversity of periphyton at sampling S_5, which has high macrophyte growth.

Bacillariophyceae, mucilaginous diatoms are resistant to sloughing when compared to long filamentous algal species which can only thrive at very low flow rate (Biggs *et al.* 1998). This can be the reason for high density of species of Bacillariophyceae. Constancy in the dominance pattern of certain taxa results from the physico-chemical stability of springs, a fact well supported by Lone *et.al.* (2013).

In accordance with the studies conducted by Oleksowics (1982), Laugaste and Reunanen (2005) the periphyton community showed maximum growth during autumn and summer. This was rather predictable as optimum temperature enhances the reproduction of organism in any aquatic biotopes. High water temperature during summer can be the possible cause of high periphytic density (Muller, 1994; Bhatt and Pandit, 2010; Lone *et.al.* 2013).

CONCLUSION

Despite the relative homogeneity of the springs under investigation, periphyton diversity was found to be considerably high. The diversity variations were observed was not only between springs but also in different seasons. It is concluded the basis of the present study undertaken on periphyton diversity of Sahashradhara springs that the members of the Bacillariophyceae thrive well in the Sahashradhara Springs. Therefore, these can be used as the most appropriate and efficient bio-indicators for assessing the health of the important aquatic ecosystem. Thus, keeping in view the typical characteristics springs and survival of the fittest indicator species in Sahashradhara springs, the conservation and management of aquatic biodiversity of Sahashradhara should be taken on priority basis.

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