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Seasonal phytoplanktonic diversity of Kitham lake, Agra

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Abstract: *Two years (Jan. 2000 – Dec. 2001) data on the seasonal studies of phytoplanktonic diversity of Kitham lake (Sur Sarovar) Agra revealed the presence of 73 algal species. A limited number of these were recorded throughout the year, while others were distributed in different seasons mainly in winter and summer seasons. During winters, Chlorophyceae was the most dominant group followed by Bacillariophyceae. On the other hand, Cyanophyceae and Euglenophyceae were the most dominant during summers. Certain species e.g. Pandorina morum, Pediastrum tetras, Gonium sp., Chlorella vulgaris, Scendesmus quadricauda, Oedogonium cardiocum, Synedra ulna, Oscillatoria agardhii and Euglena gracillis were recorded throughout the year. Chlorella, Stigeoclonium, Pandorina, Micratinium, Oscillatoria, Anacystis, Nitzschia and Cymbella were found to be good indicators of water pollution.*

Key words: *Kitham lake, Phytoplanktonic diversity*, *Agra.*

Introduction

Water pollution is one of the most serious problems faced by man today. Algae play significant ecological role and are being extensively used as indicator of water pollution because they are natural inhabitants of water. Aquatic ecosystem harbours a variety of communities, which constitute the characteristics and functioning of the ecosystem in terms of maintaining production and food chain. Phytoplanktons are the primary producers and constitute the first level in aquatic food chain for all aquatic animals and thus, play a key role in fishery and help in the improvement of pisciculture. The use of density and diversity of phytoplankton and their association as biological indicators in the assessment of water quality or trophic status has been made by several workers (Chaturvedi *et ai.,*1999). The seasonal variation of phytoplankton in lakes has been studied by different workers (Kaur *et al*., 2001; Jarousha, 2002). The present paper deals with the seasonal variation of phytoplanktons in an important water reservoir of the Kitham lake, Agra.

Materials and Methods

Study area: The city of Agra is situated in the upper Gangetic plain on the right bank of Yamuna river at 27º 12' N latitude and 78 º 4' E longitude. It occupies the mid-west corner of Uttar Pradesh. It is tropical with summer season extending from March to June, rainy season from July to October and winter season from November to February. The maximum temperature in April to May ranges between 35 - 48 ºC and minimum between 7-25 ºC during December to February. Kitham lake (Sur Sarovar) is situated at about 20 Km in north-west of Agra. It serves as a reservoir but for last few years, the lake has been invaded with thick growth of aquatic angiosperms particularly, *Eichornia, Trapa*, *Potamogeton*, *Ceratophyllum* and *Hydrilla*.

In the present study four sites were selected at different ecological regions of the lake. Site 1 is located in the western part, site 2 is southern, site 3 in northern part and site 4 in eastern part of the lake. (Fig.1). Various physico-chemical parameters of lake water were analysed after APHA (1995). Algal collections were made during different seasons periodically from different sites. The collected algal samples were preserved in 5% formalin. The preserved samples were brought to the laboratory for quantitative and qualitative analysis. Counting of the planktons was done by using a Sedgwick-rafter cell method. Algae were identified by work of Desikachary (1959) and Cramer (1984).

Results and Discussion

The data on the physico-chemical characteristics and phytoplankton population of Kitham lake water are presented in Tables 1 and 2 respectively. The algal population of the lake consisted of 73 genera, of which 34 belong to Chlorophyceae, 21 to Cyanophyceae, and 14 to Bacillariophyceae and 4 to Euglenophyceae (Table 2). During the study period, the phytoplankton population showed two peaks, winter (November-March) and summer (April- June). The maximum population of Chlorophyceae was recorded in winter season. The filamentous algae dominated other algal forms during a period between December - early March (Table 2). It may be due to higher concentration of nutrients (4.1-9.0 mg. l^{-1}) high dissolved oxygen (6.1-7.0 mg l^{-1}), low quantity of Mg (6.9-12.6 mg.l^{-1}), Ca (7.5-10.5 mg.l^{-1}) CO_2 (30.0-32.4 mg.l^{-1}) and slow water current during this period (Table 1). *Chlamydomonas conferata*, *Pandorina morum*, *Cladophora fracta, Drapernaldia* sp., *Stigeoclonium tenue, Oedogonium cardiocum*, *Zygnema* sp., *Spirogyra longata*, *S. condensata, Ulothrix zonata*, *Chara* and *Nitella* constituted the bulk of population during the winter period (Table 2). Saha (1985) stated that Conjugalean members prefer to grow luxuriently during winter months and species of *Chara* and *Nitella* flourished well in this season especially from December to February.

Similarly, Mittal and Senger (1989) concluded that the low temperature, turbidity and total solid enhance the growth of green algae. Kaur *et al.* (2001) have established that

Table – 1: Seasonal variation of physico- chemical parameter of water at Kitham lake from January 2000 - December 2001.

Parameters	Ranges		
	Summer	Rainy	Winter
Temperature (ºC)	28.5 – 34.5 ºC	24.0 – 31.5 ºC	17.0 – 18.5 ºC
pH	8.2 –8.4	7.0 –7.5	8.3 – 8.6
Turbidity	83 – 320	90 – 450	70 – 205
Colour	Green	Dark brown	Light brown
Dissolved oxygen	1.0 – 4.9	1.3 – 6.3	4.5 – 7.0
Total alkalinity	135 –550	130 – 450	125 – 309
Chloride	70 – 247	65 – 170	70 – 220
Sulphate	15 – 60	10 – 40	10 – 45
Phosphate	2.8 – 5.6	1.5 – 2.4	2.0 – 4.0
Magnesium	7.5 – 17.5	8.5 – 23.5	6.9 – 12.6
Free CO_2	40 – 55.5	38.2 – 40.0	30.0 – 32.4
Calcium	11.7 – 27.5	12.5 – 20.8	7.5 – 10.5
Nitrate	1.6 – 3.3	2.0 – 3.9	4.1 – 9.0
Ammonia	5.2 – 10.2	4.5 – 7.0	2.5 – 5.0
Total hardness	60 – 210	220 – 350	240 – 310

All values are in $mg.l^{-1}$except water temperature, colour and pH.

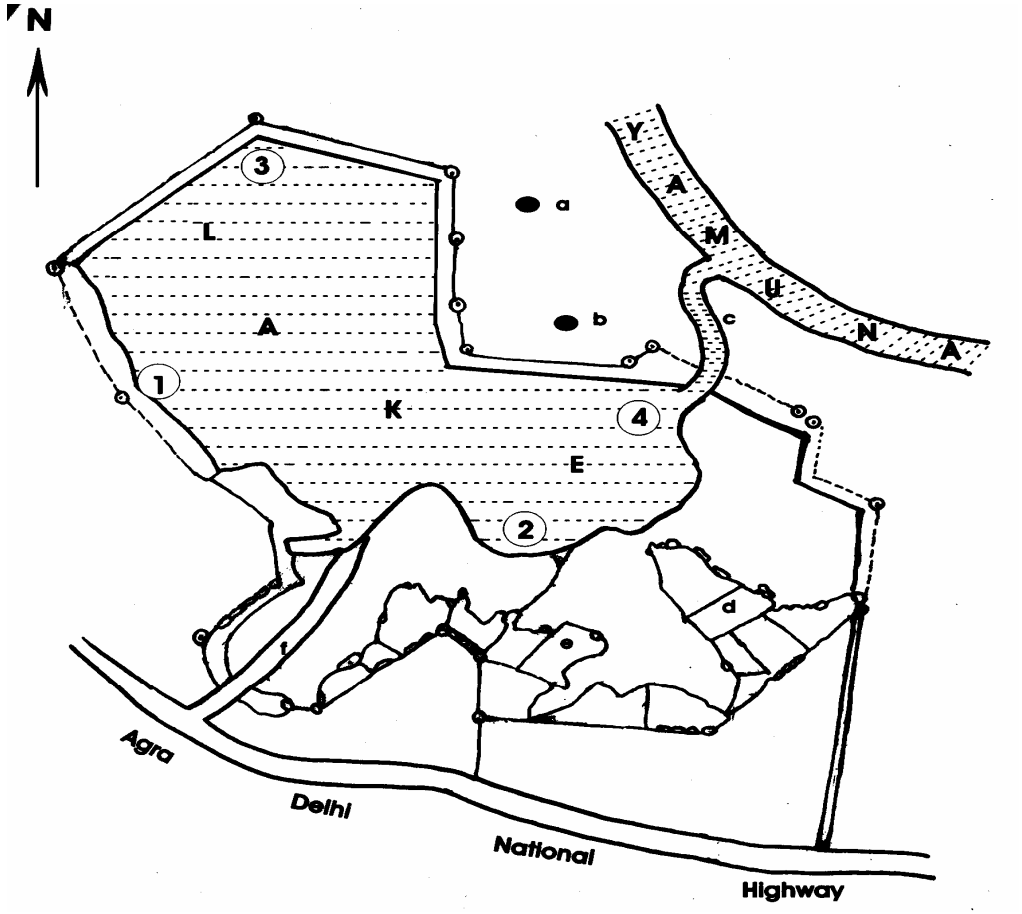

Fig. 1: Sampling sites of Kitham lake.

Index: Study sites 1,2,3, and 4

a. Village Bahadurpur
b. Village Singna
c. Stream of lake joining Yamuna
d. Forest office
e. Residential area
f. Entry to the lake

temperature is the major factor influencing species richness and diversity.

However, the Chlorococcalean forms were high in summers and rainy season (April – September) and low in winters (Table 2). High CO_2 (40.0-55.5 mg.l^{-1}) and high temperature (28.5 – 34.5 ºC) were favourable for them. In July and August the water level increases and becomes quite turbid. Higher quantity of Mg (7.5- 23.5 mg.l^{-1}) and Ca (11.7- 27.5 mg.l^{-1}) content of water (Table 1) have been shown to promote the growth of Chlorococcalean algae. All the peaks consisted of *Pediastrum tetras, P. simplex, P. duplex, Ankistrodesmus falcatus, Chlorococcum humicola, Actinastrum* sp., *Kirchneriella obesa, Elactrothrix gelatinosa, Micratinium pusillum* and *Scendesmus* (Table 2). Senger and Sharma (1986) have recorded that higher concentration of nitrate, calcium and phosphate in water favour the growth of Chlorococcalean algae.

During the present study, presence of *Stigeoclonium, Chlorococcum, Scendesmus, Micratinium, Chlorella, Pandorina* and *Cladophora* is considered as indicator of organic pollution, because all these genera were collected from highly polluted water. At this site, a stream of Yamuna joins the lake. These findings are in agreement with those of Chaturvedi *et al.* (1999). They have collected the same species from six sites of dyes waste water in Sanganer, Jaipur. It is interesting to note that the

Table – 2: Seasonal variation of the phytoplankton in Kitham lake, Agra during the year January 2000 - December 2001.

S.No.	Name of the algal forms	Summer	Rainy	Winter
	Chlorophyceae			
1	*Chlamydomonas conferata*	-	-	+
2	*Gonium* sp.	±	±	+
3	*Pandorina morum*	+	±	+
4	*Elactrothrix gelatinosa*	+	±	-
5	*Micratinium pusillum*	+	+	-
6	*Pediastrum tetras*	+	+	±
7	*P. simplex*	+	+	-
8	*P.duplex*	+	+	+
9	*Ankistrodesmus falcatus*	+	+	±
10	*Kirchneriella obesa*	+	+	-
11	*Actinastrum sp.*	+	±	-
12	*Chlorococcum humicola*	+	+	-
13	*Golenkinia radiata*	+	+	±
14	*Chlorella vulgaris*	+	±	±
15	*Oocystis borgei*	+	+	-
16	*Scendesmus quadricauda*	+	+	±
17	*S. bijuga*	-	-	+
18	*S. dimorphus*	-	+	+
19	*Cosmerium biculatum*	+	-	-
20	*Netrium digitus*	±	-	+
21	*Stigeoclonium tennue*	±	±	+
22	*Cladophora fracta*	±	-	+
23	*Oedogonium cardiocum*	±	±	+
24	*Zygnema* sp.	-	-	+
25	*Spirogyra condensata*	-	-	-
26	*S. longata*	-	-	+
27	*Uronema* sp.	-	-	+
28	*Rizoclonium hookeri*	-	-	+
29	*Ulothrix zonata*	-	-	+
30	*Drapernaldia sp.*	-	-	+
31	*Closterium cynthia*	+	-	-
32	*Hydrodictyon reticulatum*	±	-	+
33	*Chara* sp.	-	-	+
34	*Nitella* sp.	±	-	+
	Cyanophyceae	±	-	+
35	*Microcystis elabans*	+	±	-
36	*Merismopedia* sp.	+	±	+
37	*Scytonema coactile*	+	-	±
38	*Synechosystis aquatilis*	+	-	-
39	*Oscillatoria chalybea*	+	+	-
40	*O.principes*	+	+	-
41	*O.limosa*	+	-	-
42	*O. platensis*	+	±	-
43	*O.acuta*	+	+	-
44	*O.tenuis*	+	-	-
45	*O. formosa*	±	+	-
46	*O. platensis*	+	-	-
47	*O. agardhi*	+	+	±
48	*Arthrospira* sp.	+	±	+
49	*Lyngbya birgei*	+	-	-
50	*Phormedium* sp.	+	-	-
51	*Nostoc linckia*	+	+	-
52	*Aphanocapsa pulchra*	+	-	±
53	*Nodularia* sp.	+	±	-
54	*Anacystis* sp.	+	-	+
55	*Anabaena iyengarii*	+	-	-
	Euglenophyceae			
56	*Euglena virids*	+	-	+
57	*E. oxyuris*	+	+	±
58	*E. gracillis*	+	+	±
59	*Phacus triquter*	+	-	+
	Bacillariophyceae			
60	*Pinnularia major*	+	-	+
61	*Syndrea ulna*	+	±	+
62	*Navicula pupula*	-	+	-
63	*N. confervacea*	+	-	+
64	*Gomphonema parvulum*	-	-	+
65	*G. montalum*	±	-	+
66	*Cymbella ventricosa*	±	-	+
67	*C. deliculata*	-	-	+
68	*C. hustedii*	+	-	±
69	*Cyclotella glomerata*	-	-	+
70	*Nitzschia acicularis*	-	-	+
71	*N. communis*	+	-	+
72	*Fragilaria vaucheriae*	-	-	+
73	*Frustulia* sp.	-	-	+

+ present - absent ± rare.

pH and quantity of chlorides in dye waste water in Sanganer is similar to polluted Yamuna water collected at Agra.

Blue- green algae attained maximum number during a period between April–June and decreased thereafter. *Oscillatoria chalybea, O. limosa, O. platensis, O. tenuis, O. principes, Nostoc, Anabaena iyengarii, Phormedium, Nodularia, Scytonema coactile, Microcystis elebans, Lyngbya birgei, Synechosystis aquatilis* and *Anacystis* were the most dominant species during high temperatures (Table 2). This only be because of higher values of CO_2 (40 – 55.5 mg. l^{-1}), pH (8.2-8.4) and high turbidity (83-320 mg. l^{-1}) (Table 1) which favours Cyanobacterial growth. On the other hand, *Oscillatoria formosa,* and *O. agardhi* constituted the bulk of population during rainy season and the density of *Merismopedia* was found to be very low (Table 2). Water blooms were also found in summer season (April- May) when oxygen contents were very low. These species of Cyanobacteria which are tolerant to organic pollution can be used as 'Marker species' or indicator of water pollution.

Sarojini (1996) and Tarar and Bodhke (2002) have observed that high turbidity, pH, bicarbonate, orthophosphate, alkalinity, chloride may be responsible for the Cyanophycean growth and bloom. Kumar and Saini (1998) have recorded an inverse relationship between CO_2 and pH. Jarousha (2002) have reported that higher diversity of the blue-green algae may be attributed to high nitrate values during the rainy season. In the present study, 14 species of diatoms were recorded (Table 2). The common diatoms were *Pinnularia major, Synedra ulna, Navicula confervacea, Gomphonema montanum, Frustulia* sp., *Nitzschia communis* and *Cymbella deliculata.* During present investigation, *Gomphonema parvulum, G. montanum, Cymbella hustedii* and *Nitzschia acicularis* showed some interesting results in their dominance. These are good indicators of water pollution. They attain maximum development during winter months. Diatoms were more in winters than in summers and least in rainy season. The species of diatoms grow luxuriantly during high value of pH, nitrate, high organic matter, low quantity of phosphate and low temperature (Table 1). According to Nautiyal *et al*. (1996) and Tarar and Bodhke (2002) winter months were more favourable for multiplication of diatoms. However, Kaur *et al*. (2001) have recorded minimum population of diatoms during moderate temperature.

As compared to other classes of algae, the members of euglenoid were recorded least in number. The highest peaks of *Phacus triquater* and *Euglena viridis* were found during winters. On the other hand, *Euglena oxyuris* and *E. gracillis* were more abundant in rainy season where the water was highly polluted while small peaks were recorded during winters with low range of CO_2. Kiran *et al*. (2002) have reported that higher range of (15-24 mg.l^{-1}) carbon dioxide promoted the moderate growth of Euglenophyceae. Kaur *et al.* (2001) stated that *Euglena* was found at all the sites studied at Jaipur by them and these could be considered as pollution tolerant species.

Thus, from the foregoing observations of the present authors, it is clear that winters are more favourable for the Chlorophyceae and Bacillariophyceae. On the other hand, there is abundance of Cyanophyceae during summers. Certain species e.g. *Chlorella vulgaris, Pandorina morum, Scendesmus dimorphous, Stigeoclonium tennue, Chlorococcum humicola, Pediastrum tetras, Micratinium pusillum, Oscillatoria agardhi, Anacystis* sp., *Arthrospira* sp., *Euglena oxyuriss, Cymbella hustedi, Nitzschia acicularis* and *Frustulia* sp. are good indicators of water pollution.

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