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Some Studies on Water Quality and Biological Life at Kinjhar and Haleji Lakes of District Thatta, Sindh, Pakistan

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Abstract: Water samples were collected from ecological important Kinjhar and Haleji Lakes during 1998-1999 and were analysed for conductivity, total dissolved solids, hardness, chloride, alkalinity, dissolved oxygen, nitrate, silica, orthophosphate, sodium, potassium, calcium and magnesium metal ions. The water quality was observed within the limits for drinking purposes, but there is an extensive growth of algae and higher aquatic plants in both the lakes. Total of 205 algal species were identified, comprising 43 sp. of *Cyanophyta,* 92 sp. *Chloruphyta,* 6 sp. *Charophyta,* 11 sp. *Euglenophyta,* 57 sp. of *Bacillariophyta.* Higher aquatic plants belonging to 31 species were also identified. Zooplanktonic fauna of both the lakes were quite different. The Cladoceran species. *Ceriorlaphnia cornuta, Bosminopsis deitersi, Diaphanosoma hrachyurum* and *Bosmina longirostris* were dominant, at Kinjhar. In Haleji lake, on the other hand *Macrothrix* sp., *Chydorus* sp., *Sirnocephalus vetulus* and *Moina* sp. were dominant.

Key words: Kinjhar and Haleji lakes, water quality, flora and Zooplankton assessment

Introduction

Kinjhar and Haleji are artificial and sub-tropical lakes, located in Thatta, about 120-140 Km from Hyderabad and 90-120 Km from Karachi. They are supplied water from River Indus at Kotri barrage by Kalri Baghar Feeder. Kinjhar takes water through K.B. Feeder and Haleji by K.B. Feeder via Jam Branch. The water from Kinjhar and Haleji continues to be a main source of drinking water for Thatta District, Nooriabad Industrial area and Karachi city.

Kinjhar has an area of about 80 sq. miles with Perimeter of 88 K.M. The Haleji has an area of about 6.5 sq. K.M. Both lakes are of ecological importance and in addition to being gazetted wildlife sanctuaries established by the Government of Sindh, they are also defined under Article-2 of Ramsar convention as waters of international importance for water Fowl refuge, Their proximity to and accessibility tram Karachi and Hyderabad adds to their importance from both ecological and recreational view point.

The lakes are rich of phytoplankton due to the presence of intense light during days of the whole year, high temperature, concentration of nutrients and favourable pH. The phytoplankton of the tropical lakes are able to tolerate high temperatures (Nazneen, 1980) and support fish production. About 48 species of different fishes have been reported from Kinjhar, with 20 species of commercial importance (Baqai *et al.,* 1974a, b). A number of studies have been made about water quality and the life inhibiting at Kinjhar and Haleji, including Baqai *et al.* (1974a, b), Nazneen (1974, 1980) and from this laboratory (Khuhawar *et al.,* 1999), also some work available on the Lakes of Sindh, Bakar (Leghari and Khuhawar*,* 1999), Hub lake (Iqbal, 1986) Manchar lake (Baig and Khan, 1976; Khuhawar and Mastoi, 1995). The present work reports the assessment of water quality alongwith flora and fauna of Kinjhar and Haleji lakes of District Thatta Sindh, Pakistan.

Materials and Methods

Water samples for chemical analysis were collected from the surface at the depth of (10-40 cm) from Kinjhar and Haleji lakes during 1998-99. Water samples from Kinjhar were collected from 3 to 5 places and Haleji 2 to 4 places (Table 1-4) to cover maximum surface area of the lakes. The sampling scheme was repeated 3 times. The water samples were collected in pre-cleaned plastic bottles 1.5 L and were rinsed several times with sample before collection. Water samples from Kinjhar were collected by boat about 100 m away from the lake side. However from Haleji, water samples were collected about 5-10 m from the side. The temperature was rioted from air and water. Secchi depth, conductivity, salinity, total dissolved solids (TDS) and dissolved oxygen (0.0) were measured on the site. The samples for pH, chloride, alkalinity, hardness, nitrite, nitrate, phosphate, silica, sodium, potassium, calcium and magnesium were determined quickly in the laboratory using standard procedures (APHA, 1981).

The samples for conductivity, salinity and TDS were analysed with WTW 320 conductivity bridge. Dissolved Oxygen was determined by Wrinkler method. pH was recorded with Orion 420A pH meter. Chloride, alkalinity and hardness were estimated by titration with standard silver nitrate, hydrochloric acid and E.D.T.A. respectively. Nitrite, nitrate, phosphate and silica were determined by spectrophotometry using Hitachi 220 spectrophotometer.

Nitrate was determined using brucirie sulphate as derivatizing reagent. Nitrite was determined by coupling diazolized sulphanic acid with N-1(1-napthyl) ethylenediamine dihydrochloride Orthophosphate was determined, when acid molybdate was added to orthophosphate, followed by reduction with ascorbic acid to molybednum blue. Total phosphate was estimated by

Table 1: Water quality analysis of samples collected from Haleji lake of Sindh on 19-9-1998

Parameters	1	2	3	4	5	6	7
Temperature of air in (°C)	30.50	30.00	31.0	30.5	30.5	30.00	30
Temperature of water (°C)	27.70	287.00	28.2	30.6	26.0	27.90	28.6
Conductivity (µS/cm)	375.00	398.00	482.00	496.00	502	513.00	529.00
TDS (mg/L)	240.00	254.00	308.4	317.4	321.28	328.32	338.56
Osmotic pressure in atoms	0Z1206	'0.126	0.1755	0.178	50.1807	0.184	0.1904
Hardness as $CaCO_3$ (mg/L)	82.83	90.23	93.40	92.22	112.29	117.21	102.79
Chloride in (mg/L)	35.00	40.00	70.00	60.00	75	70.00	66
Nitrate (mg/L)	. 0.4	0.5	0.45	0.25	0.2	0.4	0.3
Silica (mg/L)	10_00	5.00	8.00	5.90	5	6.00	2.00
Na in (mg/L)	23.4	30.7	53.00	48.00	56	62.00	54
K in (mg/L)	6.4	8.3	7.9	6.30	10.41	11.71	8.54
Ca in (mg/L)	29.00	31-8	37.49	41.06	36.38	27.56	33.4
Mg in (mg/L)	8.6	8.7	15.8	15.7	17.35	17.83	16.85
Orthophosphate in (g/L)	12.00	25.00	23.00	25.00	25	28.00	25
SAR value	1.584	1.98	3.368	3.0766	3.252	3.522	3.276
pH	7.82	7.94	7.96	8.10	7.2	7.95	7.83
M-alkalinity as $CaCO_3$ (mg/L)	30.00	30.00	30.00	25.00	52.5	30 00	37.5
P-alkalinity as ($CaCo_3$) (mg/L)	-ve	ve	-ve	-ve	-ve	-ve	-ve

Sampling Stations:
1. Haleji lake bridge, intake water source from K.B. Feeder through) Jam Branch (Thattal surface sample. = 2. Haleji lake bridge, intake water source hum K.8. Feeder through Jam Branch = (Thatta) surface sample. (5 feet in depth) = 3. Near Zero RD Haleji Lake. 4. 43 RD. Haleji Lake = 5. Haleji outlet Gharo via Oslo to Karachi. 6. Haleji outlet via Gharo to Karachi Water and Sewerage Board (KWS8) Karachi.
7. Haleji outlet to Gharo and Pakistan Steel Mill Karachi.

Table 2: Water quality analysis of samples collected from Kinjher lake on 8-11-1998

Parameters	1	2	3	4	5
Temperature of air in (°C)	36,0	36,2	36,2	36,5	36.7
Temperature of water (°C)	32.8	33.0	33.0	33.8	33.8
Conductivity (µS/cm)	405.00	435.00	412.00	418.00	394.00
TDS (mg/L)	260.8	278.4	364.00	268.00	252.00
Osmotic pressure in atoms	1.1152	0.1561	0.11232	0.11268	0.10944
Hardness as ($CaCo_3$) (mg/L)	138.00	118.00	96.0	92.0	84.0
Chloride in (mg/L)	31.9	38.9	24.8	24.8	24.8
Nitrate (mg/L)	-ve	0.4	-vs	-ve	ve
Silica marl	3.0	5.0	2.5	2.4	-ve
Nitrite (µg/L)	-ve	0.2	-ve	-ve	-se
Na in (mg/L)	20.6	28.9	19.9	32.5	19.2
K in (mg/L)	6.8	7.2	5.3	3.6	4.2
Ca in (mg/L)	12.0	12.6	24.0	23 8	20.5
Mg in (mg/L)	9.0	9-8	8.7	8.15	8.2
Orthophosphate in (µg/L)	;.g/L	8.00	12.00	6.00	4.00
SAR value	1.38	1.97	1.62	2.11	2.50
pH	8.5	7.90	8.3	8.3	8.7
M-alkalinity as ($CaCo_3$) (mg/L)	15.0	20.0	16.0	15.5	15.0
P-alkalinity as ($CaCo_3$)	mg/L	35.00	-ve	25.00	25.00
Dissolved Oxygen in (mg/L)	8.3	7.5	8.5	8.4	7.3

Sampling Stations:
1. Hilya Village near boat Basin, Kinjhar lake = 2. Mir Rasool Bux Link Canal , Inlet to (Kalari Lake) Kinjhar lake. = 3. Inside the lake about 150 meter from Hilya village near boat Basin, Kinjhar lake = 4. Inside the lake about 250 meter from Hilya village near boat Basin, Kinjhar lake. = 5. Water supply pumping station to Hilya Town, near Guest House, Kinjhar lake

Table 3: Water analysis of samples collected from Kinjhar and Haleji lakes of Sindh on 31-7-1999

Parameters	Kinjhar		Haleji		
	1	2	3	4	5
Temperature of air (°C)	32.00	34.00	34.00	30.00	30.00
Water Temperature (°C)	30.60	29.50	3000	29.10	29.00
Conductivcity (µS/cm)	507.00	475.00	490.00	615.00	344.00
Total dissolved solids (mg/L)	324.00	304.00	313.00	394.00	220.00
Salinity in g/L	0.00	0.00	0.00	0.10	0.00
pH	8.30	8.55	8.00	7.15	7.98
M-Alkalinity as $CaCo_3$ (mg/L)	25.00	250.00	25.00	35.00	20.00
Chloride (mg/L)	56.00	530:00	50.00	106.00	40.00
Hardness as $CaCo_3$ (mg/L)	100.00	70.00	80.00	80.00	60.00
Nitrate (mg/L)	0.50	0.50	0.40	0.40	0.60
Silica (mg/L)	1.00	0.50	1.00	6.00	8.00
Sodium (mg/L)	44.00	47.00	43.00	106.00	27.00
Potassium (mg/L)	6.00	5.00	5.00	10.00	3.00
Calcium (mg/L)	52.00	44.00	36.00	46.00	di 00
Magnesium (mg/L)	22.00	20.00	16.00	18.00	12.00
Orthophosphate (µg/L)	30.00	20.00	22.00	10.00	38.00
Total Acid Hydrolyseable Phosphate (mg/L)	0.9	0.25	0.05	0.29	0.09

Sampling stations:
1. Hilaya village near boat Basin, Kinjhar lake Thatta = 2. Water supply pumping station to Hilya town, Kinjhar lake (Thatta) = 3.Cliilia station (Kinjhar lake) outlet to Kadri village and paper factory. = 4. Haliji lake outlet to KWSB (Karachi), = 5. Haliji lake bridge, intake water source from K.B. Feeder through Jam Branch (Thatta).

perstilphate acid hydrolysis followed by determination as and magnesium were determined by air-acetylene atomic fororthophosphate. Silica was determined as absorption using Varian AA-20 atomic absorption molybdosilicate (APHA, 1981). Sodium, potassium, calcium spectrometer at the conditions recommended by the

Table 4: Water analysis of samples collected from Halal' and Kenjhar lakes of Sindh, Pakistan on 12-12-1999

Parameters	Haliji				Kenjher		
	1	2	3	4	5	6	7
Time	2.00 PM	2.15 P.M	2.45 P.M	4.00 P.M	5,25 P.M	6.45PM	7.30 P.M
Temperature of air in (°C)	27.00	27.00	27.00	27.00	26.00	24.00	24.00
Water Tempratnre in (°C)	19.00	19.00	20.00	18.40	22.00	22.3	23.60
Salinity (g/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Conductivity (μS/cm)	500.00	578.00	320.00	428.00	246.00	235.00	255.00
Total dissolved solids (mg/L)	320.00	370.00	204.00	273.00	157.00	150.00	163.00
Dissolved Oxygen (mg/L)	7.60	8.60	8.50	8.40	-	8.3	6.90
Chloride (mg/L)	106.50	106.00	39.00	74.50	28.4	35.5	35.00
M. Alkalmity ad ($CaCo_3$)	13.00	14.50	14.00	11.00	9.0	5.8	7.50
Hardness as ($CaCo_3$) (mg/L)	100.00	95.00	100.00	110.00	96.00	80.00	40.00
Sodium (mg/L)	64.00	70.00	26.00	52.00	16.00	18.00	20.00
Potassium (mg/L)	25.00	18.00	12.00	26.00	14.00	10,00	14.00
Calcium (mg/L)	88.00	57.00	48.00	58.00	75.00	31.00	53.00
Magnesium (mg/L)	35.00	30.00	16.00	22.00	16.00	12.00	14.00
P Alkalmity ($CaCo_3$) (mg/L)	-	-	-	-	-	10.00	5.00
PH	7.92	7.97	7.87	7.85	7.90	7.97	7.76
Silica (mg/L)	2.00	2.00	6.00	1.00	1.00	2.00	3.00
Nitrate in (mg/L)	0.10	0.75	0.10	0.20	0.15	0.25	0.20
Total acid Hydrolysable Phosphate (mg/L)	0.10	0.20	0.10	0.05	0.10	0.30	0.10

1. Haliji lake outlet to Dhabeji mill areas.= 2. East side when water enters into the Haliji lake. =3. Haliji lake bridge, intake water source from K.B. Feeder through Jam Branch (Thatta). 4. From Rest House of Haliji lake S.K. B. loWer regulator bridge, water source to the Karachi for drinking purpose = 6. Water supply station from to Hilya Town near Guest House Kinjhar lake = 7. Hilya village near Boat Basin, Kingher lake

Table 5: Aquatic plants of Kinjhar Kalri and Haleji lakes district Thatta Sindh, Pakistan

		Kinjhar	Haleji
	Azolla pinnate H. Brown*	+ +	+ +
2.	*Marsilea minute* linnaeus**	+ +	+ +
3.	*Selvinia molest*," Mitchell*	+ +	+ +
4.	*Pistia stratiotes* Linn.*	+ +	+
5.	*Ipumuea aquatic* Forsskal**	+	+
6.	*Hydrilla verticillata* (linnaeus) Royle***	+ +	+ +
7.	*Vallisneria spiralis* linnaeus***	+ +	+ +
8.	*Lenma gibba* brineetis*	+	+ +
9.	*Lenma minor* linnaeus*	+	+
10.	*Utriculeria australis* R. Brown**	+	+ +
11.	*Nvmplinicies hydrophylla* (Loweiro} Kuertz**	+	+ +
12.	*Najas minor* Ailinia***	+	+ +
13.	*Jajas indica* (Wilidenow) Chanissn***	+	+ +
14.	*Nelumbobo nucfera* Gaertner**	+	+ +
15.	*Nyinphaea letas* Linn.**	+ +	+ +
16.	*Echinochloa oryzaides* (Arouinci) Fritsch**	+	+
17.	*Phragmites vellatoria* (P. Communis)****	+	+ +
18.	*Polygonum barbatum* Linn.***	+	+ +
19.	*Potamogotons crisbus* linnaeus***	+ +	+ +
20.	*P. nodosus* pouret***	+ +	+ +
21.	*P. pectinatos* lionacus"**	+	+ +
22.	*P. indicus* Roxburgh***	+	+ +
23.	*P. natans* Linn.***	+	+ +
24.	*Typha donlingensis* persoon****	+ +	+ +
25.	*Typha elephamina* Roxburgh****	+	+ +
26.	*Phyla nodiflora* (Oinriceos) Greene****	+	+
27.	*Zannichellie palustris* linnaeus*	+	+
28.	*Cyperes dittarrnis* Linn.****	+	+ +
29.	*Scirpus Intoralis* Vahl****	+	+ +
30.	*Ceratophyllern demersum* Linn***	+	+ +
31.	*Myropnylum spicaturn* Linn***	+	+ +

Table 6: Bacillarophyta Cillarophyta recorded from Kinjhar and Haley lakes district Thatta Sindh, Pakistan

	Bocillarophyta	Kinjhar	Haleji
1	*Achanthes hongarica* Grun	+	+ +
2	*Amphora cofteannformis* Ag.	+	+ +
3	*A. avalis* Knelt	+	+ +
4	*A. veneta* Kuetz	+ +	+ + +
5	*A. coffeeeformis* Ag. (Ag.) Kuetz	+ +	+
6	*Asterionella forinosa* Hass	+	+
7	*Anonnoeoneis exiiis* (Kuetz) Cl.	+	+
8	*Cocconeis placentula* Ehr	+ +	+
9	*C. placentula* var. euglypta (Ehr} Cl-	+	+ +
10	*Cycluteila stelligera* Cl. et Graun.	+ +	+ +
11	*Cyclotella comta* (Ehr.) Kuetz.	+	+ +
12	*C. meneghiniana* Kuetz	+	+ +
13	*C. operculata* (Ag.) Kuetz	+	+ +
14	*C. elliptien*	+	+ +
15	*Cyrnbella cymbiformis* (Ag.) Kuetz	+ +	+ +
16	*G. gracilis.* (Rabb)	+ +	+ +
17	*C. helvetica* Kuetz	+	+ +
18	*C. lecustris* (Ag.) Ci.	+	+ +
19	*C. parva* (Smith) Cleve	+	+ +
20	*C. turnida* (Breb) Van Henerck	+	+ +
21	*C. veritricose* (Kg.) Kuetz	+	+ +
22	*Diatorne vulgare* Bory	+	+ +
23	*Epithemia argus* Kuetz	+ +	
24	*E. zebra* (Ehr.) Kuetz	+ +	+ +
25	*Fragilaria constricta* (Ehr.)	+	+
26	*Gyrusigma attenuaturn* (Keetz) Rabh	+	+
27	*Gorriphonema ecuminatum* Ahr	+	+
28	*G. parvulum* (Kg.) Graun	+	+ +
29	*Gyrosigrna* sp.	+	+ +
30	*G. scalproides* (Rabli) Cl.	+	+ +
31	*Melosira granulata* (Ehr) Rails	+ +	+ +
32	*Navicula cryptocophela* kutz	+	+
33	*N. radiosa* (Kg.)	+	+
34	*N. rhynhocephala* Kutz	+	+
35	*N. viriduic* krrti	+	+
36	*Navicels dicephala* (Dir.) Smith	+	+
37	*N. tripunctata* Bony	+	+
38	*Neidiuni iridis* Cl	+	+
39	*N. productum* Cl	+	+
40	*Nitzschia hungarica* Gratin	+	+
41	*N. Palea* (Kuetz) Smith.	+	+
42	*N. acuminate* Graun	+	+
43	*N. sigmoidea* Ehr.	+	+
44	*N. arnphibie* Gratin	+	+
45	*N. vermicullaris* (Kuetz) Graun	+	+
46	*Pinnuiaria gibba* Ehr.	+	+
47	*P. melon* Kurz	+	+
48	*P. nobilis* Ehr.	+	+
49	*P. viridis* = Ehr.	+	+
50	*Rhoicosphema gibba* Ehr	+ +	+ +
51	*R. curvata* (Kuatz) Gres	+	+
52	*Stauraneis anceps* Ehr.	+	+
53	*Surirella splendida*	+	+
54	*Synedra acus* Kuetz	+	+
55	*S. rumpens* Kuetz	+	+
56	*S. ulna* (Nlitzsch) Ehr.	+	+
57	*Synedra tabulate* var. *fasciculata (*Kuetz) Grum	+	+

- Absent, + Present, + + Dominant

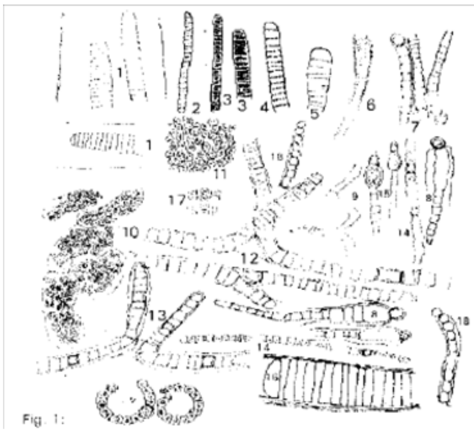

Fig. 1: Katagnymene pelagica lemm. 2: Oscillatoria curviceps Ag. 3: Oscuiatoria omata f. Planktonica Elenk. 4: Oscillatoria cf. Oranata var. ceassa Rao. 5: Oscillatoria limosa. 6: Calothrix maechica 7: Ricularia aquatica, 8: Gloeotricnia natans Rabenhordl. 9: Arthorospria platenis, 10: Microcystus aeruginosoa kuetz. 11: Microcystis flosaquae kutz. 12: Scytoncima simplex Bharadwaja. 13: schyoncma Chiastum Geiler. 14: Anabaona cf. Oscillariodes. 15: Cylindropermun stagnale 16: Lyngbya mausclia Harv. 17: Merismopedia pubctata Meyen 19: Anabeanacnopss reciborskii

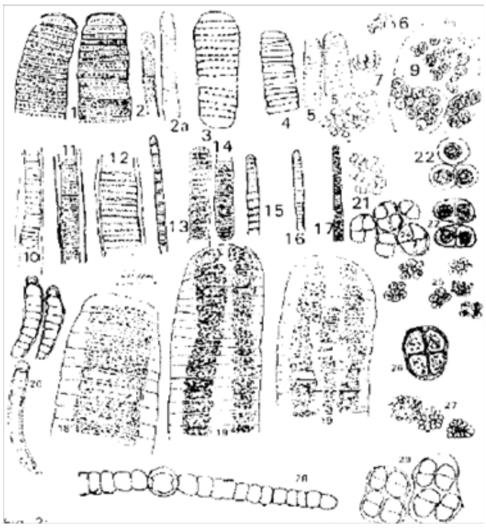

Fig. 2: 1: Oscllatoria princeps var. pseudolinosa Glose. 2: Oscillatona subbrevis D. Sc 2: Oscillatoria simphcissima. 3: Oscillatoria sancta. 4: Osciatoriad d. chaybea. 5: Oscillatoria curciceps. 6: chamoococcus minutus Nag 7&21: Chrococcus pallidus Nag. 8: Aphanotece salina Elenk. 9: Microcysys anruginosa kuetz. 10: Lyngbya astuarii Lieb. 11: Lyngbya cryptovaginata schkorb. 12: Lyngbya hierony musii Lem. 13: Oscillatoria tenuits 14&17: Oscillatoria prolifica Gomiount. 15: Oscillatoria curviceps Ag. 16: Oscillatoria formosa Bory. 18&19: Oscilatoria peinceps Vacher 20: Colothrix matchica. 22&23: Gloeothece confluens nag. 24: Chroococcus turgidus var. maximus Bygaard. 25: Chroococcus dispersus Lemn. 26: Chroocuccus cf. Giganteus west. 27: Cociosphaerim uetzinganum Naeg. 28: Anabaena sphaerica. 29: Chroococcus imnericus lemm

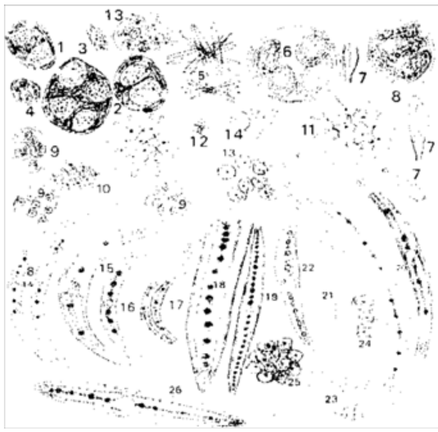

Fig. 3: 1&2: Gloentaenum htelesberg erianurm. 2: Oocystis soliartia Wattrock. 4: Chlorella vulgans Beij. 5: Ankistrodesmus falcatus Ralts. 6: Ocystis eliptica W. West. 7&23: Fungal spore. 8: ocystis naeglii A brown 9&13: Oalmellocystis planktonica Korsch. 10: Scenedesmus bijugatus Kuet. 11: Pedastrum duplex var. clathratum (A. Br) Length 12: Coelastrum microporum Nag. 14: Hadiastrum cotras (Ehr.) Relfs. 15: Closterium Leikbloinji Kutz. 158: Closterium pavulum var. maius. W. & West. 16: Closterikium venus, var major strom. 17 closterium wenus var. crosdale. 18: *Closterium peitchardianum* sp. 20: Closterium venus var. apollonionis croasdale. 21: Closterium globosum Bulnh. Var mnus. 22: Closterium tumdutumn gay. 24: teraedrom minimum Hansg. 25 Coelastrum sphaericum Baegeli. 26 Closterum tancolatum Kuetz

Fig. 4: 1&2: Cosinorinci granott Bret). 3: Cosmarium venustum f. minor Wille. 4&17: Cosmanur» regnelli Wile var. chnnerophomm Sikujo 5: Cosmarium ciecuriituril. 6: Cosmanum sub quareratum. 7: Cosmariorn Javanicum Nordst. 8,9&22: Cosmarium ouculatuill Bret). 1011.35: Cosmarium ornatum Sch. 11&20: Cosmarium poi Tomlin', Archer. 12: Cosmanum subquadrous Al. et G. S. West 13: Cosmarium depressurn var. placcannir.um Reverdin. 14: Cosrnarium *ciranaturn* var. Ocellatum West & West. 15: Cosmarium gib5erulum lutkern. 16&23: Cosmatium subimpressuluoi Borg. 18: Cosmarium laeve Rabenhorst. 19: Cosmarium globosum var. minus Hansg. 21: Cosmaritim inc.onspictrum Archer. 22: Cosmaritun subtorniduin. 24: Cosmantan dorsitruncatum INordst1 West. 25: Cosmariurn quinarium Lundell. 26: Cosrnarium margaritatum var. margaritatum. 27: Cosmarium ceytaiiictiiii Lurid. 28: Euasuurn spinulosuin var. icerrnius Nordst. 29-31: Euastruni spit Delp. 32: Cosmariton sp. 33: Etiastrum ritibium Nag. 34: Fusarium silbstellaturn Noulst. 36: Cosmarium meroldorin Rads. 37: Cosmanum bior_ailato in Nort ist F. minor. 38, Cosmarium depressum Lund.

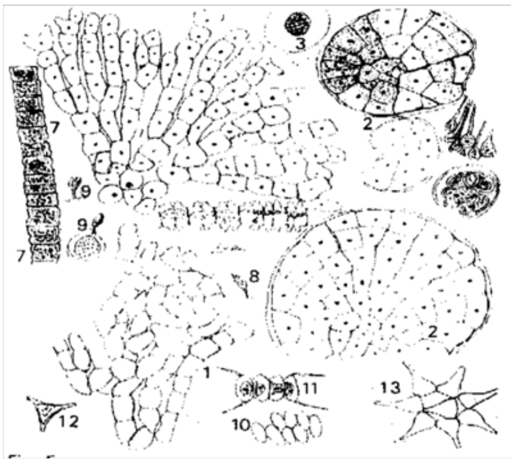

Fig. 5: 1: Coleochaete solute, Coleochaete scutata Breb. 3: Planktosphaeria gelatinosa G. M. Smith 4: Chaetosphaeridium giobosum (Nord) Klebahn 5: Oocystis bnrgei Snow. 6: Desmidium swartzii. 7: Hyalotheca dissiliens. 8: Characium Ornithoceohalum A. Braun. 9: Characium obtusum. 10: Scenedesruus abundans Chodat. 11: Scenedesmus quadricauda (Torp) Breb. 12: Tetraedron trigomum. 13: Pethastrum simplex

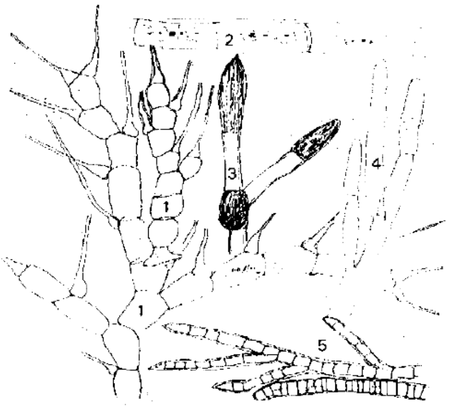

Fig. 6: 1: Bulhocheete sp. 2: Zygnarna sp. 3: Pithophora mooreana Collins 4: Cladophora glornerata IL) Kuetzing. 5: Stignocolniurn arnaenum

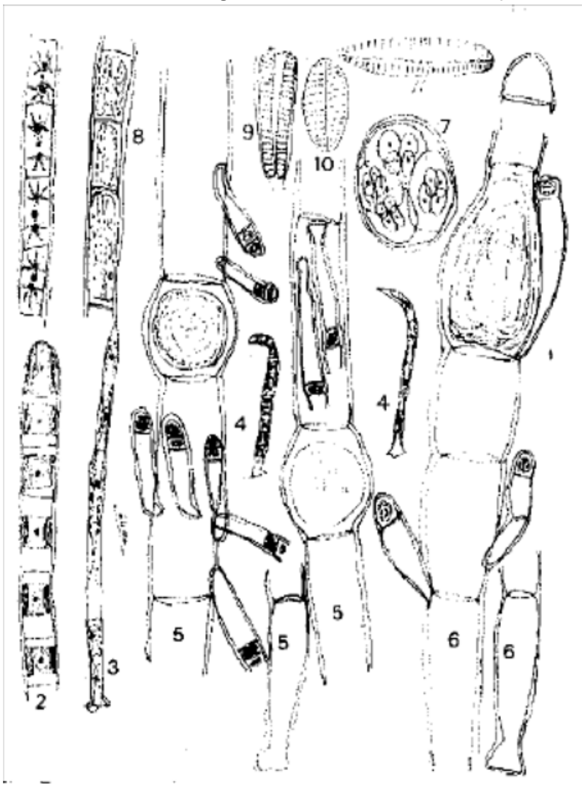

Fig. 7: 1: Zygenina sp. 2: Ulothrix subconstricta G. S. West. 3: Uronerna confer'ncolum Larger. 4: Uronema elongaturn Hadgetts. 5: Oedogonerm Ct. nanurn Kingense jao, 6: Oedogoniurn straitum Tiffany. 7: Oocystis pusilla. 8: RhizOcloolum Crassipekitum West. 9: Gomphonema ghosea. 10: Cocconeis placentula Ehr. 11: Navicula cficephala

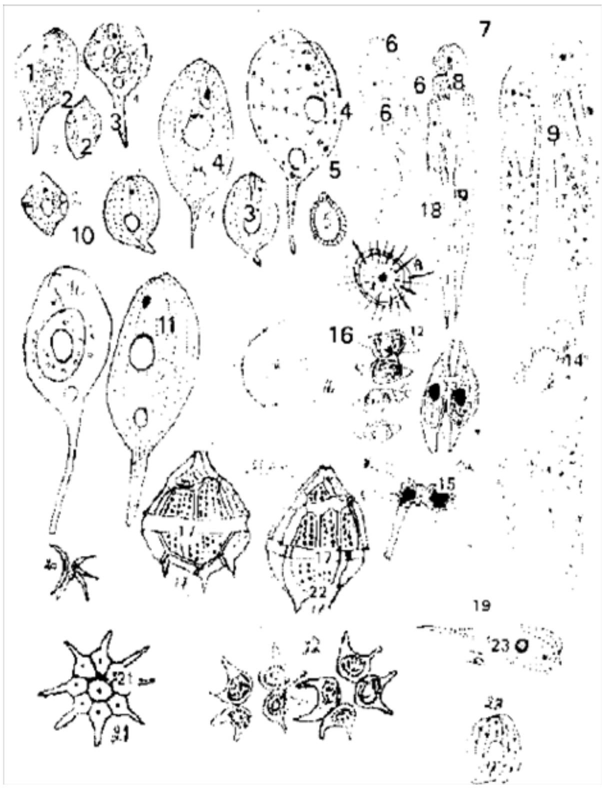

Fig. 8: 1: Phacus tortus (Lemm) Skr. 2: Lepocinciis sphagnophila Eemrn 3: Phacus curvicauda. 4&11. Phacus ranula Pochrn. 5: Trachelornoria vanans Lamm. 6: Trachelornonas sp. 7: Cosmarium moniiitorme Crurp) Rafts. 8: Euglena acus Ehr. 9: Euglena sociabifis Dang. 10: Phacus longicauda (Ehr) Dtij var. Longicauda major. 12: Staurastrum astedas Nygaard. 13: Staurodesmus convergens var. ralfsii Turner. 14: Euglena oxyuris var. minor prescnti. 15: Staurastrum paradoxum Mayen. 16: Rhizocyrysis Jimnetica G. M. Smith. 17: Peridinium sp. 18: Golenkinia paucispina West & West, 19: Phacus caudatus Huebner. 20: Selenastrurn westii G. M. Smith 21: Pediastrum smplex var. microporum lemur. 22: Sorastrum americanum Sch. 23: Phascus unguis Pochm

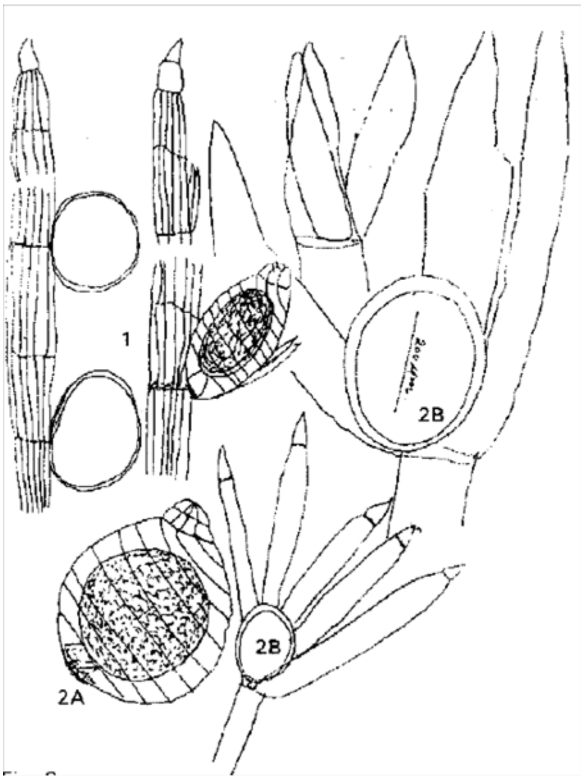

Fig. 9: 1: Chara connivers Salzm ex. A. Br. 2: Nitella hyalina (DC.) Ag

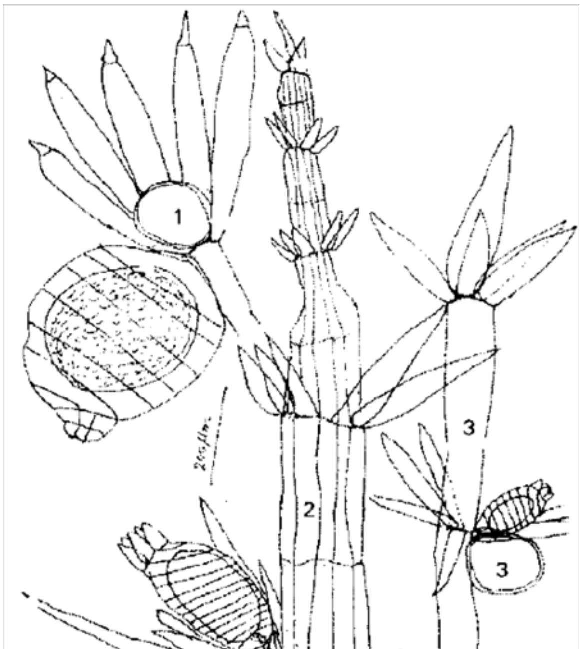

Fig. 10: 1: *Nitella* hyaline (Dc.) Age. 2: Chara zeylanica. 3: Chara fibrosa Ag. ex Bruz., em

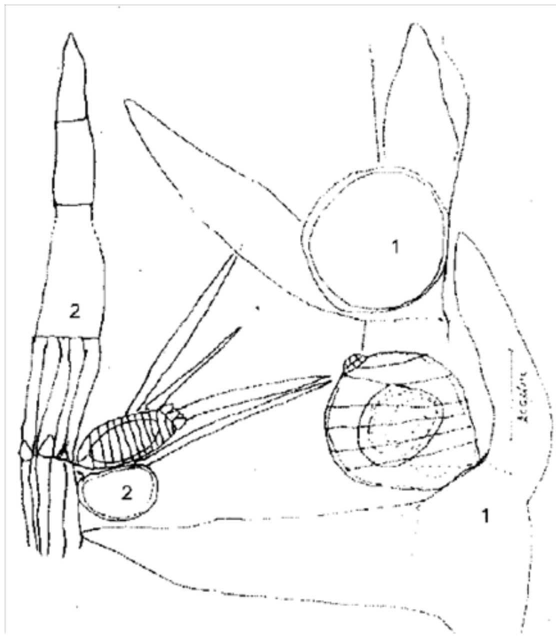

Fig. 11: 1: *Nitellopsis* obtusa (Desk', in lois) J. Gr. 2: *Chara vulgaris* L., em

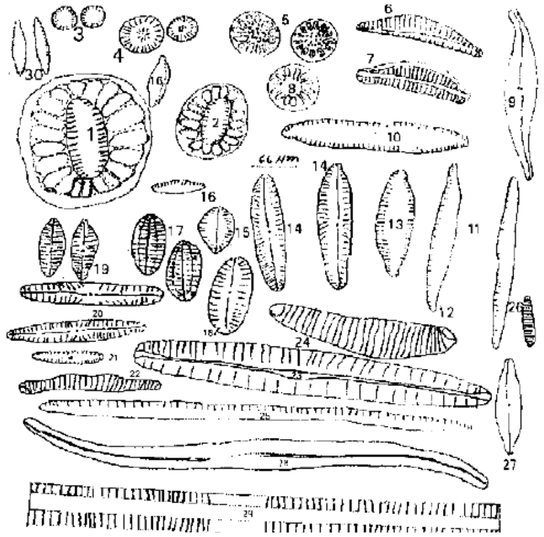

Fig. 12: 1 and 2: Camylodiscus biocostatus Hus. 3: Cyclotella operculata Kutz. 4: Cyclotella stelligera Cl at Grun 5: Cyclotella striatata Grun. 6: Amphora veneta Kutz. 7: Amphora ovalis Kutz. Rys. 8: Cyclotella meneghiniana Kutz. 9: Gyrosigma sp. 10: Nitzschia accuminata Grun. 11: Synedra affinis Kutz. 12: Nitzschia hungarica Grun 13: Achnanthes hungarica Gr. 14: Navicula dicephala Ehr. 15: Cocconeis pediculus Ehr. 16: Nitzschia sp. 17: Cocconeis placentula var. Lineata Ehr. 18: Cocconeis placentula Ehr. 19: Navicula sp. 20: Gomphonema helveticum Brun. 21: Gymphonema parvulum K. 22: Eunatia pectinatis Rab. 23&24: Eunatia sp. 25: Nitzschia gracilis Hantzsch. 26&28: Nitzchia ffrustulum (Kutz) G. 27: Navicula sp. 29: Nitzschia vermicularis Kutz. 30: Nitzschia amphibia Grun

manufacturer. Sodium, potassium, calcium and magnesium were determined at 589, 766.5, 422.7 and 285.2 nm respectively in triplicate, with delay time 3 seconds and integration time 3 seconds. Sodium absorption ratio (SAR) was calculated using the relation, where concentrations are in millimoles:

$$SAR = \frac{Na}{\sqrt{Ca + Mg}}$$

The plankton were collected by the plankton net No. 25. Algal filaments and higher free floating plants were collected by hand picking. Submerged Chlorophytes and higher aquatic plants were collected by using grapnel. Identification of algal flora was carried out using keys. Bacillarophyta, (Majeed, 1935; Patrick and Reimer, 1966). Cyanophyta and Chlorophyta (Desikachary, 1959; Prescott, 1962), Charophytes (Wood and Imahori, 1964) higher aquatic plant (Cook, 1996) and Zooplankton (Mizuno and Takahashi, 1991; Ward and Whipple, 1959).

Results and Discussion

The temperature of water is important for biological activity and varied with atmospheric temperature. The water temperature was observed within 19-34°C with atmospheric temperature of 24-37°C. A similar variation in the temperature has been reported by Nazneen (1980) at Kinjhar during 1968 to 71.

The water at Kinjhar and Haleji lakes was observed slightly alkaline with the pH within 7.9 to 8.73 and 7.4 to 8.1 respectively. The higher growth of phytoplankton and aquatic plants in both the lakes may be due to higher pH. values (Nazneen, 1974, 1980; Gerloff e*t al.,* 1952; George, 1962).

The dissolved oxygen which supports the biological life in water, was present adequately both at Kinjhar and Haleji lakes within the range 6.9 to 8.5 mg/L, may be because of the factors like continuous blowing of wind on the large surface area of the lakes, temperature of the water, light penetration and photosynthesis activity of the algal flora and abundance of higher aquitic plants (Ganapati, 1940; Hutchinson, 1967).

Electrical conductivity (EC) at Kinjhar and Haleji lakes was observed within 235-307 A/cm and 320-615 isS/cm corresponding to 150-324 mg/L and 214-394 mg/L, total dissolved solids (IDS) respectively. The EC and TDS observed were within the acceptable limits of EC 0.75 mS/cm and TDS 500 mg/L for the water used for domestic consumption.

Total alkalinity at Kinjhar varied between 25-200 mg/L and at Haleji 20-145 mg/L as $CaCO_3$. Similarly chloride contents at Kinjhar and Haleji lakes during study period varied within 25-56 mg/L and 35-106 mg/L respectively. The hardness calculated as $CaCO_3$ also varied within 40-135 mg/L and 60-122 mg/L at Kinjhar and Haleji lakes respectively.

Inorganic phosphate, nitrate and water soluble silica are nutrient for phytoplankton. Orthophasphate phosphorus was observed within 3-22 µg/L at Kinjhar and 12-28 pg/L at Haleji. Total acid hydrolysable phosphate phosphorus was observed within 60-900 µg/I_ at both the lakes, nitrate 0.1-1.4 mg/L and silica 1.0-10 mg/L (Table 5, 6, Fig. 1-12). The metal contents of sodium, potassium, calcium and magnesium were determined and were found in the range of 19-44 mg/L, 3-14 mg/L, 12-75 mg/L and 12-30 mg/L respectively at Kinjhar and 26.-10 mg/L,3-26 mg/L, 27-88 mg/L and 9-38 mg/L respective at Haleji. Result of the metal contents indicates that at Kinjhar Ca > Na >Mg> K, but at Haleji Na > Ca >Mg >K. Sodium absorption ratio (SAR) was calculated to evaluate the suitability of the water for agricultural purposes and was found within acceptable limits of 1.3-3.4 (Table 1, 2).

Kinjhar and Haleji are subtropical lakes with all types of aquatic plants. Total 31 species of higher aquatic plants were found present in which *Azolla pinnata, Pistia stratiotes, Lemna minor, Salvinia molesta, Lemna gibba* are found free floating. *Ipomoea aquatica , Marsilea minuta , M. quadrifolia, Nymphaea lotus, N. nouchli, N. stellata* are attached floating plants. *Typha domingensis, T. elephantina, Phragmites karka IP. communist Cyperus difformis, Scirpus litorals* are emergent. Hydrilla verticillata, *Vallisneria spiralis, Najas minor, N. major, N. indica, Potamogeton pectinatus, P. crispus, P. nodosus, P.natans, Ceratophylum demersum* and *Myriophylium spicatum* are sub-merged platns (Table 5).

The water of the Kinjhar lake is blue green in color, the bottom sediments are calcareous and silty . The submerged vegetation is dominated by Charophyta (6 species) belong to *Nitella hyalina, Nitellopsis obtusa, Chara flaccida, Chara contraria, Chara zeylanica, Chara globularis* and *Chara connivens* were present. While *iVitellopsis obtusa, Chara globularis* and *Chara connivens* occur in deep water. Fig. 9 and 10: 1 to 3, Fig. 11, 12.

In Kinjhar and Haleji lakes a total of 205 algal species were identified, out of these 43 species belongs to *Cyanophyta,* 94 sp. to *Chlorophyta,* 6 sp. of *Charophyta,* 10 sp. *Euglenophyta,* 2 sp. *Dinophyta* and 57 species of *Bacillarophyta* were observed as Planktonic and Peryphytonic (Table 6, Fig. 12: 1 to 30).

Cyanophyta is abundant by the planktonic species belonging to *Microcystis*, *Merismopedia*, *Chroococcus*, *Aphanocapsa, Gloeocapsa*, *Gomphosphearia*, *Oscillatoria*, *Lyngbya, Anabaena*, *Scytonema, Cylindrosperrnum* and *Spirulina* species. While *Gloeotrichia*, *Nostoc*, *Calothrix* and *Katagnymene* are found peryphytic on the aquatic plants. (Fig. 1: to 17 and Fig. 2: 1 to 29).

In *Chlorophyta*, *Caelastrum*, *Oocystis*, *Planktosphaeria*, *Ankistrodesmus*, *Cosmarium, Euastrum, Closterium* are found planktonic (Fig. 3: 1 to 26 and Fig. 4: 1 to 38) and *Cladophora Oedogonium, Ulothrix, Stigeocoloniurn, Bulbochaete*, *Coleochaete* and *Characium* are found peryphytic (Fig. 5: 1-13 and Fig. 6: 1 to 5).

The Zooplankton compositionm of Kinjhar and Haleji lakes showed great difference among the two lakes. In Kinjhar lake Cladoceran, *Ceriodaphnia reticulata, Bosmina longirostris, Bosminopsis deitersi* and *Diphanosoma brachyurum* were dominant. All these species usually occur in limnetic or open waters of mesotrophic to eutrophic lakes.

In Haleji lake the dominant Cladocerans generally were *Chydorus* sp., *Macrothrix laticornis, Simocephalus vetulus* and *Moina rectirostris.* All these are considered as shallow and weedy water species. The Copepoda species *Paracyclops* sp. is also a creeping species found in debris of shallow waters.

In the view of flora and Zooplantonic fauna it can be concluded that Kinjhar lake is still a deeper lake having a limnetic or open water zone. However the Haleji lake became a shallow and weedy lake i.e. lacking limnetic zone.

Although both the lakes are considered as eutrophic water bodies, the former is in the initial stage of eutrophication while the later one is completely eutrophic lake.

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