

# PHYTOPLANKTON DIVERSITY OF IN FOUR LAKES OF SATARA DISTRICT, MAHARASHTRA STATE

LEELA J. BHOSALE\*, SUREKHA N. DHUMAL AND ANJALI B. SABALE

Department of Botany, Shivaji University, Kolhapur – 461 004

E-mail: ljbhosale@yahoo.com

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\*Corresponding  
author

## ABSTRACT

The paper deals with occurrence and biodiversity of phytoplankton. Occurrence of phytoplankton in four lakes, namely, Mayani, Dhakani, Divad and Rajewadi (Dist. Satara) were investigated in the months July, August and December, 2009. In these lakes 68 species of phytoplankton and 13 species of filamentous algae were recorded belonging to five major classes of algae, namely, Cyanophyceae, Chlorophyceae, Euglenophyceae, Dinophyceae, and Bacillariophyceae. Further, Divad site was studied up to December 2009. It was found at Divad that the density of phytoplankton was, 1470, 1584 and 2741 cells/L in July, August and December, respectively. The class Chrysophyceae was represented in August. The species diversity index is very high because of the number of contributing species. Similarity index is determined to know seasonal variations.

## INTRODUCTION

The phytoplankton of Maharashtra has been studied by Gandhi (cf. Sarode and Kamat, 1984), especially for lakes in and around Kolhapur. Recently Bhosale et al. (2010, 2010a and 2010b) have studied some of the sites from three districts of Maharashtra. Present paper records the occurrence of phytoplankton in four lakes of Satara district, namely, Mayani, Dhakani, Divad and Rajewadi. These lakes are situated geographically at a short distance from each other.

Site	N Latitude	E Longitude
Mayani	17°26.533'	074°34.100'
Dhakani	17°35.038'	074°40.755'
Divad	17°37.834'	074°45.076'
Rajewadi	17°35.290'	074°52.270'

The present work was carried out in three months July, August and December 2009. The rains were delayed in this region and summer conditions prevailed even in July. Therefore, July refers to summer, August to rainy and December to winter seasons. Mayani dries up during summer to almost a very small ditch. During rainy season it has enough water to attract winter migratory birds and the wetland becomes fully active. Dhakani is not listed as wetland but is a large water body (lake). Usually it supports painted storks, spoon bills and white necked black ibis along with other common birds such as little cormorant, heron, coots and others. Similarly Rajewadi is a reservoir and is pretty large. Divad is a very small lake which due to the impact of summer, shrinks to muddy substratum. The phytoplankton of the four lakes have been studied.

## MATERIALS AND METHODS

The samples for phytoplankton were collected in July 2009,

from each site in a 50mL sample bottle by filtering about 50 liters of water through plankton net. These samples were brought to laboratory and preserved in 4% formalin. The phytoplankton samples were observed under microscope and microphotography was carried out on Nikon L-20 camera. The phytoplankton were identified by using monographs, books and journals viz., West and West, 1907; Fritsch, 1935; Biswas, 1980; Prescott, 1982; APHA, 1985; Sarode and Kamat, 1984; Cox, 1996; Jena et al., 2005; Pingale and Deshmukh, 2005; Tiwari and Chauhan, 2007 a and b; Deshmukh and Gunale, 2007; Tessa and Sreekumar, 2007; Perumal and Anand, 2008; Hosmani, 2008; Dhande and Jawale, 2008.

The density (cells/L) was measured by drop method. The similarity index (Sorensen, 1948) was calculated using formula,

$$S = 2C / (A + B)$$

where,

A = Number of species at sites A, B = number of species at site B, C = number of species shared by sites A and B. Instead of sites months can be compared.

## RESULTS AND DISCUSSION

The results are shown in Tables 1 to 3 and Plate 1. Table 1 records the occurrence of phytoplankton species in four lakes during July when the summer conditions persisted. In these lakes 68 species of phytoplankton were recorded, out of these 57 species are in Divad lake including filamentous forms (Table 2) whereas only 19 species were found in Rajewadi lake. One interesting observation is with Mayani sample, diverse cell forms of *Ankistrodesmus septatus* have been recorded which are similar to cell forms seen in single culture of *A. septatus*

**Table 1: Occurrence of phytoplankton from four lakes of Satara district**

S.N.	Name of species/sites	Dia ( $\mu\text{m}$ )	Mayani	Dhakani	Divad	Rajewadi
A.	Class – Cyanophyceae					
01	<i>Burkillia cornuta</i>	09	"	"	+	"
02	<i>Chroococcus limneticus</i>	05	"	"	+	"
03	<i>Merismopedia glauca</i>	06	"	"	+	"
04	<i>M. elegans</i>	02	+	+	+	+
05	<i>Microcystis aeruginosa</i>	05	+	+	+	+
06	<i>M. incerta</i>	04	"	"	+	"
07	<i>Oocystis elliptica</i>	08	"	"	+	"
B	Class – Chlorophyceae					
08	<i>Ankistrodesmus falcatus</i>	06	+	+	+	+
09	<i>A. septatus</i>	05	+	"	"	"
10	<i>Closterium acutum</i>	04	"	"	"	+
11	<i>C. navicula</i>	08	"	"	+	"
12	<i>Cosmarium biculatum</i>	12	"	"	+	"
13	<i>C. obtusatum</i>	19	"	"	+	"
14	<i>C. undulatum</i>	25	+	+	+	"
15	<i>C. seangulare</i>	27	"	"	+	"
16	<i>Coelastrum microporum</i>	25	+	"	"	"
17	<i>Crucigenia truncata</i>	08	+	"	"	+
18	<i>Chlorochytrium Lemnae</i>	18	"	"	+	"
19	<i>Dictyosphaerium ehernbergianum</i>	16	"	"	+	"
20	<i>Euastrum inermis</i>	47	"	"	+	"
21	<i>E. pulcherrimum</i>	28	"	"	+	"
22	<i>Elakatothrix gelatinosa</i>	04	+	"	"	"
23	<i>Golenkinia paucispina</i>	74	"	"	+	"
24	<i>Kirchneriella contorta</i>	03	"	"	+	"
25	<i>Lagerheimia genevensis</i>	05	+	"	"	"
26	<i>Monoraphidium capricornutum</i>	04	"	"	+	"
27	<i>Pediastrum simplex</i>	60	"	+	"	"
28	<i>P. simplex</i> var. <i>radians</i>	14	+	+	"	+
29	<i>P. simplex</i> var. <i>granulatum</i>	18	+	+	"	+
30	<i>P. duplex</i> var. <i>gracilimum</i>	81	"	"	+	"
31	<i>P. duplex</i> var. <i>clathratum</i>	70	"	"	+	"
32	<i>P. tetras</i>	65	"	+	"	"
33	<i>Pandorina morum</i>	16	"	"	+	"
34	<i>Protosiphon botryoides</i>	23	"	"	+	"
35	<i>Scenedesmus quadricauda</i>	12	+	+	+	+
36	<i>S. quadricauda</i> var. <i>minutum</i>	08	"	+	+	"
37	<i>Staurodesmus dejectus</i>	20	"	"	+	"
38	<i>Staurastrum pseudopaligicum</i>	16	+	"	"	"
39	<i>S. sebalzii</i>	16	+	"	"	"
40	<i>Tetraedron limneticum</i>	15	"	"	+	"
41	<i>T. minimum</i>	23	"	"	"	+
42	<i>T. gracile</i>	25	"	"	"	+
43	<i>Cylindrocystis</i> sp.	12	"	"	+	"
44	<i>Cymatoplura solea</i>	28	"	+	"	"
45	<i>Actinastrum Hantzschii</i> var. <i>elongatum</i>	07	+	"	"	"
C	Class – Euglenophyceae					
46	<i>Euglena gracile</i>	30	+	"	"	"
47	<i>Phacus caudata</i>	16	"	"	+	"
48	<i>Trachelomonas pulcherrima</i>	13	"	+	+	"
D	Class – Dinophyceae					
49	<i>Gymnodinium palustrae</i>	20	"	"	+	"
50	<i>Peridinium aciculiferum</i>	22	"	"	+	"
E	Class – Bacillariophyceae					
51	<i>Amphora ovalis</i>	24	+	+	+	+
52	<i>Biddulphia mobeliensis</i>	28	"	"	+	"
53	<i>Cyclotella meneghiniana</i>	12	"	+	"	+
54	<i>Cymbella lanceolata</i>	11	+	+	+	"
55	<i>C. ventricosa</i> var. <i>depressus</i>	14	"	+	+	"
56	<i>Diploneis subovalis</i> var. <i>perminuta</i>	18	"	"	"	+
57	<i>Fragilaria construens</i> var. <i>venter</i>	04	"	"	+	"
58	<i>Melosira granulata</i>	07	"	+	+	"
59	<i>M. islandica</i>	12	"	+	+	+

Cont.....Table 1: Occurrence of phytoplankton from four lakes of Satara district

S.N.	Name of species/sites	Dia (µm)	Mayani	Dhakani	Divad	Rajewadi
60	<i>Navicula minuscule</i>	12	"	"	+	"
61	<i>N. papula</i>	08	"	+	+	+
62	<i>Nitzschia acicularis</i>	04	"	+	"	"
63	<i>N. archibaldii</i>	04	"	+	+	+
64	<i>N. palea</i>	04	"	"	+	"
65	<i>Pinnularia viridis</i>	12	+	"	+	+
66	<i>Synedra acus</i>	06	"	"	"	+
67	<i>S. ulna</i> with chromatophore	04	+	"	"	"
68	<i>S. ulna</i> var. <i>contracta</i>	05	"	"	"	+
	Total no. of species		22	23	45	19

Dia – diameter or length of cell

Table 2: Filamentous algae from Divad

S.N.	Species	Cell breadth in µm
A.	Class – Cyanophyceae	
01	<i>Aulosira bombyansis</i>	08
02	<i>Nostoc punctiforme</i>	04
03	<i>Oscillatoria tenuis</i>	12
04	<i>O. angustissima</i>	03
05	<i>O. tenuis</i> var. <i>tergestina</i>	06
B	Class – Chlorophyceae	
06	<i>Mougetia sphaerocarpa</i>	09
07	<i>Oedogonium australe</i>	12
08	<i>Oedogonium rafescens</i> var. <i>lundellii</i> *	10
09	<i>Rhizoclonium crassipellitum</i>	14
10	<i>Sphaerosozoma pyamaeum</i>	34
11	<i>Tribonema</i> sp.	08
12	<i>Zygnema kashmirensis</i>	14

\*Plate reference – *Oedogonium* sp.

Table 3a: Similarity index (S) for different sites

Mayani		Dhakani		Rajewadi	
0.44					
0.25	0.37				
0.42	0.46		0.23		

Table 3b: Similarity index (S) for different months for Divad

July		August		December	
0.59					
0.31	0.58				

(Fritsch, 1935). The microphotographs of the same are presented in Fig. 1.

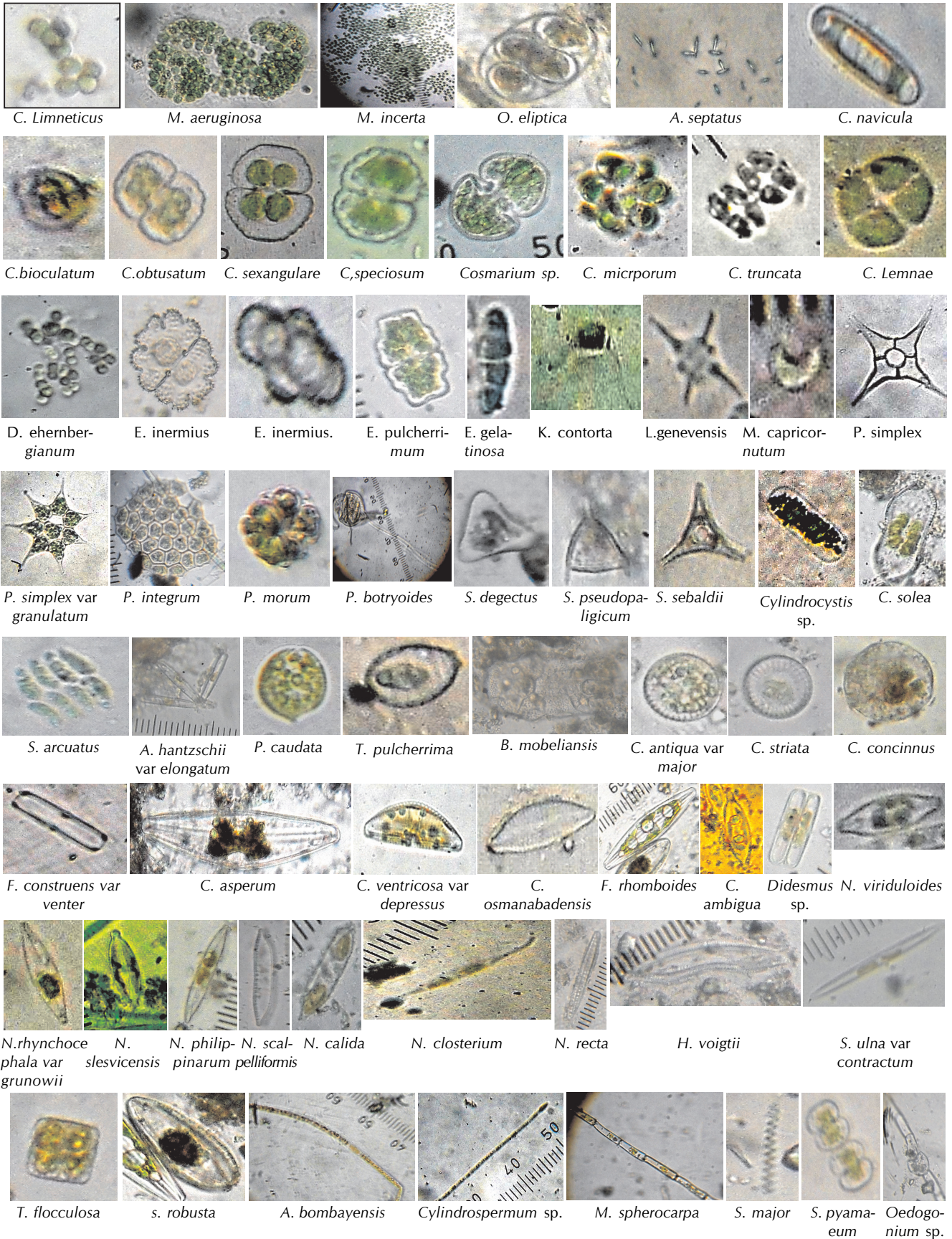
Table 2 records filamentous forms from Divad. The other sites did not show occurrence of filamentous forms, however, Rajewadi lake showed the presence of *Cylindrospermum* sp. (Fig.1) which was not found at Divad. *Closterium acutum*, *Tetraedron minimum*, *T. gracile*, *Diploneis subovalis* var. *perminuta* and *Synedra ulna* var. *contracta* are the species found only in Rajewadi. There are 27 species (Table 1) of phytoplankton specific to Divad site. Thus the Divad site is different from other sites.

The highest value of similarity indices for the sites (Table 3a). 0.46 was found for Dhakani and Rajewadi. Similarity index studied for six sites in Sangli district by Bhosale et al. (2010) ranged between 0.22 and 0.67. Table 3 indicates that four water bodies studied are dissimilar with respect to phytoplankton species richness. The index determined for

Table 4: Occurrence and density of phytoplankton at Divad (seasonal aspect)

S.N.	Species	Density*		
		Jul	Aug	Dec
A.	Class – Cyanophyceae			
01	<i>Burkillia cornuta</i>	10	10	"
02	<i>Chroococcus limneticus</i>	10	"	"
03	<i>Merismopedia glauca</i>	50	30	"
04	<i>Merismopedia elegans</i>	10	07	40
05	<i>Merismopedia tenuissima</i>	"	10	"
06	<i>Microcystis aeruginosa</i>	10	20	"
07	<i>Microcystis incerta</i>	10	20	"
08	<i>Lyngbya</i> sp.	"	10	"
09	<i>Nostoc microscopicum</i>	10	10	01
10	<i>Oocystis elliptica</i>	10	10	"
11	<i>Oscillatoria angustissima</i>	80	50	"
12	<i>O. sancta</i>	"	45	227
13	<i>O. tenuis</i>	100	60	50
14	<i>O. tenuis</i> var. <i>tergestina</i>	20	20	30
15	<i>Spirulina major</i>	"	20	70
16	<i>Aulosira bombyansis</i>	100	"	"
B	Class – Chlorophyceae			
17	<i>Ankistrodesmus falcatus</i>	120	70	70
18	<i>Closterium navicula</i>	10	10	"
19	<i>Coelastrum microporum</i>	"	20	40
20	<i>Cosmarium biculatum</i>	10	10	"
21	<i>C. obtusatum</i>	20	"	"
22	<i>C. speciosum</i>	"	10	10
23	<i>C. sevangulare</i>	10	10	10
24	<i>C. undulatum</i>	30	20	40
25	<i>Cosmarium</i> sp.	"	10	10
26	<i>Chlorochytrium Lemnae</i>	10	"	"
27	<i>Cylindrocystis Brebissonii</i>	10	"	40
28	<i>Dictyosphaerium ehrenbergianum</i>	30	30	50
29	<i>Euastrum inermius</i> var. <i>Burmense</i>	10	10	10
30	<i>E. inermius</i>	"	"	1
31	<i>E. pulcherrimum</i>	10	10	1
32	<i>Golenkinia paucispina</i>	10	"	"
33	<i>Kirchneriella contorta</i>	10	"	"
34	<i>Lagerheimia genevensis</i>	10	"	"
35	<i>Monoraphidium capricornutum</i>	10	"	"
36	<i>Oedogonium australe</i>	100	130	"
37	<i>Oedogonium</i> sp.	10	"	"
38	<i>Pandorina morum</i>	30	"	"
39	<i>Pediastrum clathratum</i> var. <i>baileyianum</i>	"	10	10
40	<i>Pediastrum integrum</i>	"	"	10
41	<i>Pediastrum simplex</i> var. <i>granulatum</i>	"	20	10
42	<i>Pediastrum simplex</i> var. <i>radians</i>	"	40	30
43	<i>Pediastrum duplex</i> var. <i>clathratum</i>	20	10	10
44	<i>Pediastrum duplex</i> var. <i>gracilimum</i>	20	10	20
45	<i>Pediastrum tetras</i>	"	"	30







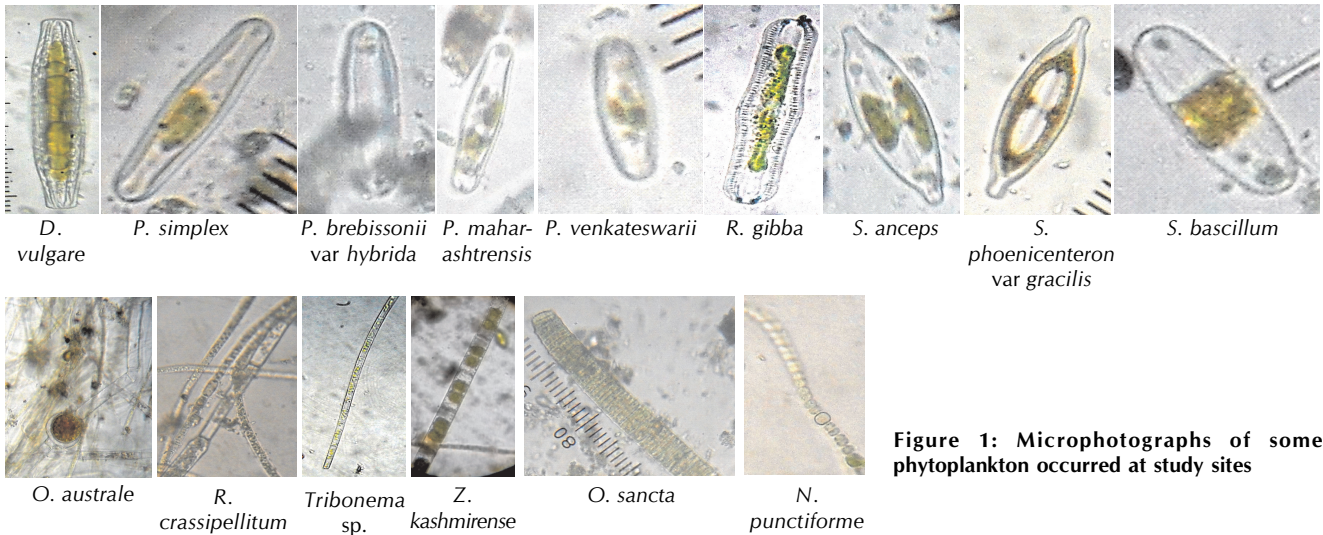
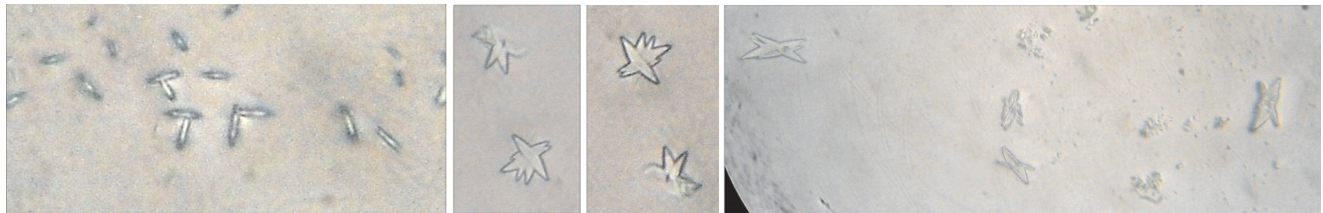


Figure 1: Microphotographs of some phytoplankton occurred at study sites

Diverse cell forms of *Ankistrodesmus septatus* found at Mayani site



Cont.....Table 4: Occurrence and density of phytoplankton at Divad (seasonal aspect)

S.N.	Species	Density*		
		Jul	Aug	Dec
46	<i>Protosiphon botryoides</i>	10	"	"
47	<i>Rhizoclonium crassipellitum</i>	60	40	"
48	<i>Scenedesmus arcuatus</i>	"	"	20
49	<i>S. bijuga</i>	"	"	40
50	<i>S. quadricauda</i>	30	50	20
51	<i>S. quadricauda</i> var. <i>minutum</i>	20	10	10
52	<i>Sphaerosoma pyamaeum</i>	10	"	"
53	<i>Spirogyra condensata</i>	"	"	01
54	<i>S. crassa</i>	"	"	80
55	<i>S. pratensis</i>	"	"	04
56	<i>Spirogyra</i> sp.	"	"	20
57	<i>Staurastrum sebaldii</i>	"	10	20
58	<i>Staurodesmus dejectus</i>	20	"	"
59	<i>Tetraedron limneticum</i>	10	10	"
60	<i>Tetraedron minimum</i>	"	30	"
61	<i>Tribonema</i> sp.	10	"	"
62	<i>Ulothrix zonata</i>	"	40	"
63	<i>Zygnema kashmirensis</i>	90	40	"
C	Class – Euglenophyceae			
64	<i>Euglena proxima</i>	"	"	04
65	<i>Euglena</i> sp.	"	"	01
66	<i>Lepocinclis ovum</i>	"	10	10
67	<i>L. playfairiana</i>	"	10	10
68	<i>L. sphagnophila</i>	"	"	10
69	<i>Phacus caudata</i>	10	"	"
70	<i>Trachelomonas pulcherrima</i>	20	"	"
D	Class – Dinophyceae			
71	<i>Gymnodinium palustrae</i>	20	10	"
72	<i>Peridinium aciculiferum</i>	10	20	"
E	Class " Chrysophyceae	"	10	"
73	<i>Dianobryon divergens</i>	"	10	"

Cont.....Table 4: Occurrence and density .....

S.N.	Species	Density*		
		Jul	Aug	Dec
74	<i>D. socialis</i>			
F	Class – Bacillariophyceae			
75	<i>Amphora ovalis</i>	30	40	30
76	<i>Biddulphia mobeliensis</i>	20	"	"
77	<i>Coscinodiscus concinnus</i>	"	"	10
78	<i>Craticulla ambigua</i>	"	"	10
79	<i>Cyclotella antiqua</i> var. <i>major</i>	"	"	10
80	<i>C. meneghiniana</i>	"	15	50
81	<i>C. striata</i>	"	"	01
82	<i>Cymbella aspera</i>	"	06	10
83	<i>C. lanceolata</i>	20	40	70
84	<i>C. osmanabadensis</i>	"	"	30
85	<i>C. powaiana</i>	"	"	10
86	<i>C. tumida</i>	"	10	40
87	<i>C. ventricosa</i> var. <i>depressus</i>	10	05	40
88	<i>Diatoma valgare</i> var. <i>producta</i>	"	"	70
89	<i>Diademesmis</i> sp.	"	"	30
90	<i>Fragillaria construens</i> var. <i>venter</i>	10	10	16
91	<i>Frustulia rhomboides</i>	"	"	70
92	<i>F. saxonica</i>	"	"	40
93	<i>Frustulia</i> sp.	"	"	10
94	<i>Hantzschia voigtii</i>	"	"	01
95	<i>Melosira granulata</i>	30	50	20
96	<i>Melosira islandica</i>	10	10	10
97	<i>Navicula halophila</i>	"	"	10
98	<i>N. minuscula</i>	10	10	40
99	<i>N. papula</i>	40	70	51
100	<i>N. radiosa</i>	"	30	80
101	<i>N. rhyngocephala</i>	"	10	50
102	<i>N. rhyngocephala</i> var. <i>grunowii</i>	"	"	10
103	<i>N. slesvicensis</i>	"	"	10
104	<i>N. subrhyngocephala</i>	"	"	20

**Cont.....Table 4: Occurrence and density of phytoplankton at Divad (seasonal aspect)**

S.N.	Species Jul	Density*		
		Aug	Dec	
105	<i>N. viridula</i>	"	06	40
106	<i>N. viriduloides</i>	"	"	10
107	<i>Nitzschia acicularis</i>	"	20	"
108	<i>N. archibaldii</i>	30	20	50
109	<i>N. calida</i>	"	"	10
110	<i>N. capitellata</i>	"	"	10
111	<i>N. closterium</i>	"	10	30
112	<i>N. commutata</i> var. <i>pamirensis</i>	"	"	10
113	<i>N. disipata</i>	"	"	10
114	<i>N. palea</i>	10	40	03
115	<i>N. philippinarum</i>	"	"	10
116	<i>N. recta</i>	"	"	10
117	<i>N. scalpelliformis</i>	"	"	10
118	<i>Pinnularia brebissonii</i> var. <i>hybrida</i>	"	"	70
119	<i>P. maharashtrensis</i>	"	"	10
120	<i>P. simplex</i>	"	"	130
121	<i>p. venkateswarii</i>	"	"	30
122	<i>P. viridis</i>	20	10	70
123	<i>Rhopalodia gibba</i>	"	"	30
124	<i>Sellaphora bascellum</i>	"	"	10
125	<i>Stauroneis anceps</i>	"	40	50
126	<i>S. phoenicenteron</i> var. <i>gracilis</i>	"	"	10
127	<i>Surirella robusta</i>	"	10	70
128	<i>Synedra acus</i>	"	40	29
129	<i>S. affinis</i>	"	"	10
130	<i>S. ulna</i>	"	30	90
131	<i>Tabellaria flocculosa</i>	"	"	10
	Total number of individuals	1470	1584	2741
	Diversity index (D)	27.81	38.80	42.99

\*Density as cells (or filaments)/L of lake water

Divad site for three months (Table 3b) indicates that though the similarity in July- August and August-December is very close, the contributing species are different. Chlorophyceae is well represented in July whereas Bacillariophyceae is more represented in December (55 species). The samples of July and December vary greatly in composition.

It is to be noted that Mayani and Divad lakes had a status of a small ditch at the time of sample collection. As a matter of fact, Mayani is a large lake supporting thousands of migratory birds. It is being over exploited mainly for irrigation. When rains are delayed, the situation becomes worst. The study at this period of time records important observations which can be related to the season. *Ankistrodesmus* is an interesting species from this point of view. This species is abundant in the samples from Mayani and Divad. It is highest in July at Divad (Table 4).

Table 4 records the density of each species at Divad during three months. July is a rainy month, however, because of delayed monsoon the summer conditions prevailed. August had rains and December showed low water level. Thus the changes in phytoplankton diversity can be attributed to seasonal changes. The diversity index determined for Divad also indicates seasonal changes showing lowest diversity in summer.

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