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Ecology, Distribution Pattern, Density and Diversity of Periphyton in Khankra Spring Fed Stream of Garhwal Himalaya, India

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Abstract: Periphyton are the principal primary producers of the aquatic river ecosystems. Present paper deals with the study of ecological characteristics and the periphytic algal community of the Khankra stream of Garhwal Himalaya. During the investigation it was found that the periphytic algal community of Khankra stream was represented by 21 taxa belonging to 3 major classes namely Bacillariophyceae (*Amphora sp., Bacillaria sp., Cymbella sp., Diatoma sp., Fragilaria sp., Gomphonema sp., Navicula sp., Synedra sp. and Tabellaria etc*), Chlorophyceae (*Cladophora, Closterium sp., Microspora sp., Oedogonium*, *Spirogyra sp., Ulothrix sp*., *Volvox sp. and Zygenema sp.)* and Cyanophyceae (*Anabeana sp., Calothrix sp., Nostoc sp., and Rivularia sp).* Relationships of some important ecological parameters with periphytic community are also discussed.

Keywords: Ecology • Periphyton • Khankra Stream • Garhwal Himalayas

Introduction

Headwater streams are important freshwater ecosystems of the Himalayas. Periphyton in stream and river are important components of aquatic ecosystem, providing food for aquatic organisms. These freshwater ecosystems are nurseries of primary production due to high clarity of water. They are the initial biological components from which the energy is transferred to higher organisms through food chain. Periphyton community structure, species composition and succession respond to environmental condition and thus can be utilized to classify water ways. Changes in physico-chemical parameters of ecosystems have a substantial impact on the dynamics and structure of species that live within them. Seasonal variations in these parameters have an important role in the distribution, periodicity and quantitative and qualitative composition of freshwater biota. Though huge amount of literature on the limnology of springs at international level is available (Di Sabatino et al., 2003; Wojtal and Solak, 2006 and Angeli et al., 2010). Similar studies on some geological and limnological aspects of the springs of the Kashmir valley are available with the work of Bhat and Pandit (2010) and Bhatt and Yousuf (2002). In Uttarakhand the

available references are Dobriyal and Kotnala (1993), Dobriyal et al., (1999), Balodi et al. (2004), Balodi et al., (2014 & 2015), Chauhan and Sharma (2015) and Koshal et al., (2016), Baluni et al. (2017). It was considered desirable to investigate the periphyton community of mountain stream Khankra Gad of Garhwal Himalayas.

Material and Methods

Khankra Gad is an important spring fed stream originating from the Bansoun peak (Latitude 30.24°21′82″ E, Longitude 78.91°96′92″ N) in the Garhwal region. The physic-chemical analysis of 2 sites was done as per standard Method recommended by APHA (2005). Stones of different sizes were picked up from the bottom of stream and known area (1cm^2). The periphyton from the marked area (1cm^2) were scrapped with the help of scalpel and brushes and mixed with small amount of water and then preserved in 5% formalin solution for further analysis to be done in laboratory. The counting was done with the help of Sedgwick- Rafter counting slide using following formula

$$n = (a \times 1000) \times c$$

Where, n = number of units of Periphyton / cm^2, a = average number of periphyton in a cubic millimeter capacity and c = Concentration prepared in ml.

Photo micrographic images of phytoplankton were analyzed with the help of Stereo Zoom Trinocular Microscope with Tucsan camera attachment. The identification of the sample was carried with the help of taxonomical works of Prescott (1939 a & b), Patric and Reimer (1966), Palmer (1968), Desikachary (1959) and Ward and Whipple (1992).

Result and Discussion

The average ecological parameters of Khankra Gad (spring fed) are presented in Figure 1 to 5. Maximum water temperature was recorded in the month of September (21.3 ± 0.25°C) and minimum in the month of February (12.7 ± 0.11°C). Brown and Hannah (2008) suggested that temperature is recognized as a major role player for species distribution in spring water. Maximum abundance of periphyton was observed during December and January month in the Khankra Gad springs, which may be due to increased growth efficiency of periphyton during this period in addition to favorable physico-chemical attributes.

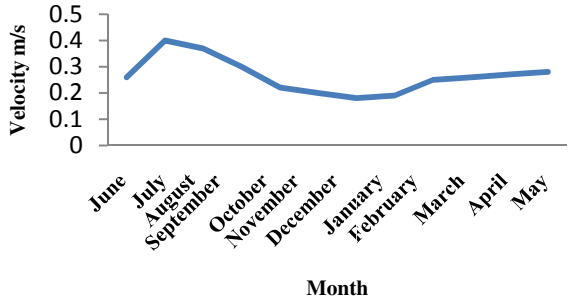

Figure 1 Monthly variation in the average velocity (m/s) of Khankra Gad stream**.**

Average water velocity showed fluctuations throughout the year with the maximum value in the month of July (0.40 ±0.04 ms^{-1}) whereas minimum value in the month of January (0.18 ±0.05 ms^{-1}). Mean turbidity was found to be highest in July (90.0 ±0.810 NTU) whereas and lowest in February (10.5±0.45 NTU). Welch (1952) and Dobriyal et.al. (1999) observed that the adverse effect of velocity and turbidity is always due to the blanketing bottom effect of suspended bottom material. Dobriyal et al., (1999) noticed that high turbidity during monsoon floods greatly reduced the light penetration which adversely affected the rate of photosynthesis.

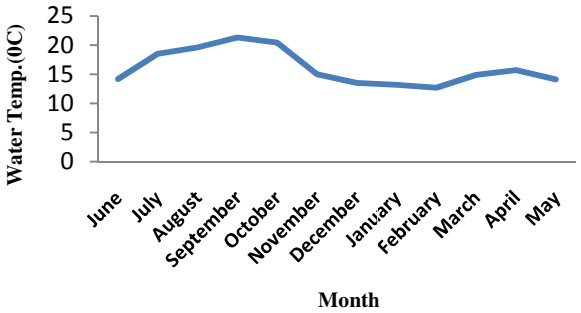

Figure 2 Monthly variation in the average water temperature of Khankra Gad stream

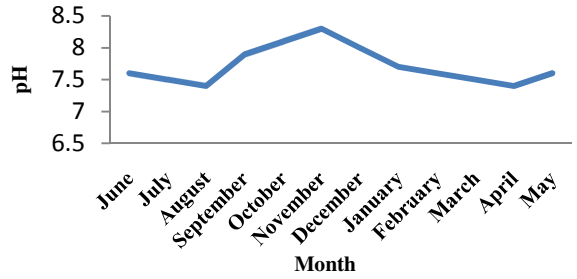

Figure 3 Monthly varition in the average pH of Khankra Gad stream.

Average lowest pH was recorded in the month of August (7.4 ± 0.60) and highest in the month of November (8.3 ± 0.40). Average dissolved oxygen was noticed maximum in the month of February (11.9± 0.25 mgl^{-1}) and minimum in the month of October (8.1± 0.55 mg l^{-1}). Average total Alkalinity was found to be lowest in the month of February (20.5± 1.80 mg l^{-1}) and highest in the month of November (34.0 ±2.30 mgl^{-1}). Cantonati (1998) also suggested that among various environmental factors, pH and conductivity are the most important factors influencing diatom assemblages. A minor change in hydro-chemical parameters can influence the primary production.

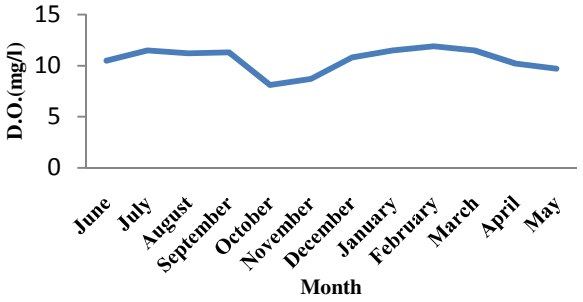

Figure 4 Monthly varaition in the average D.O. of Khankra Gad stream.

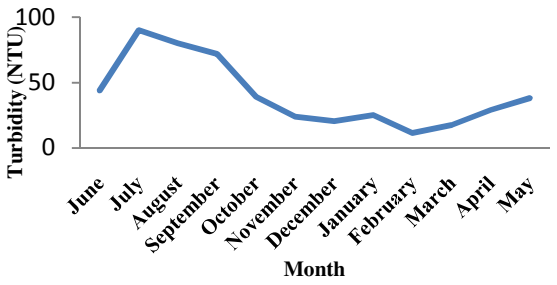

Figure 5 Monthly varaition in the average T.A. of Khankra Gad stream

The monthly mean variations in the density of periphyton observed for a year from Khankra Gad springs have been presented in the Table 1. The overall mean density of the periphyton was found to be highest number in the month of January (239.35±9.13 Units cm^{-2}) and minimum in the month of August (4.9±0.22 Units cm^{-2}). In the present study, density of periphyton was found to be decreasing from February to August. This may be due interaction of various physico-chemical parameters with periphyton.

The maximum number of periphytic concentration was noticed in the month of January (239.35± 9.13 Units cm^{-2}) which was attributed to diatoms (145.2±9.6 Units cm^{-2}), green algae (81.45±15.7 Units cm^{-2}) and blue green algae (12.7±2.10 Units cm^{-2}). The minimum number of periphyton was observed in August (4.9±0.22 Units cm^{-2}) which was dominated by the diatoms (4.9±0.22 Uunits cm^{-2}) but green algae and blue green algae were completely absent due to heavy monsoon period.

Table 1 Monthly average variations of periphytic algae of the Lastar Gad streams.

Months	Total numbers of periphyton units/cm^2.	Green algae	Blue green algae	Diatoms
June - 2017	118.5±4.5	42.8±7.21	5.10±0.71	70.6±4.3
July - 2017	8.75±3.5	nil	nil	8.75±3.5
August - 2017	4.9±0.22	nil	nil	04.9±0.22
September - 2017	70.20±3.4	25.20±3.55	3.2±0.50	41.8±4.1
October - 2017	177.95±5.8	48.57±7.1	75.1±6.2	54.28±4.20
November- 2017	196.52±5.4	74.9±6.1	36.30±2.9	85.32±7.20
December - 2017	208.21±8.87	74.61±5.2	9.3±3.15	124.30± 18.3
January - 2018	239.35±9.13	81.45±15.7	12.7±2.10	145.2± 9.6
February - 2018	217.9±3.95	87.9±3.54	9.9±0.90	120.1±7.4
March - 2018	170.3±3.59	62.5±6.24	5.1±0.58	102.7±3.94
April - 2018	153.15±2.28	66.9±3.05	4.05±0.78	82.2±3.01
May - 2018	133.55± 2.94	51.5±2.20	3.25±0.42	78.8±6.2

In the present work the annual percentage composition of periphytic flora of Khankra Gad (Figure 6) revealed that major contribution was made by Bacillariophyceae (54%) followed by Chlorophyceae (36%) and Myxophyceae (10%) (Fig.6). Bhatt and Yousuf (2002) observed periphytonic community of seven springs of Kashmir and noticed a total of 50 taxa of periphytic algal community of which 33 belonged to Bacillariophyceae, nine to Chlorophyceae, five

to Cyanophyceae, two to Chrysophyceae and one to Euglenophyceae.

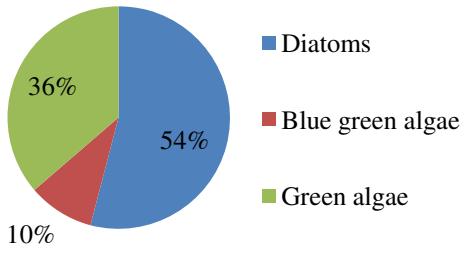

Figure 6 Percentage distribution of periphyton in Khankra Gad stream

Table 2 List of periphyton from Khankra Gad stream during study periods

S.No	Name of Periphyton	Sampling Site A	Sampling Site B
1	**Bacillariophyceae**		
	Amphora sp.	+	++
	Bacillaria sp.	+.++	+++
	Cymbella sp.	+++	+++
	Diatoma sp.	++	++
	Fragillaria sp.	+	++
	Gomphonema sp.	+	+
	Navicula sp.	++	+++
	Synedra sp.	+++	+++
	Tabellaria sp.	+	++
2	**Chlorophyceae**		
	Cladophora	++	++
	Closteriumsp.,	+	+
	Microspora sp.,	+	+
	Oedogonium	+++	+++
	Spirogyra sp	+++	+++
	Ulothrix sp	+++	+++
	Volvox sp.,	+	++
	Zygenema sp	+	++
3	**Cyanophyceae**		
	Anabeana sp.	++	++
	Calothrix sp.	+	++
	Nostoc sp.	++	+++
	Rivularia sp.	.+	++

+ = commom, ++ = abundant, +++ = most abundant.

list of periphyton from Khankra stream as shown in Table 2. The distribution of lithophytic algae showed Bacillariophyceae as the most dominant group from Khankra stream which constitute the most dominant species group of phytoplankton. The diatoms were mainly represented by the species of *Amphora sp., Bacillaria sp., Cymbella sp., Diatoma sp., Fragilaria sp., Gomphonema sp., Navicula sp., Synedra sp. and Tabellaria etc. Bacillaria sp., Cymbella sp., Navicula and Synedra sp.* was recorded to be the most dominant species amongst Bacillariophyceae.

Chlorophyceae was mainly represented by *Cladophora, Closterium sp., Microspora sp., Oedogonium*, *Spirogyra sp., Ulothrix sp*., *Volvox sp. and Zygenema sp. Oedogonium*, *Spirogyra sp. and Ulothrix sp*. was found to be the most dominant species at sampling sites. Blue greens were noted as the third but least dominant group represented by 4 taxa. Species of *Anabeana sp., Calothrix sp., Nostoc sp., and Rivularia sp.* was recorded in good number.

Periphyton communities have received relatively little attention in the study of lotic system. We have argued that attached algae often play a critical role in the nutrient cycles, energy flow and food web of spring fed streams.

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