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SEASONAL DISTRIBUTION OF PHYTOPLANKTON IN KINJHAR (KALRI) LAKE

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Abstract

An ecological survey of phytoplankton in Kinjhar Lake was carried out from March 1968 to February 1971 at the surface and from March 1970 to February 1971 at various depths. Phytoplankton belonging to three algal groups, Myxophyceae (22 species belonging to 12 genera), Bacillariophyceae (53 species belonging to 27 genera) and Chlorophyceae (19 species belonging to 8 genera) were observed. *Microcystis aeruginosa* was the most abundant species present throughout the year at the surface but its maximum growth was observed in summer. *Melosira granulata* and *Spirogyra fuellebornei* were next in abundance. Kinjhar Lake is highly eutrophic due to the presence of nearly permanent bloom of Myxophyceae and significant growth of diatom species.

Introduction

Qualitative and quantitative determinations of phytoplankton are essential for the studies of the aquatic environment especially for production aspects. Phytoplankton, the primary producers of the water reservoirs, are the chief source of food both directly and indirectly to the fish population. An ecological survey of phytoplankton species in Kinjhar Lake was therefore carried out. Kinjhar formerly known as Kalri, is an artificial tropical lake (Micheal, 1967). It is situated nearly 75 miles from Karachi and lies between 24° 47'N and 68° 2' E (Blatter, et. al, 1929). The lake is 17 miles long and has an area of 50 sq. m, (Qureshi, 1964-66).

Materials and Methods

The lake was divided into six stations called Chull-inlet, Sunehri, Ali-Bar, Boat Club, Chilya—Outlet, Jhampir (Fig. I) and the survey of phytoplankton species was carried out from March 1968 to February 1971 at surface and from March 1970 to February 1971 at various depths. Water samples from the surface were taken mostly fortnightly by hauling for 10 min. usually between 12 a.m. to 3 p.m. with the help of row boat through a fine net of 105 nm mesh apertures. The depth samples were taken by a sampler of half liter capacity. Samples from the plankton net and from the sampler were transferred carefully to 500 ml plastic bottles and were preserved in 4% formalin solution (Mason, 1967). Water samples were generally collected from the whole area at Boat Club due to boating facillaties but collection of water samples from other points were done at the shores of the lake. The species composition and cell numbers were determined by Utermohl method (Lund et al, 1958). Cells of *Microcystis aeruginosa* were counted by haemocytometer. Taxonomical study of the species was done after centrifugation of the water sample. The diatom species were studied after boiling the centrifuged material in concentrated nitric acid (Holland, 1968) and then washing the residue with distilled water.

Results and Discussion

Ninety four species belonging to 47 genera of three algal groups Myxophyceae, Bacillariophyceae, and Chlorophyceae were recorded. In respect of species number, Bacillariophyceae was the most dominant group followed by Mxyophyceae and Chloro-

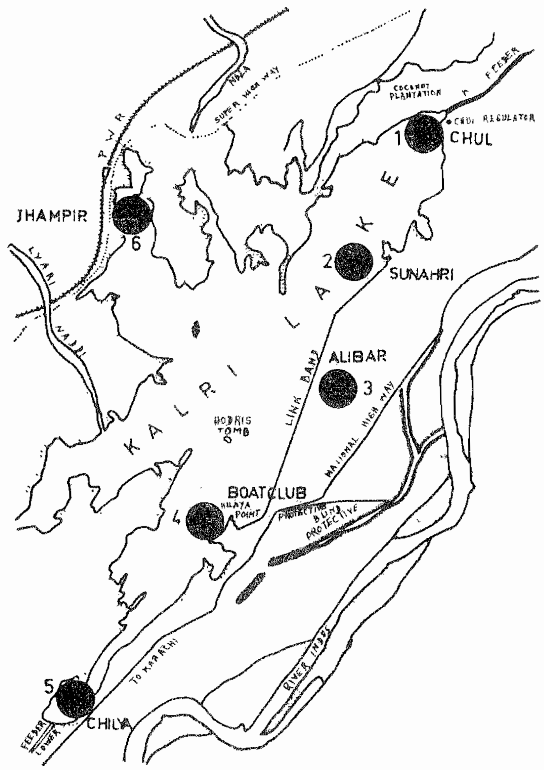

Fig. 1. Map of the Kinjhar (Kalri) Lake. (Black circles indicate the stations).

phyceae. In respect of cell concentration however Myxophyceae was the most dominant group. The colourless microflagellates were observed mostly in May.

Seasonal variations in the abundance of total phytoplankton show that the maximum bloom occurred during summer 1970 (Fig. 2) while the minimum summer peak was observed in 1969. The maximum bloom of phytoplankton was related to a heavy growth of Myxophyceae during this period. Of the other two groups of algae the growth of Bacillariophyceae was greater than Chlorophyceae. A decrease in the abundance of total phytoplankton as observed in May 1969 and 1970 and in November 1969 and 1970, was related to the disappearance of *Microcystis aeruginosa.*

Dickman (1969) has argued that those lakes which act as temporary impoundments to the flow of water from inlet and outlet are unusual because of the major role of flushing in regulating their primary productivity.

A continuous bloom of phytoplankton especially *Microcystis aeruginosa* occurred throughout the year with maximum bloom in summer. In normal conditions and in

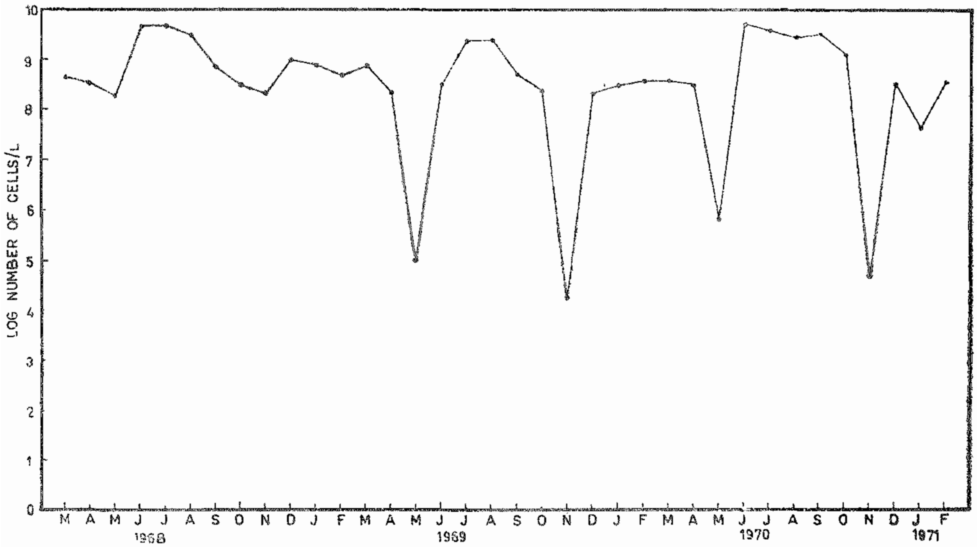

Fig. 2. Seasonal distribution of total phytoplankton (monthly mean values) at the surface from March 1968 to February 1971

close water bodies of tropical impoundments such bloom has also been noticed by Ganapati (1940) during the study of permanent algal bloom in a fish tank in India. Kinjhar Lake also acts as a temporary impoundment and it appears that flushing may be a major cause of observed irregularities (Dickman, 1969). The abundance of phytoplankton at Boat Club in comparison to other points of the lake seems to be due to the slow movement of water at this spot since it is situated at a considerably long distance from inlet and is also the deepest part of the lake.

The abundance of phytoplankton was irregular at various depths, maximum growth usually occurred in August and September while the highest cell concentration of total phytoplankton was observed at a depth of 3' in March (Fig. 3) due to the presence of luxuriant growth of a Myxophycean species. The usual minimum cell concentration 1×10^3 cells/l was observed intermittently at various depths during the period of observation. Minimum cell concentration at all depths was observed in January, while no growth was observed in December when *Melosira granulata* was observed during this month at a depth of 1'. The disappearance of phytoplankton at each depth during December seemed to be due to a sharp fall in water temperature.

Phytoplankton of Myxophyceae group were represented by 22 species belonging to 12 genera. This group dominated the others in quantity due to the luxuriant growth of a single species *Microcystis aeruginosa* while the other species were rare (Table I). Since Myxophyceae constituted the maximum part of phytoplankton population, its distribution curve was very similar to the curve of total phytoplankton (Fig. 2,4). The usual cell concentration occurred in July but sudden rise in cell numbers usually started from June and the increased concentration of the cells remained upto October.

Below the surface the abundance of Myxophyceae was observed in March at a depth of 3' due to the abundance of *Anabaenopsis elenkinii* but the maximum cell

TABLE 1. Seasonal Distribution of Myxophycean species in 10^3 cells/l (Mean of three years, from 1968-1971)

Name of the Species	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Anabaena sp.	—	—	—	..	9444	..	—	—	—	—	—	—
Aphanizomenon flos aquae	..	..	—	—	—	—	—	—	—	—	..	10
Gomphosphaeria naegeliana	—	—	—	..	26	3	—	—	—	—	—	—
Lyngbya birgei	—	19	332	115	4951	..	..	111	—	—	—	1
Merismopedia glauca	—	—	—	23	13	..	—	—	—	—	—	—
M. tenuissima	—	—	—	1	5760	3	..	—	—	—	—	—
Microcystis aeruginosa	510000	303333	93333	1587916	2573543	2776666	1556666	2267933	77500	523333	381666	436666
Nostoc sp.	—	—	—	..	—	—	—	—	—	—	—	—
Chormidium boryanum	—	—	—	1	96	..	—	—	—	—	—	—

— — absent
.. — below the range

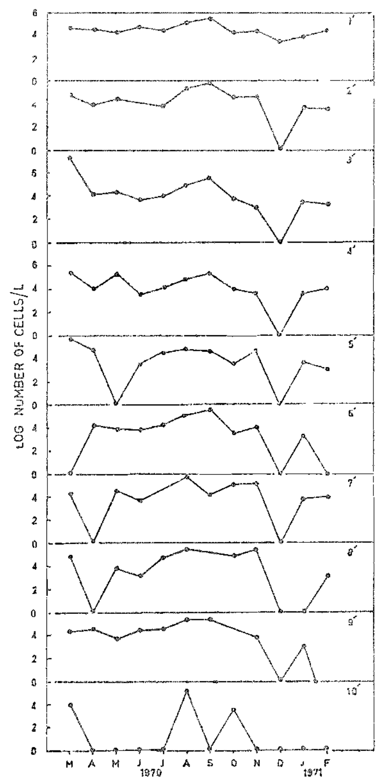

Fig. 3. Seasonal distribution of total phytoplankton (monthly mean values) at various depths (from 1 to 10 ft. depth) from Mar. 1970 to February 1971.

concentration of Myxophyceae at various depths (Table 4) occurred generally during August and September due to the presence of *Microcystis aeruginosa*. It was interesting to find that the Myxophycean species especially *Microcystis aeruginosa* was particularly abundant below the surface during August and September, almost immediately after the period of maximum bloom in summer season. It seems reasonable to suggest that perhaps due to some damage a significant proportion of the cells become heavier and settle down. The exact nature of damage could not be determined although the cells collected from various depths were rather paler in colour and some what distorted. It appears that this damage is caused by intense interspecific and intraspecific competition since the cells, in any significant concentration in depth samples, were found only after the period of maximum growth of dominant species.

Amongst the observed species, a total of 53 species of diatoms belonging to 27 genera were identified, Of these 2 genera were Centric while the remaining species belonging to 25 genera were Pennate diatoms. With few exception all the species were observed in surface samples (Table 2) but only 33 species were found below the surface. The species composition of diatoms showed a reseblance with other tropical

Table 2. Seasonal Distribution of Bacillariophycean species in 10^2 cells/l (Mean of three years, from 1968-1971)

Name of the species	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Achnanthes hungarica	20	8	..	33	43	..	152	9	31	33	—	4
Amphora affinis	..	13	13	—	—	—	—	—	—	—	.	4
A. ovalis	50	29	26	—	—	—	—	—	—	—	6	5
Anomoeoneis axilis	..	15	—	—	—	—	—	—	—	—	8	..
A. serians	..	24	38	—	—	—	—	—	—	—	8	.
Cocconeis placentula	..	145	46	29	21	..	20	37	21	38	45	26
Cyclotella compta	—	—	—	.	..	16	—	—	—	—	—	—
Cymatopleura elliptica	—	—	—	..	7	..	—	—	—	—	—	—
C. solea	—	—	—	3	4	..	—	—	—	—	—	—
Cymbella cymbiformis	8	37	3	327	32072	..	..	..	—	..	19	13
C. gracilis	—	—	—	—	—	—	10	2	.	—	—	—
C. helvetica	—	—	—	—	—	—	—	—	—	—	3	—
C. lacustris	—	18	..	..	.	7	16	..	10	26	—	1
C. parva	—	..	—	..	—	..	220	19	14	16	..	1
C. tumida	375	10	75	.	..	.	330	4	..	16	6	.
C. ventricosa	39	82	115	28	..	414	790	37	9		21	9
Diatoma vulgare	—	8	4	.	161000		—	10	3	—	—	..
Epithemia argus	435	32	45	84	32043	.	..	31		48	9	17
E. zebra	37	2	45	—	—	—	—	—	—	27	10	12
Eunotia arcus	—	—	—	—	—	—	—	—	—	4	—	3
Fragilaria construens	—	19	.	..	21	.	—	—	—	—	—	—
F. virescens	5	21	59	1731	16225	96	64	16	..	56	40	15
Gomphonema ghosea	16	39	13	—	..	41	129	..	21	33	10	..

G. parvulum	—	—	—	—	—	—	1	15		—	—	—
Gomphoneis sp.	4	6	—	8	—	.	—	—	.	4	—	3
G. attenuatum	23	8	—	—	—	—	—	—	—	—	—	—
G. scalbroides	.	23	4	—	—	—	—	—	-	—	—	—
Melosira granulata	21718	521	1878	13991312	6944516	1384	2676	1349866	296	9312	262	37
Navicula cryptocephala	2	16		—	—	—	—	—	—	—	—	—
N. radiosa	16	.	42	29	—	110	100	—	—	—	.	1
N. rhyncocephala	—	-	—	—	—	—	330	3	..	—	—	—
N. seminulum	—	.	33	—	—	—	—	—	-	—	-	—
N. viridula	—	—	—	—	—	—	220		..	—	—	—
Neidium iridis	.	2	100	—	—	—	—	—	—		8	.
N. productum	—	7	8	.	11	.	.	—	—	—	—	—
Nitzschia hungarica	3		4	—	—	—	—	—	—	—	—	—
N. palea	32	3	—	—	—	—	—	—	—	2		1
N. sigmoidea	8	5	3	3	11		—	—	—	—	—	—
Pinnularia gibba	—	—	—	128	31333	391	478		26	—	—	—
P. major	41	29	108	144	16	16	—	—	—	—	—	1
P. nobilis	—	—	—	.	—	.	220	18	—	—	—	—
P. virdis	—		50	—	.	4	100	—	-	—	.	—
Rhopalodia gibba	16	10	10	..	31333		—		—	26	2	2
Rhoicosphemia curvata	—	1	8	—	—	—	—	—	—	..	8	1
Stauronies ancep	20	24	..	—	—	—	20	—	102	.	116	1
Suirirella splendida	2	..	10	4	—	—	—	—	—	—	—	—
Synedra acus	—	—	—	11	11	—	—	—	—	—	-	—
S. rumpens	..	7	—	—	—	—	—	—	—	.	2	—
S. ulna	913	4677	62	1508	39391	2867	1852	141	72	95	26	12

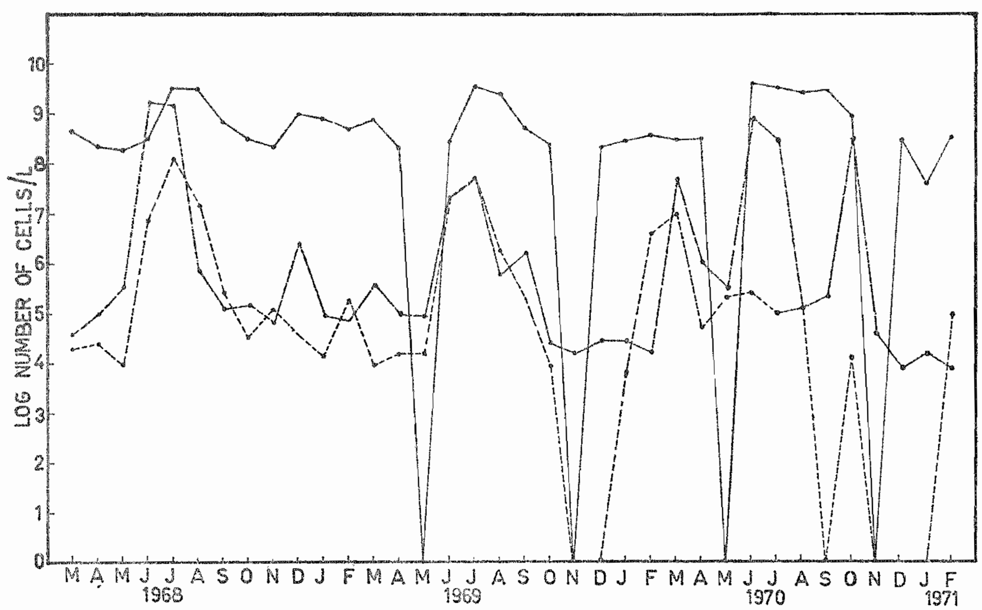

Fig. 4. Seasonal distribution of three different phytoplankton groups (monthly mean values) at the surface from March 1968 to February 1971. (o——o) indicates the distribution of Myxophyceae (o– – –o) indicates the distribution of Bacillariophyceae (o—.—.o) indicates the distribution of Chlorophyceae.

bodies of Indo-Pakistan subcontinent. (Majeed, 1935) Singh, (1960, 1964; Jayangoudar, 1964, Sreenivasan, 1964).

Of the species of diatoms, *Melosira granulata* was the predominant species observed throughout the year with maximum growth in June and July followed by sudden decrease in August. Jayangoudar (1964) has also observed *Melosira granulata* as the most dominating phytoplankton species in Nuggikari Lake.

In addition to *Melosira granulata* other common diatoms species were *Cocconeis placentula*, *Cymbella cymbiformis*, *Cymbella tumida*, *Cymbella ventricosa*, *Diatoma vulgare*, *Epithemia argus*, *Fragilaria virescens*, *Navicula radiosa*, *Synedra ulna*. Other species were rare and appeared only for a very short period.

The maximum growth of dominating diatom species was observed in June and it occupied a place next to Myxophyceae in respect of cell concentration (Fig. 4). It seems significant to note that the growth of diatoms as compared to Myxophyceae was least decreased in April or May when absorption of light in water was poor due to the marked turbidity.

Phytoplankton of Chlorophyceae group were present during most part of the year with a concentration of 1-5 x 10^4 cells/l except in the blooming period when cell concentration increased upto 10-100 times more than the usual value. The maximum cell concentration was usually observed in July except in 1970 when it was observed in March

TABLE 3. Seasonal Distribution of Chlorophycean species in 10^3 cells/l (Mean of three years from 1968-1971)

Name of the Species	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Chlorhormidium flaccidum	5	..	171	..	—	—	—	—	—	—	—	—
Posmarium fontigerum	333	..	—	7	64000	..	—	—	—	—	—	—
P. saprosperiosum	2	—	—	—	—	—	—	—	—	—	—	—
Desmid sp.	..	—	—	—	—	—	—	—	—	—	—	—
Mougeotia thylespora	3	..	—	—	—	—	—	—	—	—	—	—
Pediastrum sp.	7	..	8	62	64043	..	—	—	—	—	—	—
P. simplex	3	..	15	20	3	—	—	—	—	—	—	—
Scenedesmus quadricauda	—	—	—		326	..	—	—	—	—	—	—
Spirogyra juellebornei	14680	5	..	230	350934	40568	352	..	222	692	75	290
S. hollandiae	4	—	—	10	150000	—	..	..	..	—	..	14
S. mirabilis	135	..	.	42	14562	4890	..	156	..	—	.	53
S. quadrilaminata	145	..	467	295	9207	7321	1048	..	—	—	..	42
S. sphaerocarpa	—	—	962	21	.	—	—	—	—	—	—	—
S. submaxima	2	..	50	25000	20493	40	..	..	221	..	..	—
Zygnema conspicuum	27894	92	17	79601	..	6631	.	..	—	—	..	7488
Z. gangeticum	148	..	—	..	41300	3450	..	—	—	—	..	7316

Table 4. Seasonal Distribution of phytoplankton species in 10^3 cells l (Mean values of 1 to 10' depths)

Name of the species	Mar.	Apr	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
MYXOPHYCEAE *Anabaena circinalis*	—	—	—	—	—	—	..	7	113	—	—	—
A. sproides	—	—	—	—	—	—	—	..	150	—	—	—
A. variabilis	27	—	—	—	—	—	..	..	—	—	—	—
Anabaenposis elenkini	17616	.	..	—	—	—	—	—	—	—	—	—
A. milleri	2379	.	12	—	—	—	—	—	—	—	—	—
Lyngbya birgei	13	49	—		29	—	—	.	35	—	—	—
L. polysiphonae	—	—	—	—	—	—	.	6	—	—	—	—
L. saxicola	—	—	—	—	—	—	.	9	—	—	—	—
Merismopedia glauca	—	—	—	.	30	6	—	—	—	—	—	—
Microcystis aeruginosa		.	—	.	78	7879	5536	924	.	—	..	.
M. ramosa	—	—	—	—	—	-		5	—	—	—	—
M. robusta	—	—	—	—	—	—	71		—	—	—	—
M. viridis	—	—	—	-	—	—	47	.	—	—	—	—
Mycanthococcus sp.	—	—	—	—	—	—	.	11	4	—	—	—
Stigonema ocellatum	214		—	—	—	—	—	—	—	—	—	—
Tetrachloris merismopediodes	—	—	—	—	—	—	7	1	1	—	—	—
BACILLARIOPHYCEAE *Achnanthes hungarica*	2		—	—	1	-	121	1	—	—	—	—
Amphora affinis	2		—	—	—	—	—	—	—	—	—	—
A. ovalis	3	1	—	—	—	—	—	—	—	—	1	—
Asterionella formosa	1	1	1	—	—	—	—	—	—	—	—	—
Caloneis bacillum	—	—	5	—	—	—	—	—	—	—	—	—

Cocconeis placentula	.	.	—	—	—	—	..	1	—	—	3	—
Cyclotella compta	—	—	—	—	.	15	—	—	—	—	—	—
Cymbella cymbiformis	10	.	14	2	2	—	..	—	1	—	..	..
C. helvetica	—	—	—	—	—	—	—	—	—	—	—	
C. parva	—	—	—	—	—	—	—	—	1	—	—	—
C. tumida	—	..	12	1	1	2	..	1	—	—	—	—
C. ventricosa	12	.	.	1	..	3	..	4	1	—	4	..
Diatom sp.	—	—	—	—	—	—	—	—	1	—	—	—
Diploneis ovalis	.	—	—	—	—	—	—	—	—	—	—	—
Epithemia argus	1	..	..	..	5	2	—	..	1	..	..	..
F. zebra	—	..	1	—	—	—	—	—	—	—	—	—
Fragilaria virescens	6	..	.	—	—	2	..	—	—	—	4	—
Gomphonema ghosea	10	..	.	—	—	..	2	—	—	—	..	..
Gyrosigma attenuatum		2	—	—	—	—	—	—	—	—	—	—
G. scalproides	—	—	6	—	—	—	—	—	—	—	—	—
Melosira granulata	93	86	197	144	213	40	216	57	217	..	8	1
Navicula gastrum	1	.	7	—	—	—	1	1	—	—	—	—
N. rhyncocephala	—	—	—	—	—	—	—	..	2	—	—	—
N. viridula	—	—	—	—	—	—	—	1	—	—	—	—
Nitzschia palea	..	3	3	—	—	—	—	—	—	—	..	.
Pinnularia gibba	—	.	—	—	1	1	1	1	—	—	—	—
P. major	.	1	6	1	—	..	..	—	—	—	—	—
P. viridis	—	—	..	..	1	..	—	—	—	—	—	—

Table 4 (Contd.)

Rhopalodia gibba	—	..	—	—	—	—	—	.	1	—	—	—
Stauroneis ancep	.	—	—	—	—	—	—	—	7	—	—	—
Synedra acus	—	—	—	2	1	..	—	—	—	—	—	—
S. rumpens	—	..	..	—	—	—	—	—	—	—	4	—
S. ulna	9	16	15	10	6	2	..	3	4	—	22	11
CHLOROPHYCEAE												
Cosmarium flaccidum	—	..	—	—	3	—	—	—	—	—	—	—
C. cucurbita	—	—	—	6	2	—	—	—	—	—	—	—
Desmid sp.	—	—	..	—	—	—	—	—	—	—	—	—
Mougeotia thylespora	84	..	—	—	—	—	—	—	—	—	—	—
Pediastrum sp.	..	..	—	—	1	2	—	—	—	—	—	—
P. simplex	..	—	1	—	..	4	—	—	—	—	—	—
Scenedesmus quadricauda	—	—	—	—	—	1	—	—	—	—	—	—
Spirogyra fuellebornie	105	..	66	..	..	..	..	2	—	—	..	3
S. hollandiae	84	..	—	—	—	—	—	1	1	—	—	—
S. mirabilis	..	—	—	—	..	—	—	—	—	—	..	—
S. neglecta	—	5	19	—	—	—	—	—	—	—	—	—
S. quadrilaminata	25	1	..	..	—	..	—	..	—	—	.	..
S. sphaerocarpa	—	9	—	—	—	—	—	—	—	—	—	—
S. submaxima	..	—	—	—	—	—	..	4	1	—	—	—
S. subreticulata	2	..	23	—	—	—	—	—	—	—	—	—
Zygnema conspicuum	17	..	—	..	—	..	—	—	—	—	—	..
Z. gangeticum	2	—	—	—	—	—	—	—	—	—	—	—

— = Absent
.. = Below the range

but this was much less in comparison to the growth observed in 1968 and 1969 (Fig. 4). Das & Srivastava (1959) have also observed the bloom of Chlorophyceae during the month of June in their studies on a tropical Lake Kathata in East Africa.

In depth samples the cells of Chlorophyceae were recorded upto a depth of 9'. The growth was better in March (Table 4) and none of the member of Chlorophyceae were recorded in December.

The members of Chlorophyceae though well represented in species numbers and population density but were still comparatively less than Myxophyceae, and Bacillariophyceae in these respects. During this study 19 species of Chlorophyceae belonging to 8 genera were identified but only two of these *Spirogyra fuellebornei* and *Spirogyra quadrilaminata* were abundant (Table 3). Both of these species were present during most of the year. The observations indicate that these species could tolerate a wide range of temperature and light. The population of *Spirogyra fuellebornei* showed a maximal size usually in July.

The lakes with high nutrients and abundant growth of Myxophyceae and diatoms are called eutrophic lakes (Pearsall, 1932; Beeton, 1965). In addition to these, other criteria like Phytoplankton species e.g. *Melosira granulata*, *Microcystis aeruginosa*, *Aphanizomenon flos-aquae* and *Anabaena spp.* have also been used to charecterise eutrophic lakes (Hutchinson, et al., 1946; Lund, 1962; Hutchinson, 1967). All these features of an eutrophic lake have been observed in the Kinjhar Lake.

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