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Comparative Ecological Study of Phytoplankton of Bakar and Phoosna Lakes–Pakistan

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A comparative ecological study of phytoplankton of Lake Bakar, district Sanghar and Lake Phoosna, district Badin was carried out during August, 1993 to July, 1996. A total of 78 species belonging to 33 genera of 5 classes (Bacillariophyceae, Chrysophyceae, Dinophyceae, Xanthophyceae and Euglenophyceae) were recorded. 12 species were common in both Lakes. 58 species were present in Lake Bakar and 8 in Lake Phoosna. The study showed that the aquatic environment of Lake Bakar is qualitatively much better as compared to Lake Phoosna.

Key words: Phytoplankton, Bakar Lake, Phoosna Lake.

Introduction

Qualitative and quantitative determinations of phytoplankton are essential for determining the aquatic productivity as they are the chief source of food for aquatic animals including fishes. Bakar lake is subtropical (Blatter 1929; Mitcheal 1967) and is situated in desert area of Sindh at an altitude of 50 m, latitude 26° 06' North, longitude 68° 10' East. Its width is 2.5 km and length is 45km. According to Prescott (1961) referring to older, shallow lakes, highly productive for the eutrophic lake so Phoosna is a shallow eutrophic lake, situated in between 68°.55' longitude (East) and 24°.50' latitude (North) at a distance of 20 km from Badin, 5 km, towards North of Hyderabad Badin Road. It is a private owned fishing lake, spread over an area of 500 acres. The lake is shallow, about 2-3 meters deep. Since it is surrounded by agriculture land, consequently also receives leached plant nuterients. The present study was carried out as very little work has been done on the phytoplankton of lakes from Sindh (Nazneen 1974).

Phytoplankton is an important group of algal flora. These are the producers of food in the food cycle of aquatic ecosystems, fixing energy by the process of photosynthesis. The phytoplankton are widely distributed and are an important component of various ecosystems like marine, rivers, ponds and streams etc. Algal flora is a good indicator of pollution (Patrick 1966) and bloom in the water bodies receiving animal, poultry and household waste. The diatoms are a vast group of phytoplankton having diverse economic importance. These are present throughout the year and resist the adverse environmental conditions due to hard silica shell. Diatoms serve the purpose of indicator of oil reserves in the sediments in which they are found in fossilized forms. Many important oil reserve discoveries have been made by OGDC by the study of these diatoms. Other industrial uses include the use of diatoms as abrasive material in the tooth pastes. In advanced countries these are used in the preparation of some solutions to clean the walls, sound and fire proofing materials and polish for the heavy metals.

The present work will give the comparative results of phytoplankton distribution in the Phoosna and Bakar Lakes, where different physico-chemical properties and other parameters have been taken into consideration to study the phytoplankton flora.

Materials and Methods

Phytoplankton were collected monthly from August, 1993 to July, 1996 between 11 a.m. to 3 p.m with the help of boat using phytoplankton net of 5-10 mm mesh. Water samples were collected using water sampler (Nansen bottle) for studying physico-chemical features using standard methods (APHA 1985) and for quantitative studies of phytoplankton. Samples were preserved in 4% formalin. The species composition was determined by Utermöhl method (Lund 1958). The micro algae (Ultra nannoplankton) were not counted as Gorham *et al* (1974), considered these algae comparatively unimportant in high productive lakes. The association of (Ultra nannoplankton) with phyto and tychoplankton so easily collected with the algal net and secondly in polythene bags crush the algal material easily found ultra-nannoplankton. Phytoplankton identification and counts were done using inverted microscope (PZO Poland 10x40) and identified with

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the help of available literature (Husted 1930; Majeed 1935; Smith 1950; Prescott 1961; Patrick 1966; Tiffany and Briton 1971; Vinyard 1979; Akiyama and Yamagishi 1981; Leghari *et al* 1997).

Results and Discussion

According to the results of the comparative ecological studies of phytoplankton of Bakar and Phoosna Lakes, qualitative measurement done for the production of phytoplankton is shown in Table 1. Lake Bakar is clearly very productive as compared to Lake Phoosna. Out of 78 species identified from these Lakes 58 were present in Bakar Lake, 8 in Phoosna

Table 1
The occurrence of various phytoplankton species during August 1993 to July 1996 in the following Lakes

S. No.	Species	Bakar Lake	Phoosna Lake
Class: Bacillariophyceae			
1.	*Achnanthes biasolettiana* Kuetz.	p	a
2.	*A. hungarica* Grun.	p	a
3.	*A. lanceolata* (Breb.) Grunow	p	a
4.	*A. minutissima* (Kuetz.) Cleve	p	a
5.	*Amphora coffeaeformis* Pascher	p	a
6.	*A. delicatissima* Krab.	p	a
7.	*A. ovalis* Kuetz.	p	a
8.	*A. ovalis* var. *gracilis* Meister	p	a
9.	*Cyclotella glomerata* Bachmann	p	a
10.	*C. kuetzingiana* var. *radiosa* Fricke.	p	a
11.	*C. michiganiana* Skvortzow.	p	a
12.	*Cymbella amphicephalla* Naegeli	p	a
13.	*C. laevis* Naegeli	p	a
14.	*C. minuta* Hilse ex-Rabh.	p	a
15.	*C. naviculiformis* Averswald	a	p
16.	*C. tumida* (Breb.) van Heurck.	c	c
17.	*C. turgida* Gregory	p	a
18.	*C. ventricosa* Kuetz.	p	a
19.	*Denticula tenuis* Kuetz.	p	a
20.	*Diatoma anceps* (Ehr.) Kirchner	p	a
21.	*D. vulgare* Bory	p	a
22.	*Epithemia argus* Kuetz.	p	a
23.	*E. sorex* var. *graclis* Husted.	p	a
24.	*E. zebra* (Ehr.) Kuetz.	p	a
25.	*Eunotia pectinalis* (Kuetz.) Rab.	p	a
26.	*Fragilaria capucina* Desmazieres	p	a
27.	*Frustulia rhomboides* (Ehr.) de Toni	p	a
28.	*Gomphonema ghosea* n. sp	c	c
29.	*G. olivaceum* var. *calcarea* Pascher	p	a
30.	*Gyrosigma acuminatum* (Kuetz.) Cleve	c	c
31.	*G. scalproides* (Rabh.) Cl.	p	a
32.	*Melosira distans* (Ehr.) Kuetz.	c	c
33.	*M. granulata* (Ehr.) Ralfs.	p	a
34.	*Navicula bicephala* Hust.	a	p
35.	*N. cryptocephala* var. *intermedia* Grun.	p	a
36.	*N. confervacea* (Kuetz.) Grunow	p	a
37.	*N. distans* (Smith) Ralfs.	a	p
38.	*N. gracilis* Ehr.	p	a
39.	*N. incerta* Grun.	p	a
40.	*N. longirostris* Hust.	p	a
41.	*N. protracta* (Grunow) Cleve	p	a
42.	*N. radiosa* Kuetz.	c	c
43.	*N. radiosa* Kuetz. var. *tenella* Grun.	c	c
44.	*Neidium dubium* (Ehr.) Pfitzer	c	c
45.	*Nitzschia vermicularis* Hantzsch.	c	c
46.	*Pinnularia berbisonii* (Kuetz.) Rab.	a	p
47.	*P. borealis* (Kuetz.) Rab.	a	p
48.	*P. cardinalis* (Ehr.) Smith	a	p
49.	*P. gibba* (van Heurck) Boyer	c	c
50.	*P. lata* Breb.	a	p
51.	*P. parva* Gregory	p	a
52.	*P. tabellaria* Ehr.	p	a
53.	*Rhopaldia gibba* (Kuetz.) Mueller.	c	c
54.	*Synedra acus* Kuetz.	p	a
55.	*S. affinis* (Kuetz.) Pascher.	p	a
56.	*S. affinis* (Kuetz.) Pas. var. *fasciculata*	p	a
57.	*S. capitata* (Ehr.) Hustedt.	p	a
58.	*S. ulna* (Nitzsch) Ehr.	c	c
59.	*S. ulna* var. *amphirhynchus* (Ehr.) Grun.	p	a
60.	*Tabellaria flocculosa* (Roth) Kuetz.	p	a
Class: Chrysophyceae			
61.	*Chrysocapsa planctonica* (W.&W.)Pas.	p	a
62.	*Dinobryon divergens* Imhof.	p	a
63.	*D. sertularia* Ehr.	p	a
64.	*Mallomonas caudata* Iwanoff.	p	a
65.	*Spiniferomonas trioralis* Takakashi	p	a
Class: Dinophyceae			
66.	*Ceratium hirundinella* (Muller) Duja.	p	a
67.	*Peridinium cinctum* (Muell.) Ehr.	p	a
68.	*P. gatunense* Nygaard	p	a
69.	*P. tabulatum* Ehr.	p	a
Class: Xanthophyceae			
70.	*Botryococcus braunii* Kuetz.	p	a
71.	*Chlorellidiopsis separabilis* Pascher	p	a
72.	*Goniochloris sculpta* Geitler.	p	a
73.	*Ophiocytium majus* Naegeli	c	c
Class: Euglenophyceae			
74.	*Euglena acus* Ehr.	p	a
75.	*E. intermedia* (Klebs) Schmitz.	p	a
76.	*Phacus orbicularis* Huebner	p	a
77.	*Trachelomonas haxangulata* (Swir.) Play.	a	p
78.	*T. volvocina* Ehr.	p	a

a, absent; p, present; c, common.

Lake and 12 were common in both the Lakes. This clearly indicates 7.25 times richness of Bakar Lake in phytoplankton species. A look at the percentage reveals that 74.36% of the species are present in Lake Bakar and 10.26% in Lake Phoosna and 15.38% are common in both Lakes. This productivity of Lake Bakar can be attributed to the amount of dissolved oxygen which is an indicator that the phytoplanktons take in CO_2 for photosynthesis and give out O_2.

Total hardness was measured by the amount of $CaCO_3$ present in the Lake waters. The result reveals that Phoosna Lake has a minimum of 400 ppm hardness and Bakar Lake has 100 ppm while maximum was 516 ppm and 180 ppm present in Phoosna and Bakar Lakes respectively (Table 2). Blue green algae was in high ratio in Phoosna Lake due to its hardness and the present studies indicate that phytoplankton is drastically low in this Lake.

It is also indicated in Table 2 that salinity levels in Phoosna Lake is very high, maximum 3.8 ppt as compared to Lake Bakar which is 0.7 ppt. This is one of the reasons why the phytoplankton species are scanty in Phoosna Lake and flourish in Lake Bakar. Due to high salinity level, it was also observed that cells of the plants are damaged and deformed in Phoosna Lake. The T.D.S. ratio (330 ppm) is higher in Lake Bakar as compared to Phoosna Lake and this results in high productivity level of this Lake, due to T.D.S. support the phytoplankton production because phytoplankton is the favourite food of fish which nourish on it. It has also been observed that the taste of the fish is very delicious, the reason being the ample and high quality phytoplankton species presence in Lake Bakar.

The orthophosphate content is very low (0.002 $\mu g\, l^{-1}$) in Lake Bakar due to which phytoplankton species flourish in this water. Moreover, due to greater depth of Lake Bakar (7.8 meters) the temperature of its water does not rise as compared to Phoosna Lake which is shallow and therefore, the temperature rises more quickly in this Lake. Hence the low temperature species also survive in the Bakar Lake.

It was observed during the studies conducted that there is proper inlet for water in the Lake Phoosna but there is no outlet. Due to stagnant water mostly the species recorded

Table 2

Physico-chemical properties of Lakes Bakar and Phoosna

S.No.	Parameters	Bakar Lake		Phoosna Lake	
		Min	Max	Min	Max
1.	Surface water temperature °C	15	31.3	20	30
2.	Water bottom temperature °C	16	30.3	18	30
3.	pH	7.7	8.9	8.2	8.5
4.	Turbidity in NTU Range on 1000	.3	6.8	5	45
5.	T.D.S (ppm)	220	330	160	170
6.	Conductivity (m.Ohms x^{10})	40	103	40	58
7.	Salinity (NaC1 ppt)	0.1	0.7	3	3.8
8.	Light transparency by Secchi disc (meter)	1.2	3.6	0.49	1.10
9.	Dissolved oxygen (mg l^{-1})	5	11.5	5	9.5
10.	Saturation(%)	40.5	91	40.5	75
11.	CO_2 (ppm)	15	77	(no free)	50
12.	Ammonia Nitrogen (NH_3 N_2 ppm)	0.02	0.11	0.02	0.04
13.	Density (30°C g/v)	1.002	1.005	1.0044	1.0058
14.	Water colour (Numbers)	12	17	14	17
15.	Orthophosphate (ug 1^{-1})	0.002	0.2	0.03	0.245
16.	Total Hardness ($CaCO_3$ ppm)	100	180	400	516
17.	Ca++ Hardness (ppm)	60	120	200	258
18.	Mg Hardness (ppm)	40	80	200	258
19.	$CaC1_2$ Hardness (ppm)	66.6	109.9	222	286.38
20.	Mg $C1_2$ (ppm)	57	109.3	190	245.1
21.	Grain Per Gallon (Gpg)	6.4	10.44	23.2	29.93
22.	Refractiv index (30°C)	1.33	1.33	1.3325	1.3328
23.	Total Depth of Lake (meter)	3	7.8	2	3

Table 3
Seasonal variation of phytoplankton of Lake Bakar

S.No.	Species	Summer J-A	Autumn S-N	Winter D-F	Spring M-M
Class: Bacillariophyceae					
1.	*Achnanthes biasolettiana* Kuetz.	vc	vc	vc	vc
2.	*A. hungarica* Grun.	vc	vc	vc	vc
3.	*A. lanceolata* (Breb.) Grunow	vc	vc	vc	vc
4.	*A. minutissima* (Kuetz.) Cleve	vc	vc	vc	vc
5.	*Amphora coffeaeformis* Pascher	vc	vc	vc	vc
6.	*A. delicatissima* Krab.	vc	vc	vc	vc
7.	*A. ovalis* Kuetz.	vc	vc	vc	vc
8.	*A. ovalis* var. *gracilis* Meister	vc	vc	vc	vc
9.	*Cyclotella glomerata* Bachmann	r	r	r	r
10.	*C. kuetzingiana* var. *radiosa* Fricke.	vr	r	r	a
11.	*C. michiganiana* Skvortzow.	vr	vr	vr	vr
12.	*Cymbella amphicephalla* Naegeli	vr	a	vr	vr
13.	*C. laevis* Naegeli	a	vr	vr	a
14.	*C. minuta* Hilse ex-Rabh.	vc	vc	vc	vc
15.	*C. naviculiformis* Averswald	a	a	a	a
16.	*C. tumida* (Breb.) van Heurck.	r	vr	vc	vc
17.	*C. turgida* Gregory	vc	vc	vc	vc
18.	*C. ventricosa* Kuetz.	vc	vc	vc	vc
19.	*Denticula tenuis* Kuetz.	a	a	vr	a
20.	*Diatoma anceps* (Ehr.) Kirchner	vr	vr	vr	vr
21.	*D. vulgare* Bory	c	c	c	c
22.	*Epithemia argus* Kuetz.	a	c	vc	vc
23.	*E. sorex* var. *graclis* Husted.	c	c	c	c
24.	*E. zebra* (Ehr.) Kuetz.	c	vc	c	a
25.	*Eunotia pectinalis* (Kuetz.) Rab.	r	vr	r	c
26.	*Fragilaria capucina* Desmazieres	vc	vc	vc	vc
27.	*Frustulia rhomboides* (Ehr.) de Toni	c	c	vc	c
28.	*Gomphonema ghosea* n. sp	vc	vc	vc	vc
29.	*G. olivaceum* var. *calcarea* Pascher	c	r	vc	vc
30.	*Gyrosigma acuminatum* (Kuetz.) Cleve vr	vr	vr	a	
31.	*G. scalproides* (Rabh.) Cl.	a	vr	vr	a
32.	*Melosira distans* (Ehr.) Kuetz.	a	vr	vr	a
33.	*M. granulata* (Ehr.) Ralfs.	vr	vr	vr	a
34.	*Navicula bicephala* Hust.	a	a	a	a
35.	*N. cryptocephala* var. *intermedia* Grun.	vc	vc	vc	vc
36.	*N. confervacea* (Kuetz.) Grunow	c	c	c	c
37.	*N. distans* (Smith) Ralfs.	a	a	a	a
38.	*N. gracilis* Ehr.	c	c	c	c
39.	*N. incerta* Grun.	c	c	c	c
40.	*N. longirostris* Hust.	c	c	c	c
41.	*N. protracta* (Grunow) Cleve	vc	vc	vc	vc
42.	*N. radiosa* Kuetz.	vc	vc	vc	vc

(Table 3 Cont'd.....)

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S.No.	Species	Summer J-A	Autumn S-N	Winter D-F	Spring M-M
43.	*N. radiosa* Kuetz. var. *tenella* Grun.	vc	vc	vc	vc
44.	*Neidium dubium* (Ehr.) Pfitzer	c	vc	vc	vc
45.	*Nitzschia vermicularis* Hantzsch.	vc	c	c	vr
46.	*Pinnularia berbisonii* (Kuetz.) Rab.	a	a	a	a
47.	*P. borealis* (Kuetz.) Rab.	a	a	a	a
48.	*P. cardinalis* (Ehr.) Smith	a	a	a	a
49.	*P. gibba* (van Heurck) Boyer	c	vc	r	c
50.	*P. lata* Breb.	a	a	a	a
51.	*P. parva* Gregory	vc	vc	vc	vc
52.	*P. tabellaria* Ehr.	c	c	c	c
53.	*Rhopaldia gibba* (Kuetz.) Mueller.	vc	vc	vc	vc
54.	*Synedra acus* Kuetz.	a	vr	vr	vr
55.	*S. affinis* (Kuetz.) Pascher.	vc	vc	vc	vc
56.	*S. affinis* (Kuetz.) Pas. var. *fasciculata*	c	c	vc	c
57.	*S. capitata* (Ehr.) Hustedt.	r	r	vc	c
58.	*S. ulna* (Nitzsch) Ehr.	vc	vc	vc	vc
59.	*S. ulna* var. *amphirhynchus* (Ehr.) Grun.	c	c	c	c
60.	*Tabellaria flocculosa* (Roth) Kuetz.	c	c	vc	c
Class:	**Chrysophyceae**				
61.	*Chrysocapsa planctonica* (W.&W.)Pas.	a	vr	a	vr
62.	*Dinobryon divergens* Imhof.	vc	vc	vc	vc
63.	*D. sertularia* Ehr.	c	c	c	c
64.	*Mallomonas caudata* Iwanoff.	a	a	vr	a
65.	*Spiniferomonas trioralis* Takakashi	vc	vc	vc	vc
Class:	**Dinophyceae**				
66.	*Ceratium hirundinella* (Muller) Duja.	vc	vc	vc	vc
67.	*Peridinium cinctum* (Muell.) Ehr.	c	c	vc	vc
68.	*P. gatunense* Nygaard	c	c	c	c
69.	*P. tabulatum* Ehr.	vc	vc	vc	vc
Class:	**Xanthophyceae**				
70.	*Botryococcus braunii* Kuetz.	vc	vc	vc	vc
71.	*Chlorellidiopsis separabilis* Pascher	a	vr	vr	r
72.	*Goniochloris sculpta* Geitler.	a	vr	a	a
73.	*Ophiocytium majus* Naegeli	r	r	r	r
Class:	**Euglenophyceae**				
74.	*Euglena acus* Ehr.	vc	vc	vc	vc
75.	*E. intermedia* (Klebs) Schmitz.	a	a	vr	a
76.	*Phacus orbicularis* Huebner	c	vr	vr	vr
77.	*Trachelomonas haxangulata* (Swir.) Play.	a	a	a	a
78.	*T. volvocina* Ehr.	r	r	vr	vr

a, Absent; r, Rare; vr, Very rare; c, Common; vc, Very common.
J-A, June-August; S-N, Sep-Nov; D-F, Dec-Feb; M-M, Mar-May.

Table 4
Seasonal variation of phytoplankton of Lake Phoosna

S. No.	Species	Summer J-A	Autumn S.N	Winter D-F	Spring M-M
Class:	**Bacillariophyceae**				
1.	*Achnanthes biasolettiana* Kuetz.	a	a	a	a
2.	*A. hungarica* Grun.	a	a	a	a
3.	*A. lanceolata* (Breb.) Grunow	a	a	a	a
4.	*A. minutissima* (Kuetz.) Cleve	a	a	a	a
5.	*Amphora coffeaeformis* Pascher	a	a	a	a
6.	*A. delicatissima* Krab.	a	a	a	a
7.	*A. ovalis* Kuetz.	a	a	a	a
8.	*A. ovalis* var. *gracilis* Meister	a	a	a	a
9.	*Cyclotella glomerata* Bachmann	a	a	a	a
10.	*C. kuetzingiana* var. *radiosa* Fricke.	a	a	a	a
11.	*C. michiganiana* Skvortzow.	a	a	a	a
12.	*Cymbella amphicephalla* Naegeli	a	a	a	a
13.	*C. laevis* Naegeli	a	a	a	a
14.	*C. minuta* Hilse ex-Rabh.	a	a	a	a
15.	*C. naviculiformis* Averswald	c	c	c	c
16.	*C. tumida* (Breb.) van Heurck.	c	c	c	c
17.	*C. turgida* Gregory	a	a	a	a
18.	*C. ventricosa* Kuetz.	a	a	a	a
19.	*Denticula tenuis* Kuetz.	a	a	a	a
20.	*Diatoma anceps* (Ehr.) Kirchner	a	a	a	a
21.	*D. vulgare* Bory	a	a	a	a
22.	*Epithemia argus* Kuetz.	a	a	a	a
23.	*E. sorex* var. *graclis* Husted.	a	a	a	a
24.	*E. zebra* (Ehr.) Kuetz.	a	a	a	a
25.	*Eunotia pectinalis* (Kuetz.) Rab.	a	a	a	a
26.	*Fragilaria capucina* Desmazieres	a	a	a	a
27.	*Frustulia rhomboides* (Ehr.) de Toni	a	a	a	a
28.	*Gomphonema ghosea* n. sp	r	c	c	c
29.	*G. olivaceum* var. *calcarea* Pascher	a	a	a	a
30.	*Gyrosigma acuminatum* (Kuetz.) Cleve	c	c	c	c
31.	*G. scalproides* (Rabh.) Cl.	a	a	a	a
32.	*Melosira distans* (Ehr.) Kuetz.	vr	vr	c	r
33.	*M. granulata* (Ehr.) Ralfs.	a	a	a	a
34.	*Navicula bicephala* Hust.	vr	vr	c	vr
35.	*N. cryptocephala* var. *intermedia* Grun.	a	a	a	a
36.	*N. confervacea* (Kuetz.) Grunow	a	a	a	a
37.	*N. distans* (Smith) Ralfs.	vr	vr	vr	vr
38.	*N. gracilis* Ehr.	a	a	a	a
39.	*N. incerta* Grun.	a	a	a	a
40.	*N. longirostris* Hust.	a	a	a	a
41.	*N. protracta* (Grunow) Cleve	a	a	a	a
42.	*N. radiosa* Kuetz.	c	r	c	c

(Table 4 Cont'd.....)

(Table 4 Cont'd.....)

S. No.	Species	Summer J-A	Autumn S.N	Winter D-F	Spring M-M
43.	*N. radiosa* Kuetz. var. *tenella* Grun.	c	c	c	c
44.	*Neidium dubium* (Ehr.) Pfitzer	r	c	c	c
45.	*Nitzschia vermicularis* Hantzsch.	c	c	c	c
46.	*Pinnularia berbisonii* (Kuetz.) Rab.	vr	r	c	c
47.	*P. borealis* (Kuetz.) Rab.	vr	r	c	c
48.	*P. cardinalis* (Ehr.) Smith	c	c	c	c
49.	*P. gibba* (van Heurck) Boyer	c	c	c	c
50.	*P. lata* Breb.	vr	vr	r	r
51.	*P. parva* Gregory	a	a	a	a
52.	*P. tabellaria* Ehr.	a	a	a	a
53.	*Rhopaldia gibba* (Kuetz.) Mueller.	c	c	c	c
54.	*Synedra acus* Kuetz.	a	a	a	a
55.	*S. affinis* (Kuetz.) Pascher.	a	a	a	a
56.	*S. affinis* (Kuetz.) Pas. var. *fasciculata*	a	a	a	a
57.	*S. capitata* (Ehr.) Hustedt.	a	a	a	a
58.	*S. ulna* (Nitzsch) Ehr.	c	c	c	c
59.	*S. ulna* var. *amphirhynchus* (Ehr.) Grun.	a	a	a	a
60.	*Tabellaria flocculosa* (Roth) Kuetz.	a	a	a	a
Class:	**Chrysophyceae**				
61.	*Chrysocapsa planctonica* (W.&W.)Pas.	a	a	a	a
62.	*Dinobryon divergens* Imhof.	a	a	a	a
63.	*D. sertularia* Ehr.	a	a	a	a
64.	*Mallomonas caudata* Iwanoff.	a	a	a	a
65.	*Spiniferomonas trioralis* Takakashi	a	a	a	a
Class:	**Dinophyceae**				
66.	*Ceratium hirundinella* (Muller) Duja.	a	a	a	a
67.	*Peridinium cinctum* (Muell.) Ehr.	a	a	a	a
68.	*P. gatunense* Nygaard	a	a	a	a
69.	*P. tabulatum* Ehr.	a	a	a	a
Class:	**Xanthophyceae**				
70.	*Botryococcus braunii* Kuetz.	a	a	a	a
71.	*Chlorellidiopsis separabilis* Pascher	a	a	a	a
72.	*Goniochloris sculpta* Geitler.	a	a	a	a
73.	*Ophiocytium majus* Naegeli	r	c	c	r
Class:	**Euglenophyceae**				
74.	*Euglena acus* Ehr.	a	a	a	a
75.	*E. intermedia* (Klebs) Schmitz.	a	a	a	a
76.	*Phacus orbicularis* Huebner	a	a	a	a
77.	*Trachelomonas haxangulata* (Swir.) Play.	r	r	r	r
78.	*T. volvocina* Ehr.	a	a	a	a

a, Absemt; r, Rare; vr, Very rare; c, Common; vc, Very common.
J-A, June-August; S-N, Sep-Nov; D-F, Dec-Feb; M-M, Mar-May.

were the hard water ones. A perusal of Table 2 clearly indicates that variations in the physico-chemical properties of Lake have adverse effect on fish of the Lake.

Lake Bakar on the other hand has proper inlet and outlet for water. The Nara Canal derived from this Lake serves to irrigate the agricultural lands. Due to this inlet and outlet of water the species recorded are both soft and hard water species. The physico-chemical properties of the Lake clearly indicate that Lake Bakar is quite productive as compared to Lake Phoosna. The size and weight of the fish increases tremendously within one year which is more than 3 kgs. The fish species locally called Kurro and Dumbro attain the weight of 18 kgs which was recorded from this Lake. This clearly indicates that the ecological conditions of Bakar Lake are much better and suitable for the fish and other fauna.

The physico-chemical features of lake water are presented in Table 2. Dickman (1969) stated that lakes which act as temporary impoundments to the flow of water from inlet and outlet are unusual in species population because of the major role of flushing in regulating their primary productivity. Bakar lake also act as a temporary impoundment and it appears that flushing may be the major cause of observed irregularities. Physical, chemical and biological features are strongly conditioned by surface level fluctuations, due to flooding and dewatering (Thornton *et al* 1990). Generally water enters in lake Bakar from June to December and is released from January to May every year. Water level fluctuation are particularly striking because of semi arid climate where evaporation rates are greater than precipitation and the irregular inflows generally are not balanced by out flow. As a whole, the phytoplankton seems to be strongly related to the water level fluctuation and the climatological features, and it seems reasonable to hypothesize that abiotic (e.g. flooding, dewatering, light, mixing, temprature, turbidity, rain, storm, wind, etc.) factors mainly affected the phytoplanktons in the study period also by inhibiting or delaying the development of that biotic relationship (i.e. fry predation efficiency) which commonly takes place in aquatic environments.

Diatoms are cosmopolitan species, found through out the year. They are abundant in the inlet waters of the Lake, where grazing and other disturbances occur. Some of the species of Chrysophyceae and Dinophyceae like *Dinobryon* and *Peridinum* survive in cold waters and in low orthophosphate ratio containing waters. Their abundance can easily be judged by measuring the density of water samples. Normally water density is one (1) and any increase in the density is attributed to the ratio of phytoplanktons in the water samples.

An increase in the temperature of water help dissolve the minerals resulting pH increase which results in the increase of phytoplankton production.

Similarly the change in the colour of water from grey to greenish to dark green also results in the high production of phytoplankton. The reason may be that dark colour resists the light and ultimately temperature of water increases. The distribution of phytoplankton is also affected by the direction of the winds. In summers the winds blow from South to North and this drifts the concentration of phytoplankton in the northern banks of the Lakes and reverse happens in winters, when the winds blow from North to South concentrating the phytoplankton flora in the southern banks.

It has also been observed that floods cause increase in turbidity causing changes in the concentration of phytoplankton. They become rare with the storm and disturbed in turbidity. But as soon as the water settles down there is increased flora of the Lakes. The sampling was done through out the year and these factors affecting the distribution and concentration of phytoplankton was observed during the study and sam-pling period (Table 3, 4). It is interesting to note that about 70% of the phytoplankton isolated from these studies were recorded from the gut content of the fish caught from these waters.

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