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RESEARCH ARTICLE

Qualitative study of epilithic algae diversity spectrum in Lidder stream of Lidder Valley (Kashmir Himalayas)

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ABSTRACT
Present study was carried out on Lidder stream in Lidder valley of Kashmir Himalayas dealing with a typical taxonomic composition of epilithic algae in stream. Epilithic algal community was represented by 144 taxa belonging to four classes namely, Bacillariophyceae with104 species (72%), Chlorophyceae with 19 species (13%), Cyanophyceae with 12 species (8%), Euglenophyceae with 4 species (3%) and Phylum Protozoa with 3 species (2%) while classes Chrysophyceae and Dinophyceae of algae contributed 1 species (1%) each. Bacillariophyceae was represented by some dominant forms like Navicula (16 species), Nitzschia (11 species), Cymbella (9 species) and Gomphonema (7species). Among blue green algae (Cyanophyceae), genus Spirulina recorded 3 species and Merismopedia registered 2 species. While in Chlorophyceae, the highest number of species was documented by genus Cosmarium (3 species), moreover Closterium, Euastrum and Ulothrix registered 2 species each. Bacillariophyceae was the predominant class at all the sites with the highest contribution of 104 species at sites S1c, S2d, S2g and S4 (first year) and S1a, S1b, S2d, S2e, S2f, S2g, and S4 (second year) while the lowest of 98 species were recorded at site S3 during the entire study, rest of the groups were moderately to least represented.
Key Words: - *Taxonomic, Epilithic algae, Lidder valley, Kashmir, Himalayas*

INTRODUCTION
The high altitude, spindle shaped, flat bottomed Kashmir valley of tectonic origin is a unique natural region, lying within the north-west tip of the oriental stretch with temperate cum sub-mediterranean climate. It is situated in the western Himalayan range between 33° 20' and 34° 54'N latitudes and 73° 55' and 75° 35'E longitudes at an average altitude of 1,550 (a.s.l). This beautiful Kashmir valley is transverse by lone river namely Jhelum (solitary river system of the Kashmir valley and one of the major tributary of river Indus).
The major tributaries of the River Jhelum are Lidder, Sindh, Vishav, Sandran, Erin, Romoush, and Rambiara. Among these tributaries Lidder stream is major right bank tributary which runs through the beautiful side valley known as "Lidder valley". Lidder valley, being the great tourist hub in Kashmir and base camp, route to the Amarnath cave is subjected to heavy anthropogenic pressure resulting in the deterioration of entire landscape and streamscape. Lidder stream is at receiving end of all the wastes produced from the terrestrial land posing great threat to fragile stream ecosystem. Present work is proposed to be undertaken to study the taxonomical composition of epilithic algae of the stream which can be later taken as reference or for comparative study or base line study to collate it with future studies.

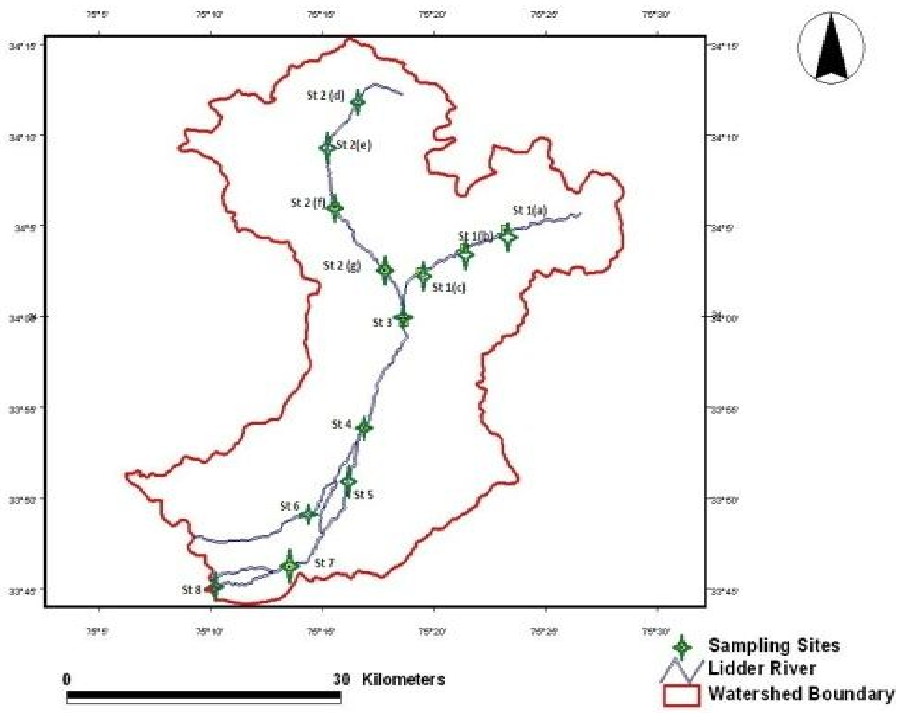
STUDY AREA AND STUDY SITES
Lidder stream is about 105 km long having two tributaries the east Lidder stream and west Lidder stream in which the east Lidder stream is formed by snow covered mountain torrents of Panjtarni range and originates from the high altitude glacier fed Sheshnag lake and Kolhoi glaciers flowing from the north towards the northeast and unites with west Lidder tributary

at Pahalgam town. The west Lidder stream, originating from Tarsar Lake (glacial fed lake) and other allied glaciers, flows torrentially through Lidderwat and Aru, unites with the east Lidder. After the junction of these torrents, just south of the Pahalgam town, the stream flows in a southwesterly direction on a steep gradient with highest turbulence, finally merges into the River Jhelum at Gur near Khanabal (Anantnag). Thirteen sampling sites (Table- 1) were selected on the basis of maximum impact of riparian zone, sediment type, habitat type (riffle, pool and run), impoundment and human habitation on stream system (Fig. 1).

Table 1: Geographical co-ordinates and Altitude of different sampling sites

Sampling station name	Geographical co-ordinates	Average altitude
Site S1a (Chandanwari)	34° 04′72″ (EW) and 75° 25′ 04″ (NS)	2,596 m (a.s.l)
Site S1b (Betab valley)	34° 04′ 78″ (EW) and 75° 24′ 61″ (NS)	2,402 m (a.s.l)
Site S1c (Laripora military camp)	34° 01′ 83″ (EW) and 75° 19′ 19″ (NS)	2,213 m (a.s.l)
Site 2d (Aru village)	34° 05′ 18″ (EW) and 75° 15′ 77″ (NS)	2,361m (a.s.l)
Site S2e (Bed rock site)	34° 03′ 97″ (EW) and 75° 01′ 25″ (NS)	2,260m (a.s.l)
Site S2f (Above power station dam)	34° 03′ 83″ (EW) and 75° 19′ 82″ (NS)	2,144 m (a.s.l)
Site S2g (Below power station dam)	34° 03′ 50″ (EW) and 75° 19′ 03″ (NS)	2,122 m (a.s.l)
Site S3 (West-east Lidder confluence)	34° 00′ 43″ (EW) and 75° 19′ 00″ (NS)	2,120 m (a.s.l)
Site S4 (Langanbal village)	33° 58′ 24″ (EW) and 75° 18′ 80″ (NS)	2,070 m (a.s.l)
Site S5 (Bumzoo village)	33° 55′ 56″ (EW) and 75° 17′ 93″ (NS	1,986m (a.s.l)
Site S6 (Srigufwara village)	33° 50′ 02″ (EW) and 75° 16′ 81″ (NS)	1,910 m (a.s.l)
Site S7 (Aishmuqam below)	33° 46′ 33″ (EW) and 75° 14′ 53″ (NS)	1,867 m (a.s.l)
Site S8 (Sangam confluence)	33° 30′ 06″ (EW) and 75° 11′ 12″ (NS)	1,598 m (a.s.l)

Fig.1: Sampling sites on Lidder stream



MATERIALS AND METHODS

Epilithon were collected by scratching 3 to 5 cm^2 of substratum. The scratched samples were collected in plastic viles containing 30 ml of distal water and later few drops of formalin

(4%) or Lugol's solution were added to ensure absolute preservation. Then the sample was transported to laboratory for qualitative and quantitative analysis.
The preserved samples were further diluted with distilled water (1ml of sample and 9ml of distilled water). The qualitative and quantitative enumeration of epilithon was done by counting 1 ml of diluted sample in Sedgwick rafter counting cell (1ml capacity). The unicellular organisms were counted as unit per centimeter square (unit cm^{-2}) while in case of filamentous forms like Chlorophyceae and Cyanophyceae one filament of specific unit (less than11 units) was recorded as single cells. A binocular compound microscope was employed for the identification of epilithon with eyepieces of 10X to 40X power. The microscope was calibrated using an ocular micrometer. Epilithon were identified using the standard taxonomic keys of Edmondson (1959), Prescott (1978), Cox (1996) and Biggs (2000).

RESULTS AND DISCUSSION

Confronting the shear stress in lotic systems the diversity of periphyton remained low as compared to lentic systems. In the present study, epilithon component of periphyton makes the major proportion of primary producers. The entire studied stretch of Lidder stream was represented by 144 species of epilithon belonging to Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, Euglenophyceae, Chrysophyceae and Protozoa were recorded. Based on the species percentage contribution, Bacillariophyceae was the most dominant class being represented by 104 species (72%), followed by Chlorophyceae with 19 species (13%), Cyanophyceae with 12 species (8%), Euglenophyceae with 4 species (3%) and Phylum Protozoa with 3 species (2%). Classes Chrysophyceae and Dinophyceae of algae contributed 1 species (1%) each (Fig. 2).
Bacillariophyceae the most species rich group, was represented by some dominant forms like *Navicula* (16 species), *Nitzschia* (11 species), *Cymbella* (9 species) and *Gomphonema* (7 species). Similarly *Amphora*, *Diatoma*, *Epithemia* and *Synedra* registered 4 species each while *Cocconies*, *Cyclotella*, *Fragilaria*, *Gyrosigma* and *Surirella* listed 3 species each. *Achnanthes*, *Achnanthidium*, *Ceratonies*, *Didymosphenia*, *Eunotia*, *Hannia*, *Neidium*, *Pinnularia*, *Rhizoclonium*, *Tabellaria*, and *Liemophora* were represented by 2 species each. *Cymatopleura*, *Denticula*, *Hantzschia*, *Meriodion*, *Rhoicosphenia*, *Stauronies*, *Enyonema*, and *Placoneis* registered only 1 species each and were least represented in the class (Table 2). While in Chlorophyceae highest number of species was documented by *Cosmarium* (3 species), *Closterium*, *Euastrum* and *Ulothrix* registered 2 species each. Similarly, taxa like *Zygnema*, *Spirogyra*, *Hormidium*, *Hydrodictyon*, *Microspora*, *Oedogonium*, *Pleurotaneium*, *Chlorohormidium*, *Cylindrocapsa*, and *Desmidium*, were represented by 1 species each. Among blue green algae (Cyanophyceae), genus *Spirulina* recorded 3 species and *Merismopedia* registered 2 species while *Myxosarcina*, *Anabaena*, *Microcystis*, *Nodularia*, *Oscillatoria*, *Rivularia*, and *Nostoc* documented only 1 species each.
On the basis of species percentage contribution the sequence of dominance followed the following trend:-
Bacillariophyceae (72%) > Chlorophyceae (13%) > Cyanophyceae (8%) > Euglenophyceae (3%) > Protozoa (2%) > Chrysophyceae (1%) = Dinophyceae (1%).
Discernable temporal and spatial variations were evinced during the two year of study and thus the qualitative (diversity) spectrum of epilithon at different sites revealed a distinct frame of diversity in Lidder stream. Bacillariophyceae was the predominant class at all the sites with the highest contribution of 104 species at sites S1c, S2d, S2g and S4 (first year) and S1a, S1b, S2d, S2e, S2f, S2g, and S4 (second year) while the lowest of 98 species were recorded at site S3 during the entire study (Table 3). Chlorophyceae listed a maximum number of species (19 species) at all sites except at sites S1b, S2e and S2f (first year) which registered 18 species each while 17 species at site S2e (second year). Cyanophyceae registered a maximum of 12 species at each of the sites S1c, S2d, S2f, S3, S4 and S5 during first study year while in the second year of study (2008-09) similar number of species were recorded at sites S1a, S1b, S1c, S1e, S2f, S2g, S3, S4, S5, S6 and S7. Euglenophyceae and Protozoa contributed only a limited number of species (4 and 3 species respectively) at most

of the sites. Chrysophyceae and Dinophyceae were least representing classes with total contribution of 1 species each at all sites during the two years of study (Table 3).

Fig.2: Overall percentage contribution

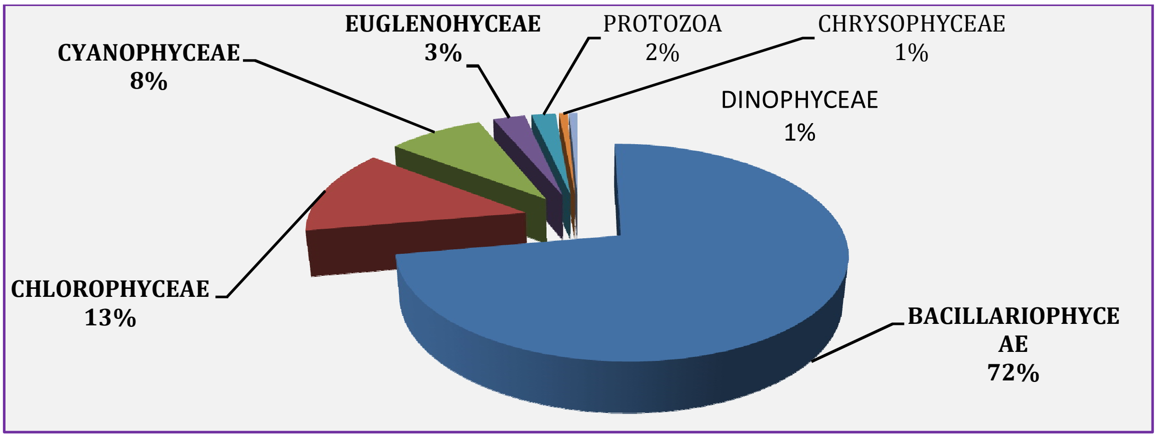


Table 2: Species composition of epilithon in whole Lidder stream

Class	Genus	No. of species	Class	Genus	No. of species
	Achnanthes	2		*Chlorohormidium*	1
	Achnanthidium	2		*Closterium*	2
	Amphora	4		*Cosmarium*	3
	Ceratonies	2		*Cylindrocapsa*	1
	Cocconies	3		*Desmidium*	1
	Cyclotella	3		*Euastrum*	2
	Cymatopleura	1	CHLOROPHYCEAE	*Hormidium*	1
	Cymbella	9		*Hydrodictyon*	1
	Denticula	1		*Microspora*	1
	Diatoma	4		*Oedogonium*	1
	Didymosphenia	2		*Pleurotaneium*	1
	Enyonema	1		*Spirogyra*	1
	Epithemia	4		*Ulothrix*	2
	Eunotia	2		*Zygnema*	1
	Fragilaria	3	**Total**	**14**	**19**
BACILLARIOPHYCEAE	*Gomphonema*	7		*Anabaena*	1
	Gyrosigma	3		*Merismopedia*	2
	Hantzschia	1		*Microcystis*	1
	Hannia	2		*Myxosarcina*	1
	Liemophora	2	CYANOPHYCEAE	*Nodularia*	1
	Meriodion	1		*Nostoc*	1
	Navicula	16		*Oscillatoria*	1
	Neidium	2		*Rivularia*	1
	Nitzschia	11		*Spirulina*	3
	Pinnularia	2	**Total**	**9**	**12**
	Placoneis	1	EUGLENOHPYCEAE	*Euglena*	4
	Rhizoclonium	2	**Total**	**1**	**4**
	Rhoicosphenia	1	CHRYSOPHYCEAE	*Dinobryon*	1
	Stauronies	1	**Total**	**1**	**1**
	Surirella	3	DINOPHYCEAE	*Ceratium*	1
	Synedra	4	**Total**	**1**	**1**
	Tabellaria	2	Phylum PROTOZOA	*Arcella*	1
Total	**32**	**104**		*Coleps*	1
				Diffuligia	1
			Total	**3**	**3**

Table 3: Total diversity of epilithon at different sites in the year 2007-09

2007-08													
Class	**S1a**	**S1b**	**S1c**	**S2d**	**S2e**	**S2f**	**S2g**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**
Bacillariophyceae	103	103	104	104	101	103	104	98	104	102	102	102	ns
Chlorophyceae	19	18	19	19	18	18	19	19	19	19	19	19	ns
Cyanophyceae	11	11	12	12	10	12	11	12	12	12	11	11	ns
Dinophyceae	1	1	1	1	1	1	1	1	1	1	1	1	ns
Euglenophyceae	4	4	4	4	2	4	4	3	4	3	3	3	ns
Chrysophyceae	1	1	1	1	1	1	1	1	1	1	1	1	ns
Protozoa	3	3	3	3	3	3	3	2	3	3	3	3	ns
2008-09													
Bacillariophyceae	104	104	100	104	104	104	104	103	104	103	103	103	ns
Chlorophyceae	19	19	19	19	17	19	19	19	19	19	19	19	ns
Cyanophyceae	12	12	12	11	12	12	12	12	12	12	12	12	ns
Dinophyceae	1	1	1	1	1	1	1	1	1	1	1	1	ns
Euglenophyceae	4	4	4	4	4	1	4	3	4	4	4	4	ns
Chrysophyceae	1	1	1	1	1	1	1	1	1	1	1	1	ns
Protozoa	3	3	3	3	3	2	3	3	3	3	3	3	ns

Ns= not sampled

Dominance of Bacillariophyceae may be attributed to the presence of good concentration of SiO_2 in Lidder stream which probably helps in the frustules formation as also reported by Wetzel and Likens, (2000). Silica or silicon dioxide (SiO_2) is a key micronutrient in diatom production. Silica concentrations can limit diatom production if concentrations become depleted in surface waters. The depletion of silica tends to occur more often in lakes and reservoirs than in running waters (Cambers and Ghina, 2005). The declines in silica in the surface waters usually lead to a rapid decline in diatom populations. Bacillariophyceae has great ability to thrive well in cold waters as Lidder stream is cold water stream which supports Bacillariophyceae to thrive well in the system (Rao, 1995). Zafar (1967) was also of the opinion that calcium is one of the important elements influencing the distribution of Bacillariophyceae.

In the present investigation high calcium content seems to favoring the dominance of Bacillariophyceae (104 species). The sub dominance position of green algae in present study might be due to light availability (Curry *et al.,* 1981), water depth and current velocity (Fisher *et al.,* 1982), light, shading and temperature (Graham, *et al.,* 1985), chemical water quality (Whitton, 1970), grazing by invertebrate animals (Power, 1990), natural reproductive cycles (Graham *et al.,* 1985), and sufficient historical time to allow the interactions with these factors to play out. Power (1990) stated that filamentous green algae are natural components of temperate streams and their abundance and seasonal periodicity are influenced by substrate type. Cyanophyceae was dominant during warmer months in Lidder stream as blue-greens has marked tendency of to appear in the warm months. Euglenophyceae was sporadic in occurrence at most of the sites while similar pattern was also seen in rest of the groups.

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