Journal of Environmental Science and Technology

ISSN 1994-7887

science alert

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Journal of Environmental Science and Technology 7 (6): 326-336, 2014
ISSN 1994-7887 / DOI: 10.3923/jest.2014.326.336

Phytoplankton Community of River Jehlum in Kashmir Himalaya

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ABSTRACT

The study is aimed to obtain a baseline data on the phytoplankton community of River Jehlum in Srinagar city and for this purpose samples were collected from four study sites from June to November 2011. During the entire study period, a total of 53 taxa belonging to Bacillariophycea (24) Chlorophyceae (17) Cyanophyceae (9) Euglenophyceae (2) and Chrysophyceae (1) were recorded. Almost a clear dominance of Bacillariophyceae over Chlorophyceae, Euglenophyceae and Cyanophyceae was observed throughout the study period. Phytoplankton displayed its maximum population in the month of October displaying its peak growth. The perusal of data at different study sites revealed no apparent changes in species composition of phytoplankton at different study sites as supported by diversity and similarity index values. Though the number of common taxa recorded from all the sites were 24 yet genera like *Desmidium*, *Achnanthes*, *Epithemia*, *Hantzschia*, *Rhizosolenia* and *Microcystis* were observed from sites III only, being recognized as the most polluted site.

Key words: River Jhelum, phytoplankton, Bacillariophyceae, Chlorophyceae, Cyanophyceae

INTRODUCTION

The valley of Kashmir is a lacustrine basin with an average altitude of 1585 m above sea level. Both the valley and surrounding mountains are home to a large number of aquatic habitats like lakes, ponds, streams, rivers and wetlands. It is estimated that 6% of the land area of Jammu and Kashmir is under aquatic habitats (Zutshi and Gopal, 2000). These aquatic habitats are dominated by algae and aquatic plants which are so important to lotic system as sources of energy, for forming microhabitats that shelter other fauna from predators and act as a food resource (Brown, 1987). Plankton particularly phytoplankton, long have been used as indicators of water quality (Palmer, 1969; Gannon and Stemberger, 1978) as some species flourish in highly eutrophic waters while others are very sensitive to organic and/or chemical waste. Further, some species develop noxious blooms, sometimes creating offensive taste and odors (Prescott, 1968) or anoxic or toxic conditions resulting in animal deaths or human illness (Carmichael, 1981). Phytoplankton dynamics have been studied extensively in lentic fresh waters (lakes and reservoirs), yet comparatively little research has focussed on lotic waters (rivers) of Kashmir Himalaya. Therefore, an attempt was made to survey of the phytoplankton community of river Jhelum.

MATERIALS AND METHODS

Jhelum, the major waterway of Kashmir, originates from the spring Verinag located in the foot of a spur of the Pir Panjal mountains in the district Anantnag from where a number of tributaries join the river and make it navigable from Khannabal to Wular lake. From the Wular, it takes a southwesterly direction to Baramulla on its way through a gorge across the Pir Panjal range. The river runs a course of 203 km through the valley. The hydrology of River Jhelum is largely controlled by snowmelt in spring season and heavy rains from June to September.

Study sites: Four study sites markedly different in respect of demographical features were selected for the sampling purposes in River Jhelum (Fig. 1 and Table 1).

Sampling was carried on the monthly basis from June to November 2011. For the estimation of phytoplankton in the river ecosystem 100 L of water was sieved through phytoplankton net having mesh size 65. The contents were then transferred to a vial and preserved with Lugol's solution and 4% formalin (APHA, 1998). The identification of phytoplankton was done with the help of microscope by adopting standard taxonomic works (Edmondson, 1992; Cox, 1996; APHA, 1998). For quantitative study, the phytoplanktonic samples were concentrated through sedimentation in a vial, as it is preferred method of concentration because it is non selective (unlike filteration) and non destructive (unlike filtration and centrifugation). Then 1 mL sample was placed in a Sedwick-Rafter cell and studied under microscope. The unicellular algae were counted as individuals whereas in the filamentous forms each filament was taken as unit while in colonial forms like *Volvox*, *Microcystis*, etc., the counting unit was a colony (Jumppanen, 1967; Pandit, 1980).

Table 1: Description of study sites

Sites	Location	Elevation (m.a.s.l)	Coordinates	Biotic stress	Pollution source
I	Marval Pampore	1601	33°58' 45.4" N and 74°54' 16.5" E	Agricultural and residential area	Agricultural and sewage
II	Zero Bridge	1582	34°4' 9.2" N and 74°50' 20.88" E	Urban settlement (residential and army cantonment) Urban	Sewage and solid waste
III	Qamarwari	1569	34°05' 35.9" N and 74°46' 45.4" E	settlement (commercial and residential)	Sewage and solid waste
IV	Tengpora	1577	74°43' 11" E and 34°7' 47.1" N	Agricultural and residential (rural)	Agricultural

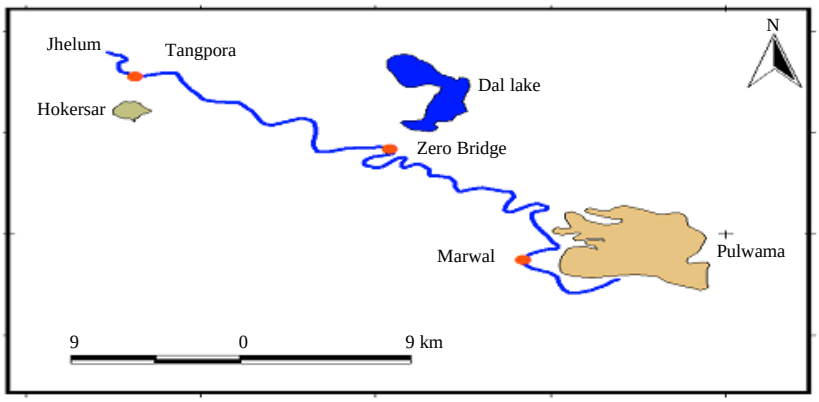


Fig. 1: Geographical map of study area depicting the location of study sites

RESULTS AND DISCUSSION

Phytoplankton in the present study exhibited little diversity in species number across different sampling sites of River Jhelum. A total of 53 genera of phytoplankton belonging to Chlorophyceae (17), Bacillariophyceae (24), Cyanophyceae (09), Euglenophyceae (2) and Chrysophyceae (1) were recorded across four different sites during the entire period of study. The number of common genera recorded from all the sites were 24, while as genera like *Desmidium*, *Achnanthes*, *Epithemia*, *Hantzschia*, *Rhizosolenia* and *Microcystis* were observed from sites III only (Table 2). There were

Table 2: Distribution pattern of phytoplankton in river Jhelum at four study sites

	Site			
Genera	I	II	III	IV
Chlorophyceae				
Ankistrodesmus sp.			+	+
Chlorella sp.	+		+	+
Cladophora glomerata			+	+
Closterium sp.	+	+	+	+
Cosmarium sp.	+	+	+	+
Desmidium sp.				+
Geminella minor			+	+
Hydrodictyon sp.	+	+	+	+
Microspora sp.		+	+	+
Oedogonium sp.	+	+	+	+
Scenedesmus sp.	+	+	+	+
Spirogyra sp.	+	+	+	+
Staurastrum sp.	+		+	+
Tetradron sp.			+	+
Ulothrix sp.	+		+	+
Volvox sp.	+		+	+
Zygnema sp.	+	+	+	+
Bacillariophyceae				
Achnanthes sp.			+	
Amphora sp.	+		+	+
Amphipleura sp.		+	+	+
Astronella sp.			+	+
Cocconeis sp.	+	+	+	+
Cyclotella sp.	+	+	+	+
Cymatopleura sp.	+	+	+	+
Cymbella sp.	+	+	+	+
Diatoma sp.	+	+	+	+
Didymosphenia sp.	+	+	+	+
Epithemia sp.			+	
Eunotia sp.			+	+
Fragilaria sp.	+		+	+
Gyrosigma sp.	+	+	+	+
Hantzschia sp.			+	
Melosira sp.	+	+	+	+
Navicula sp.	+	+	+	+
Neidium sp.	+		+	+

Table 2: Continue

Genera	Site I	II	III	IV
Nitzschia sp.	+	+	+	+
Pinnularia sp.	+	+	+	+
Rhizosolenia sp.			+	
Surirella sp.	+			+
Synedra sp.	+	+	+	+
Tabellaria sp.	+		+	+
Cyanophyceae				
Anabaena sp.	+	+	+	+
Chroococcus sp.	+		+	+
Lyngbya sp.		+	+	+
Microcystis sp.			+	
Nostoc sp.	+		+	+
Oscillatoria sp.	+	+	+	+
Rivularia sp.	+	+	+	+
Spirulina sp.	+	+	+	+
Sphaerocystis sp.	+	+	+	+
Euglenophyceae				
Euglena sp.			+	+
Phacus sp.			+	+
Chrysophyceae				
Dinobyron sp.			+	+

Table 3: Number of species encountered at different sites

Algal group	Site I	II	III	IV
Chlorophyceae	11	8	16	17
Bacillariophyceae	17	13	23	20
Cyanophyceae	7	6	9	8
Euglenophyceae	-	-	2	2
Chrysophyceae	-	-	1	1
Total	35	27	51	48

significant differences in the number of species at different sites. However, the maximum number was registered at site III (51) followed by site IV (48), site I (35) and site II (27) in decreasing order (Table 3).

Bacillariophyceae was thus the most dominant algal class at all the sites as against Euglenophyceae and Chrysophyceae which was least represented. The most numerically dominant species among the different families were (Fig. 2).

- **Bacillariophyceae:** *Coccconeis* sp., *Cyclotella* sp., *Cymatopleura solea, Cymbella* sp., *Diatoma vulgare, Didymosphenia* sp., *Gyrosigma* sp., *Melosira* sp., *Navicula lanceolata, N. radiosa, N. oblonga, Synedra acus, S. ulna, Surirella* spp. and *Tabellaria* sp.

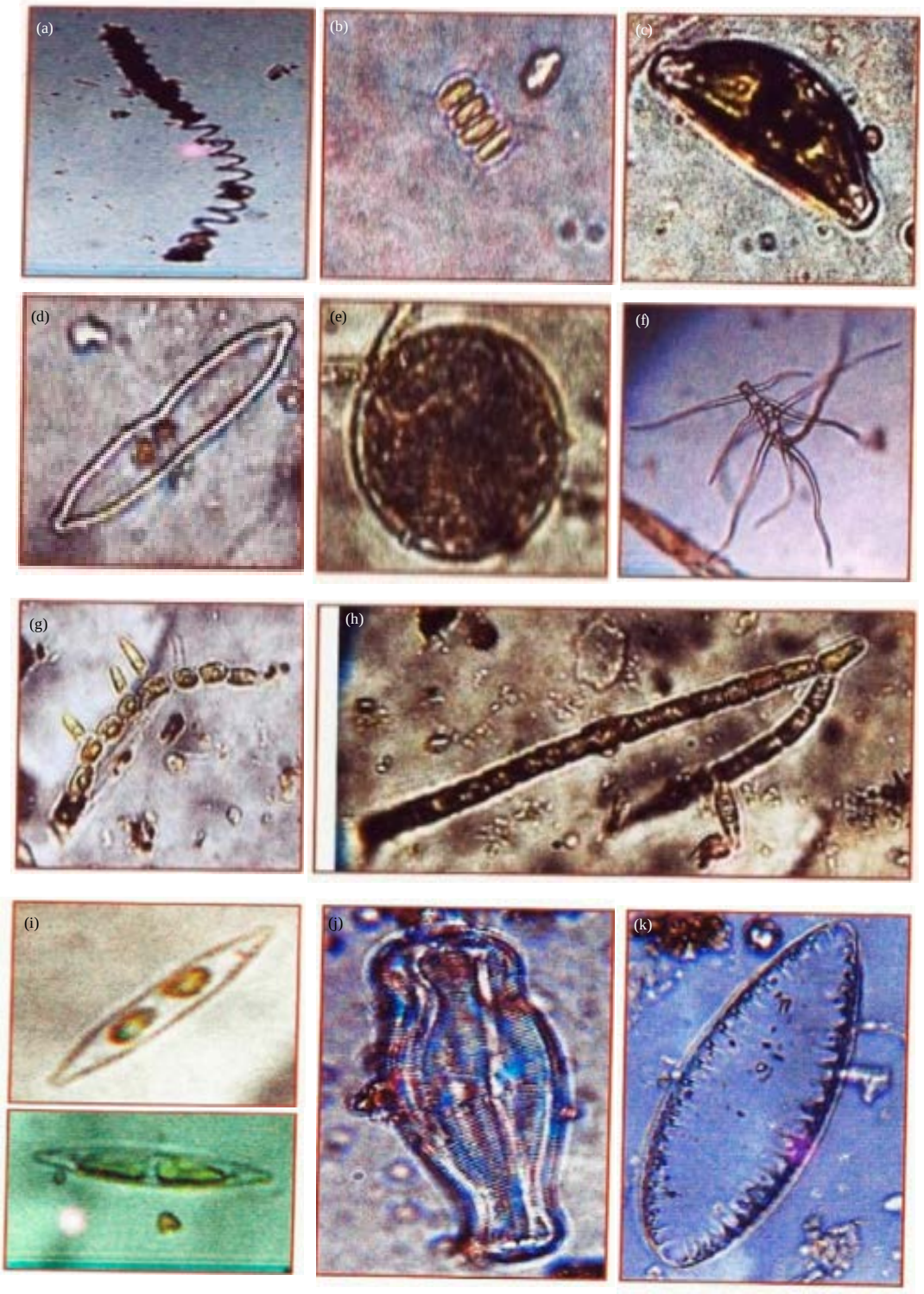
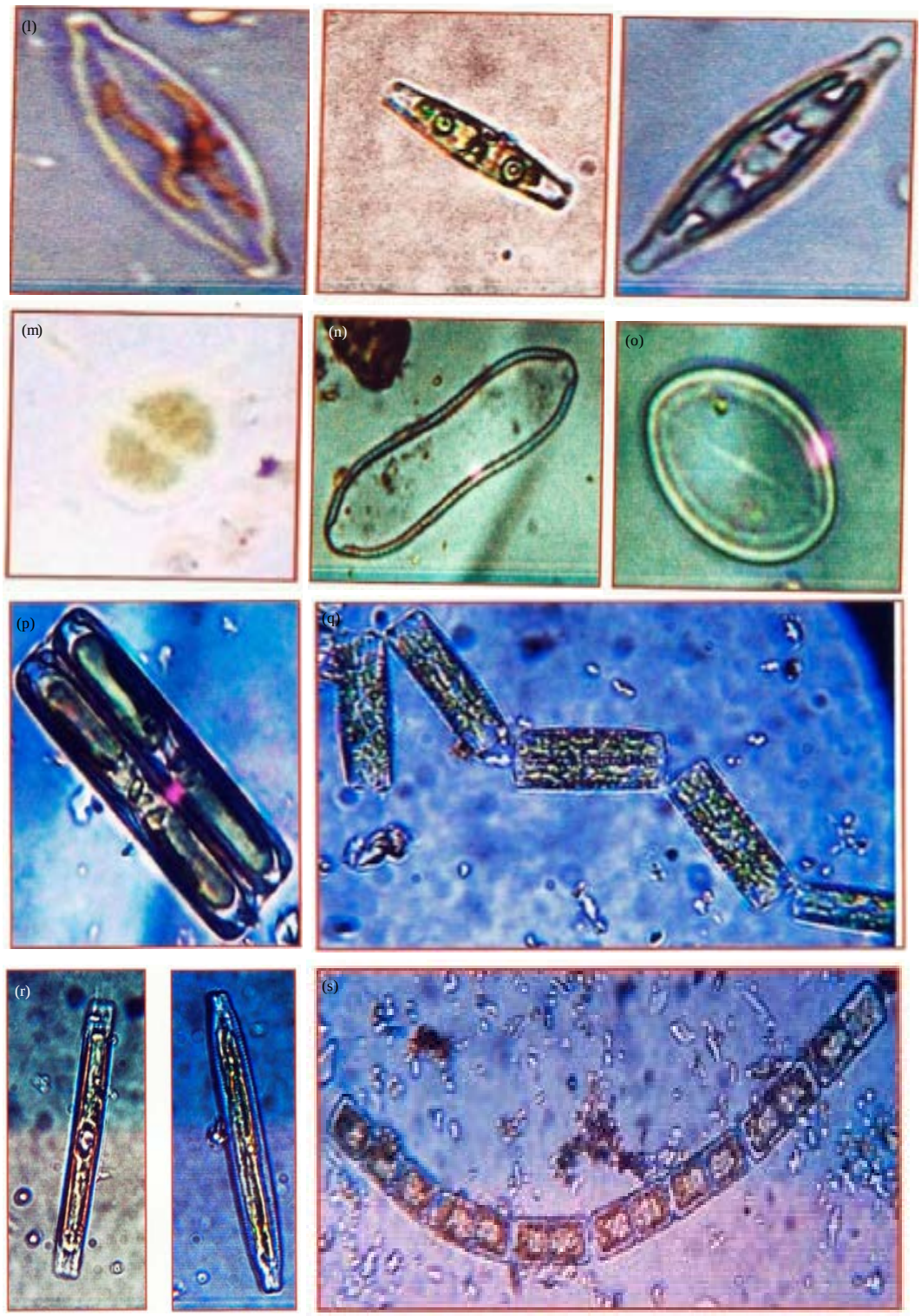


Fig. 2(a-u): Continue



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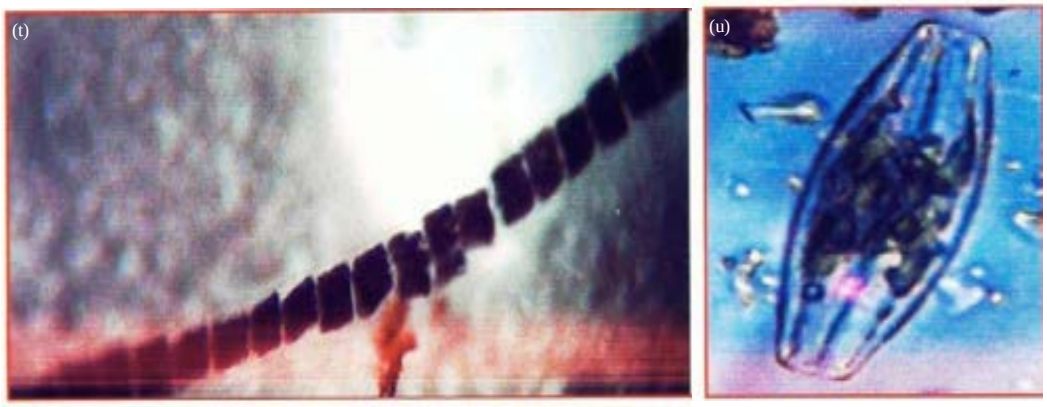


Fig. 2(a-u): Some common phytoplankton found in river Jhelum (a) *Spiruline* sp., (b) *Scenedesmus quadricauda*, (c) *Cymbella* sp., (d) *Hantzschia* sp., (e) *Cyclotella* sp., (f) *Staurastrum* sp., (g) *Geminella minor*, (h) *Cladophora* sp., (i) *Nitzshia* sp., (j) *Didymosphenia* sp., (k) *Suriella* sp., (l) *Navicula* sp., (m) *Cosmarium* sp., (n) *Cymatopleura solea*, (o) *Cocconeis* sp., (p) *Pinnularia* sp., (q) *Tabellaria* sp., (r) *Synedra* sp., (s) *Zygnema* sp., (t) *Microspora* sp. and (u) *Amphora* sp.

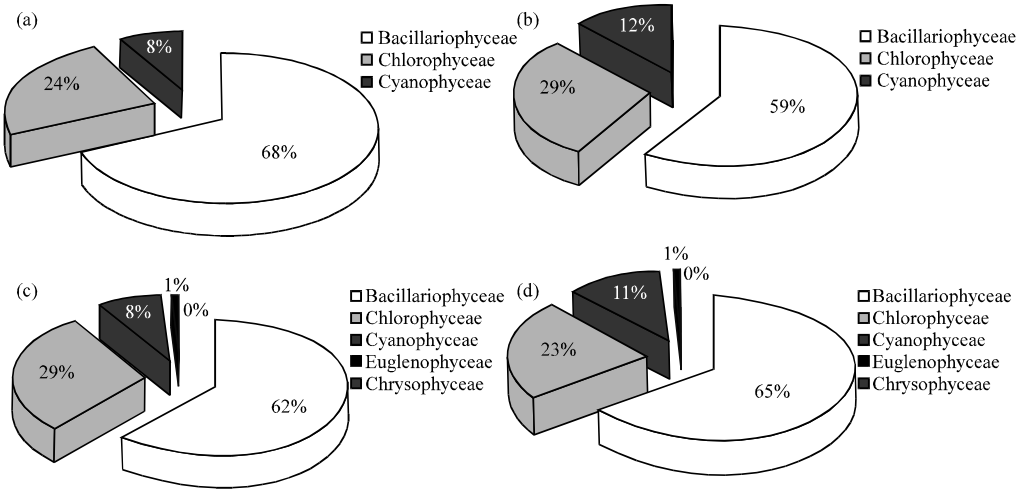


Fig. 3(a-d): Mean relative density of phytoplankton groups at sites (a) I, (b) II, (c) III and (d) IV

- **Chlorophyceae:** *Closterium* sp., *Cosmarium* sp., *Hydrodiction* sp., *Microspora* sp., *Oedogonium* sp., *Scenedemus quadricauda*, *Spirogyra* sp. and *Zygnama* sp.
- **Cyanophyceae:** *Anebaena* sp., *Oscillatoria* sp., *Rivularia* sp., *Spirulina* sp. and *Sphaerocystis* sp.
- **Euglenophyceae:** *Euglena* sp. and *Phacus* sp.

Density: Besides exhibiting significant variations in the species composition of phytoplankton, large spatial and temporal variations were recorded in the population density patterns (Fig. 3). In

Table 4: Spatio-temporal variations in density (ind L^{-1}) of phytoplankton at different sites of river Jhelum

Phytoplankton and site	June	July	Oct.	Nov.
Chlorophyceae				
I	36.0	54.5	35.0	10.0
II	21.0	40.0	23.0	8.0
III	54.0	110.0	66.5	35.0
IV	41.5	75.0	49.0	14.0
Bacillariophyceae				
I	24.0	59.5	176.0	129.5
II	19.5	33.5	80.0	57.5
III	56.5	124.0	228.5	167.0
IV	50.0	87.0	221.0	139.0
Cyanophyceae				
I	13.0	19.0	11.0	2.0
II	11.0	17.5	7.5	2.0
III	16.0	33.0	17.5	3.5
IV	21.0	33.5	21.0	5.5
Euglenophyceae				
III	0.0	3.0	3.0	0.0
IV	0.0	1.0	3.0	1.0
Chrysophyceae				
III	0.0	2.0	1.0	0.0
IV	0.0	0.5	1.0	0.0

general, the phytoplankton community exhibited greater density in the month of October while least density was registered in the month of June as shown in Table 4.

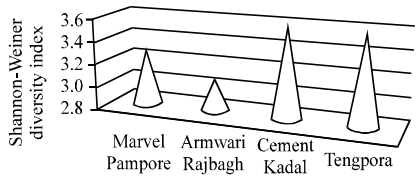
Bacillariophyceae: This was the most dominant group among phytoplankton, being represented by 24 taxa where some species like *Didymosphenia*, *Gyrosigma*, *Nitzchia*, *Pinnularia*, *Navicula lanceolata* and *N. radiosa*, were common to all sites and during the entire study period. Among the diatoms *Navicula* sp. was the most dominant and exhibit its maximum density (14.5 ind L^{-1}) at site III and minimum density at site II (9 ind L^{-1}). Some forms of diatoms like *Amphipleura* sp., *Hantzschia* sp. and *Rhizosolinia* sp. showed sporadic occurrence.

Chlorophyceae: This was the second dominant group among phytoplankton after Bacillariophyceae and is comparatively more important so far its species richness and contribution to the total phytoplankton production is concerned. The group attained its maximum density in July at all the sites. *Closterium* sp., *Cosmarium* sp., *Chlorella* sp., *Straustrum* sp., *Ulothrix* sp. were the main contributors to this group. However, *Cladophora glomerata*, *Geminella minor* and *Tetradron* sp. were sporadic in occurrence.

Euglenophyceae: Euglenoids showed maximum development in autumn and minimum in winter. The species of *Euglena* and *Phacus* were restricted to only two biotopes (sites III and IV).

Cyanophyceae: This group showed its maximum development in July at all the sites. The species of *Anabena*, *Nostoc*, *Microcystis*, *Rivularia*, *Spirulina* were recorded in greater number at all the sites.

Cyanophyceae: It was represented by only 1 taxon. *Dinobyron* sp. being noticed only in July and October at sites III and site IV.



	Marvel Pampore	Armwari Rajbagh	Cement Kadal	Tengpora
Shannon-weiner diversity index	3.3	3.1	3.6	3.6

Fig. 4: Shannon-Weiner diversity index at different study sites

Table 5: Sorenson similarity coefficient between different selected sites on the basis of phytoplankton

Sites	Similarity coefficient	Similarity coefficient (%)
Between S1 and S2	0.67	67
Between S1 and S3	0.79	79
Between S1 and S4	0.84	84
Between S2 and S3	0.69	69
Between S2 and S4	0.72	72
Between S3 and S4	0.91	91

SI: Site I, S2: Site II, S3: Site III and S4: Site IV

Diversity indices

Shannon-Wiener diversity index: Amongst the various study sites the highest values of Shannon-Weiner index (3.6) was found at sites III and IV (Cement Kadal and Tengpora) depicting highest diversity at these sites. Lowest diversity (3.1) was noticed at Armwari Rajbagh (site II). The remaining site I shows intermediate position between the two extremes (Fig. 4).

Sorenson's similarity coefficient: Amongst the study sites the highest values of Sorenson's similarity coefficient was found between site III (Cement Kadal) and site IV (Tengpora) whereas the lowest was found between site I (Armwari) and site II (Cement Kadal) as shown in Table 5.

DISCUSSION

In terms of abundance Bacillariophyceae was the most dominant, followed by Chlorophyceae, Cyanophyceae, Euglenophyceae and Chrysophyceae group which is the general trend noticed in lotic systems (Hynes, 1979). It further gives credence to the fact that diatoms constitute the major proportion of phytoplankton density in rivers and streams (Shadin, 1956). The study gains support from the findings of Talling and Rzoska (1967) who also registered diatoms to be dominant phytoplankton in the Blue Nile. The dominance of Bacillariophyceae may be attributed to the availability of silicates (SiO_2) in water bodies which are used in frustules formation in the bodies of the diatoms (Pandit, 1980; Wetzel and Likens, 1991) and its ability to thrive well in cold water (Sarwar and Zutshi, 1988) as being favoured by low temperature and high light penetration (Vasisht and Sharma, 1975).

The diatom population of river was composed mainly of *Navicula* sp. and *Nitzshia* sp. Among the study sites, site III recorded maximum number of taxa (51) followed by site IV (48), site I (35) and site II (27). High diversity of diatoms at site III and IV indicates polluted level of river (Palmer, 1969; Kanon and Krishnamurthy, 1985).

According to Hutchinson (1967) a number of genera like *Cosmarium, Pediastrum, scenedesmus, Tetradron, Selenastrum*, etc., have been reported to be abundant in eutrophic waters. Most of these genera were recorded from the stretch of river under investigation, thus indicating moderate levels of pollution.

The population of Chlorophyceae showed an increase during early July which may be attributed to the optimum conditions for the growth and reproduction of Chlorophyceae (Kant and Kachroo, 1980).

According to Hutchinson (1967) the presence of Euglenophyceae in a greater quantity is attributed to a number of variables like high level of organic matter. The presence of Euglenophyceae although in small number at site III and site IV can be attributed to the presence of organic matter and raised temperatures.

ACKNOWLEDGMENT

The study carried out is the part of M.Sc. programme of first author. The author would like to express his sincere gratitude to his research guide and teacher Prof. (Dr.) A.K. Pandit and Head, Department of Environmental Science, University of Kashmir, Srinagar for providing laboratory facilities.

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