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TROPHIC STATUS AND ECOLOGICAL EVALUATION OF CHLOROPHYCEAE

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Nutrient status and ecological studies of Chlorophyceae in two lentic water bodies has been studied for a period of two years. As compared with Volvocales and Zygnematales (desmids), Chlorococcalian flora of water bodies has shown a better representation with greater bulk among the Chlorophyceae. The greatest diversity could be seen in Banjara lake followed by O.U. semipermanent pond in which the water got dried up during summer. The presence of certain Chlorococcalian genera are also considered as the indices of eutrophication of water bodies. Desmids are better represented in O.U. pond when compared to Banjara lake indicating fresh water nature of water body.

Keywords: Ecology; Eutrophication; Indice.

Introduction

Pearsall[1] concludes that the waters harbouring green algea are different in chemical composition than those favouring diatoms and blue-green algae in large lakes. Munawar[2], holds the view that this is also true with respect to smaller bodies of water. According to Round[3], the presence of chlorophyceae in eutrophic waters is due to their higher nutrient contents. The present work is aimed at to find out the ecological factors which govern the distribution and periodicity of various groups of green algae in the water bodies under present investigation.

Materials and Methods

Banjara lake is situated in Banjara Hills of Hyderabad city and O.U. pond is situated in Osmania University campus of Hyderabad. The water samples were collected and the sampling was done at monthly intervals for a period of two years. The water samples were analysed for the various physico-chemical factors by following standard methods[4,5]. 100 ml of surface water samples were also collected for the qualitative and quantitative estimation of algae by following the drop method of Pearsall *et al.*[6] and as described by Venkateswarlu[7].

Multiple Regression Analysis (MRA) - A statistical approach which was introduced by Nageswar Rao[8], has been employed in order to evaluate the relative importance of various physico-chemical factors on the growth and development of chlorococcalian genera.

Results and Discussion

The results of various physico-chemical factors are given in Table 1 & 2. The two lakes are alkaline in nature with pH ranges from 7.8 to 9.8. Temperature fluctuated between 21 to 33 degrees centigrade. All the physico-chemical factors are in somewhat higher concentration when compared to O.U pond.

Volvocales are represented by *Phacotus lenticularis* in both water bodies. *Pandorina, Gloeocystis* and *Sphaerocystis* species are observed in O.U pond. Chlorococcales are represented by the species of *Scenedesmus, Tetraedron* in both lake and pond. Apart from these, Banjara lake is also represented by species of *Dictyosphaerium, Ankistrodesmus, Kirchneriella, Coelastrum,* *Pediastrum, Micractinium* etc. Desmids are represented by three genera, *Closterium, Cosmarium* and *Pleurotaenium.*

In Banjara lake. simple correlation analysis (SCA) reveals that except bicarbonates, chlorides, silicates total and dissolved solids, all are significant individually at both 5% and 1% level. MRA reveals that D.O, organic matter and dissolved solids together account for 25% variation in chlorococcales (Table-3, Fig-1). Griffiths[9] holds the view that higher concentrations of D.O in water are favourable for the development of chlorococcales. Chlorococcales have attained their maximum peaks during summer when the temperatures were high with moderately high total solids in Banjara lake whereas the data was not observed in O.U. pond as the pond got dried up during summer. It is indicating that growth of chlorococcales is more or less connected to water temperature. This is in accordance with the observations of Rao[10] and Singh[11]. According to Round[12], eutrophic lakes also often have large summer growths of chlorococcales eg. *Pediastrum, Scenedesmus, Dictyosphaerium, Crucigenia, Tetraedron* etc which are all observed in Banjara lake. These are considered as the indices of degree of eutrophication of water body. Eutrophic waters are characterised by the species of *Microcystis, Oscillatoria* etc which are also observed in Banjara lake. This is in concurrence with the observations of Patrick[13] and Welch[14]. Biological estimations of degree of eutrophication is more informative than chemical determinations[3], whereas the other pond which is free from *Microcystis* bloom, summer growths of chlorococcales and better representation of desmids indicates oligotrophic nature of water body. This is also in conformity with the observations of Brook[15].

The reason for the meagre representation of volvocales in Banjara lake could have been due to the continuous blooms of *Microcystis,* which was antagonistic to volvocales in Banjara lake. Similar trend was experienced by Seenayya[16]. This is also supported by Philipose[17], who reported the presence of large number of volvocales in the fish ponds of Bengal when they are only free from *Microcystis.* In the present investigation, O.U. pond which is free from *Microcystis* bloom supported somewhat better representation of volvocales which extends support to the above workers.

The poor representation of desmids could be due to eutrophic nature of water body in Banjara lake. Vanoye[18] attributed paucity of desmids in Belgium waters to their eutrophic nature which is a complicated expression in terms of organic matter, oxygen, nutritional levels etc. Round[12] also points out that desmids are generally believed to favour oligotrophic waters. This is supported by the better distribution of desmids in O.U pond.

The total solids with their lowest concentration supported higher percentage of desmids and lower number of chlorococcales in O.U. pond whereas Banjara lake with moderately high total solids has supported lower number of desmids and higher number of chlorococcales. Gonzalves and Joshi[19] observed a similar phenomenon during their investigation.

O.U. pond supported somewhat more number of desmids which were low in phosphates and nitrates concentration and somewhat higher concentration of phosphate in Banjara lake has coincided with the lower population of desmids. This is in concurrence with the observations of Pearsall[20], who while working in certain English lakes, has concluded that desmids occur in waters which are low in nitrates and phosphates concentrations.

The pH of water seems to be another factor influencing the growth of desmid populations. Strom[21], Froehne[22] are of the

Table 1

Banjara Lake — Physico-Chemical Parameters Mean (expressed in PPM except pH & Temp)

Month	Rainfall in mm	atmos. temp °C	Water temp° C	pH	CO_3	HCO_3	Cl	D.O	Org. matter
July 1987	164.8	31.1	27	8.8	48.6	269.0	191.4	6.6	5.2
August	175.1	30.5	26	8.8	21.6	142.7	105.5	5.2	2.9
September	64.3	32.8	29	9.5	54.0	126.3	92.5	7.2	5.6
October	129.6	30.8	27	9.2	43.2	120.8	70.2	5.2	4.5
November	238.7	28.2	25	8.8	16.2	104.3	46.2	8.6	2.4
December	2.8	27.6	24	8.4	32.4	87.8	55.8	5.8	6.1
January 1988	-	29.2	28	9.4	32.4	71.3	78.1	6.4	3.4
February	67.7	32.5	29	9.3	37.8	93.3	70.2	6.2	3.0
March	2.1	35.6	29	9.0	37.8	131.7	87.5	6.2	2.7
April	46.0	37.4	30	9.5	43.2	87.8	92.5	11.8	7.3
May	0.3	41.3	31	9.8	32.4	71.3	89.3	13.2	6.5
June	80.7	35.3	27	8.9	32.4	186.7	105.3	8.4	4.7
July	281.3	30.6	27	8.4	21.6	153.7	110.0	10.6	14.1
August	196.4	29.9	28	9.2	43.2	87.8	92.5	12.6	5.8
September	198.5	30.2	29	9.0	32.4	115.3	76.5	10.6	10.1
October	30.5	31.3	29	9.1	42.2	104.3	68.6	19.4	11.7
November	-	29.8	27	9.2	48.6	98.8	84.5	14.2	11.4
December	13.7	27.8	29	8.8	37.8	181.2	82.9	9.6	4.6
January 1989	-	29.3	26	9.7	81.0	192.2	98.9	15.4	10.6
February	-	33.1	26	8.5	32.4	175.7	64.5	5.6	2.2
March	56.6	33.7	27	8.3	32.4	192.2	108.4	9.0	8.1
April	1.0	38.6	30	8.2	32.4	180.9	119.6	16.4	10.1
May	0.2	40.7	31	8.9	48.6	208.6	121.6	20.8	2.2
June	122.5	33.5	33	9.5	86.4	241.6	156.3	12.8	7.1
Two Years average	77.7	32.4	24	9.02	40.4	142.6	95.3	10.2	6.2

Month	Total hardness	Ca	Mg	PO_4	NO_3	SiO_2	Fe	Total Solids	Dissolved Solids	Suspen Solid
July 1987	111.6	34.5	7.3	0.30	0.354	1.0	traces	1600.0	936.0	664.0
August	90.0	21.6	8.2	0.30	0.177	2.0	traces	840.0	668.2	272.4
September	208.8	25.9	35.0	0.10	0.443	4.0	Nil	980.0	612.2	378.3
October	90.0	21.6	8.7	0.20	0.354	traces	0.1	560.0	328.9	232.2
November	115.2	10.0	21.8	0.10	0.177	6.0	traces	612.6	390.2	222.4
December	68.4	21.6	3.5	traces	0.088	Nil	Nil	512.6	323.2	189.4
January 1988	75.6	17.2	7.8	traces	0.088	2.0	Nil	540.6	340.8	199.8
February	75.6	24.4	3.5	0.10	0.354	3.0	Nil	536.5	353.0	183.5
March	111.6	25.9	11.5	traces	0.221	2.0	Nil	605.5	398.2	307.3
April	100.8	27.3	7.8	0.20	0.177	3.0	Nil	598.6	322.4	276.2
May	82.8	25.9	4.3	0.10	0.354	5.0	0.4	560.5	340.5	220.0
June	169.2	30.2	22.7	0.70	0.265	1.0	traces	712.5	462.0	250.0
July	136.8	37.4	10.5	traces	0.177	1.0	traces	560.0	312.5	247.5
August	115.2	33.1	7.8	0.1	0.177	2.0	Nil	542.0	310.0	232.0
September	90.0	30.2	3.5	0.1	0.088	3.0	0.06	256.8	182.0	74.8
October	93.6	28.8	5.2	Nil	0.265	11.0	0.1	260.0	192.0	68.0
November	75.6	23.0	4.2	0.20	0.132	14.0	0.1	200.0	168.0	32.6
December	111.6	33.1	7.0	0.80	0.354	6.0	0.1	440.0	280.8	159.8
January 1989	140.4	40.3	9.6	1.2	0.265	7.0	0.1	520.0	362.0	158.3
February	140.4	38.8	10.5	0.30	0.265	7.0	0.1	540.3	382.0	158.3
March	144.8	33.1	14.8	0.10	0.106	5.0	0.04	562.0	392.0	170.0
April	154.8	33.1	17.5	0.20	0.177	3.0	0.08	592.0	390.0	202.0
May	111.6	28.8	9.6	0.10	0.221	3.0	1.0	563.0	328.0	235.0
June	136.8	28.8	15.7	0.10	0.310	2.0	0.06	752.0	439.0	313.0
Two Years average	114.2	28.0	10.6	0.21	0.22	3.86	0.29	539.0	342.6	199.8

Table 2

O.U. Campus pond — Physico-Chemical Parameters (expressed in PPM except pH & Temp)

Month	Rainfall in mm	Mean atmos. temp °C	Water temp° C	pH	CO_3	HCO_3	Cl	D.O	Org. matter
July 1987	164.8	31.1	26°	7.4	16.2	230.6	357.4	5.6	2.3
August	175.1	30.5	26°	8.0	16.2	153.7	295.1	8.6	1.1
September	64.3	32.8	30°	8.4	traces	98.8	248.9	5.6	3.2
October	129.6	30.8	30°	8.4	16.2	131.7	196.2	4.8	4.8
November	238.7	28.2	25°	8.4	10.8	208.6	161.1	3.6	6.3
December	2.8	27.6	21	8.4	traces	197.6	222.1	2.8	2.5
January 1988	-	29.2	23	8.0	10.8	208.6	256.8	4.4	0.55
February	67.7	32.5	27	8.0	traces	181.2	250.5	3.2	3.15
March	2.1	35.6	26	7.8	16.2	214.1	307.9	4.2	1.25
April	46.0	37.4	-	-	-	-	-	-	-
May	0.3	41.3	-	-	-	-	-	-	-
June	80.7	35.3	-	-	-	-	-	-	-
July	281.3	30.6	26	7.8	traces	98.8	78.1	3.2	4.8
August	196.4	29.9	28	7.4	Nil	241.6	153.1	5.2	0.7
September	198.5	30.2	28	7.9	16.2	252.6	162.7	5.6	2.0
October	30.5	31.3	26	7.8	21.6	296.5	93.2	5.0	4.9
November	-	29.8	28	7.8	21.6	269.0	96.2	3.4	5.0
December	13.7	27.8	22	8.1	27.0	285.5	109.1	11.0	3.2
January 1989	-	29.3	25	8.5	27.0	236.1	113.4	10.4	6.5
February	-	33.1	24	8.6	54.0	120.8	132.8	13.6	6.3
March	56.6	33.7	26	9.0	64.8	163.7	163.8	11.8	7.1
April	1.0	38.6	-	-	-	-	-	-	-
May	0.2	40.7	-	-	-	-	-	-	-
June	122.5	33.5	-	-	-	-	-	-	-
Two Years average	77.7	32.4	25.9	8.0	19.3	192.4	194.3	6.49	3.54

Month	Total hardness	Ca	Mg	PO_4	NO_3	SiO_2	Fe	Total Solids	Dissolved Solids	Suspen Solid
July 1987	57.6	17.2	3.5	Nil	0.08	1	0.4	976	698	278
August	291.6	17.2	60.4	Nil	0.04	6	0.2	920.2	692	228
September	277.2	38.8	43.7	0.40	0.26	8	0.1	940	612	228
October	154.8	18.7	26.2	0.30	0.44	8	traces	828	502	326
November	219.6	21.6	40.2	0.20	0.44	8	traces	382	348	34
December	385.2	116.6	22.7	0.10	0.17	6	traces	492	368	124
January 1988	410.4	102.2	37.6	0.10	0.17	5	traces	512	340.2	171.8
February	306.0	77.7	27.1	Nil	0.26	5	0.1	502 8	342	160.8
March	226.8	27.3	38.5	0.1	0.17	4	Nil	440.2	328	112.2
April	-	-	-	-dried up-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-	-	-
June	-	-	-	-	-	-	-	-	-	-
July	189.0	27.6	29.1	0.1	0.08	5	0.23	882.8	582	300.8
August	316.8	41.6	51.8	0.3	0.17	6	Nil	896.0	586	310
September	363.6	51.2	57.3	traces	0.08	12	traces	438	343	195
October	313.2	106.3	11.3	0.1	0.26	14	0.02	512	298	214
November	320.4	87.8	24.4	0.2	0.17	8	0.1	512	286	226
December	277.2	90.2	12.2	0.4	0.44	8	0.06	492	274	218
January 1989	284.4	70.5	26.2	0.2	0.35	7	0.1	464	262	202
February	212.4	30.2	33.3	0.1	0.08	4	traces	440	244	196
March	230.4	30.82	37.6	0.1	0.17	3	0.08	513	302	201
April	-	-	-	-	-dried up-	-	-	-	-	-
May	-	-	-	-	-	-	-	-	-	-
June	-	-	-	-	-	-	-	-	-	-
Two Years average	269.1	53.7	32.7	0.15	0.20	6.4	0.06	438	295.1	152.2

Table 3

Banjara Lake Multiple regression analysis of physico-chemical factors onChlorophyceae.

Maximum factors present	R^2	F	d.f	Equation
$x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}, x_{15},$	0.49	2.1	7.15	$y = -183.5 + 41.5\, x_1 + -4.4\, x_2 + -1.0\, x_3\, 0.29\, x_4\, 0.23\, x_5\, 0.23\, x_5\, 2.1\, x_6 + -4.0\, x_7\, 2.6\, x_8\, -6.8\, x_9 + -9.7\, x_{10} + -9.5\, x_{11}\, -48.4\, x_{12} + -0.1\, x_{13} + 0.6\, x_{14} - 0.3\, x_{15}$ -(1)
factors dropped				
x_{13}	0.49	1.7	8.14	
x_{10}	0.49	1.4	9.15	
x_{11}	0.49	1.1	10.12	
x_5	0.48	0.95	11.11	
x_2	0.48	0.77	12.10	
x_9	0.45	0.57	13.9	
factors retained				
$x_0, x_1, x_3, x_6, x_7, x_8, x_{12}, x_{14}, x_{15},$				$Y = -218.0 + 31.6\, x_1 + -0.9\, x_3 + 0.19\, x_4\, 1.7\, x_6 + -4.4\, x_7 + 0.21\, x_8 + -88.8\, x_{12} + 0.15\, x_{14} + -0.3\, x_{15}$ ---(2)

X_1 - pHX^2 - Temp X_3 - CO_2, X_4 - HCO_3 X_5 -Cl, X_6 - D.O, X_7 -O.M X_8 -T.H, X_9 - Ca, X_{10} - Mg. X_{11} - PO_4, X_{12} - NO_3, X_{13} - SiO_2. X_{14} - T S, X_{15} - D.S.

* - Significant at 5% level.
** - Significant at 1% level.

Table 4

O.U. Campus pond Multiple regression analysis of physico-chemical factors on Chlorophyceae

Maximum factors present	R^2	F	d.f	Equation
$x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}, x_{15},$	o.98	995.4*	1.15	$y = 74.2 + -2.0\, x_1 + -0.6\, x_2 + -0.9\, x_3 + .3\, x_4 + 00.6\, x_5 + -0.6\, x_6 + 4.8\, x_7 + -11.5\, x_8 + 28.5\, x_9 + -0.4\, x_{10} + 72.5\, x_{11} + -75.2\, x_{12} + -2.6\, x_{13} + -0.091\, x_{14} + 0.6\, x_{15}$ ----(1)
factors dropped				
x_2	0.98	458.2	2.14	
x_6	0.98	271.7	3.13	
x_9	0.98	156.2	4.12	
x_5	0.97	90.1	5.11	
x_7	0.96	45.4	6.10	
x_1	0.94	23.1	7.9	
x_{12}	0.92	13.0	8.8	
x_{11}	0.91	8.8	9.7	
x_{15}	0.91	6.2	10.6	
x_{14}	0.82	2.1	11.5	
x_3	0.70	0.81	12.4	
x_{13}	0.59	0.34	13.3	
factors retained				
x_4, x_8, x_{10}				$Y = 5.5 + 0.28\, x_4 + -0.2\, x_8 + 0.6\, x_{10}$ ---(2)

X_1 - pHX^2 - Temp X_3 - CO_2, X_4 - HCO_3 X_5 -Cl, X_6 - D.O, X_7 -O.M X_8 -T.H, X_9 - Ca, X_{10} - Mg, X_{11} - PO_4, X_{12} - NO_3, X_{13} - SiO_2. X_{14} - T S, X_{15} - D.S.

* - Significant at 5% level
** - Significant at 1% level

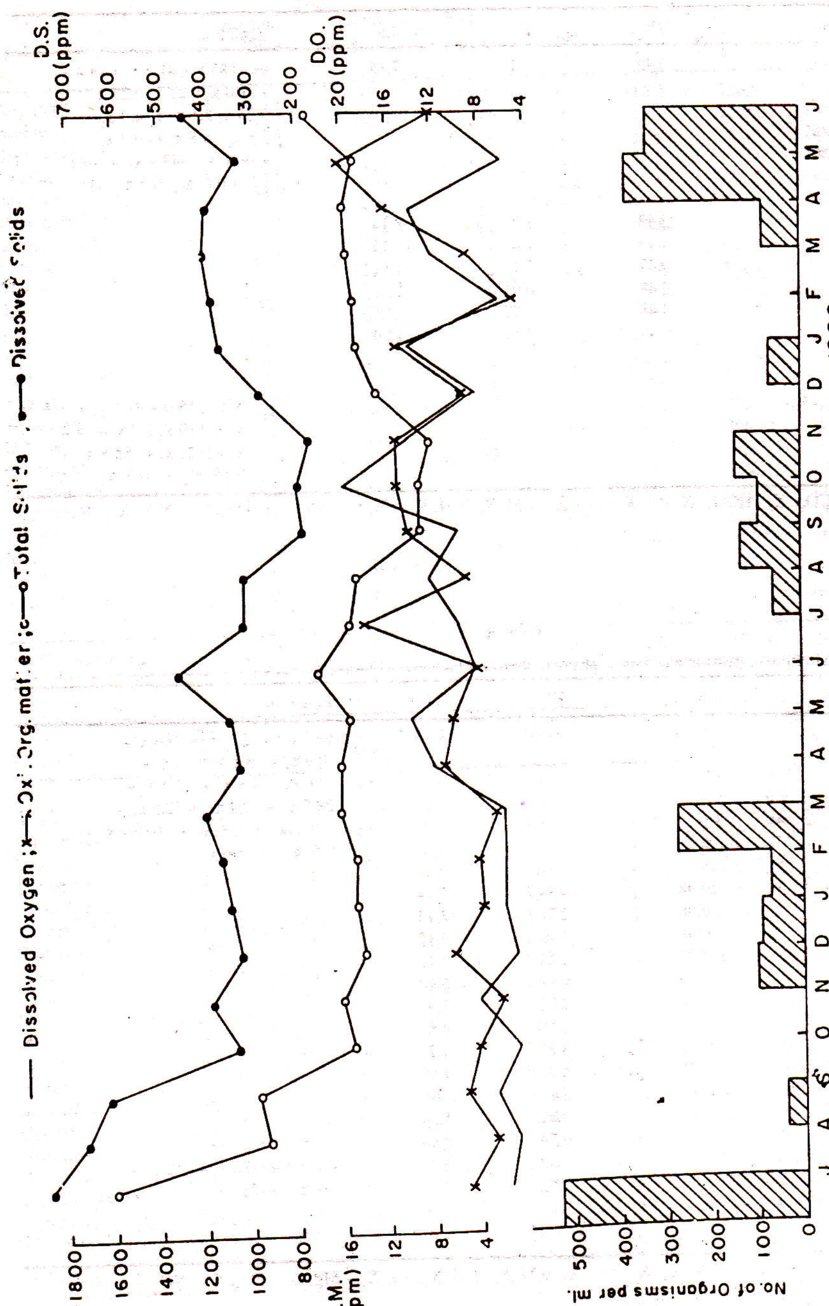

Fig. 1. Factors affecting the distribution of Chlorophyceae in Banjara lake

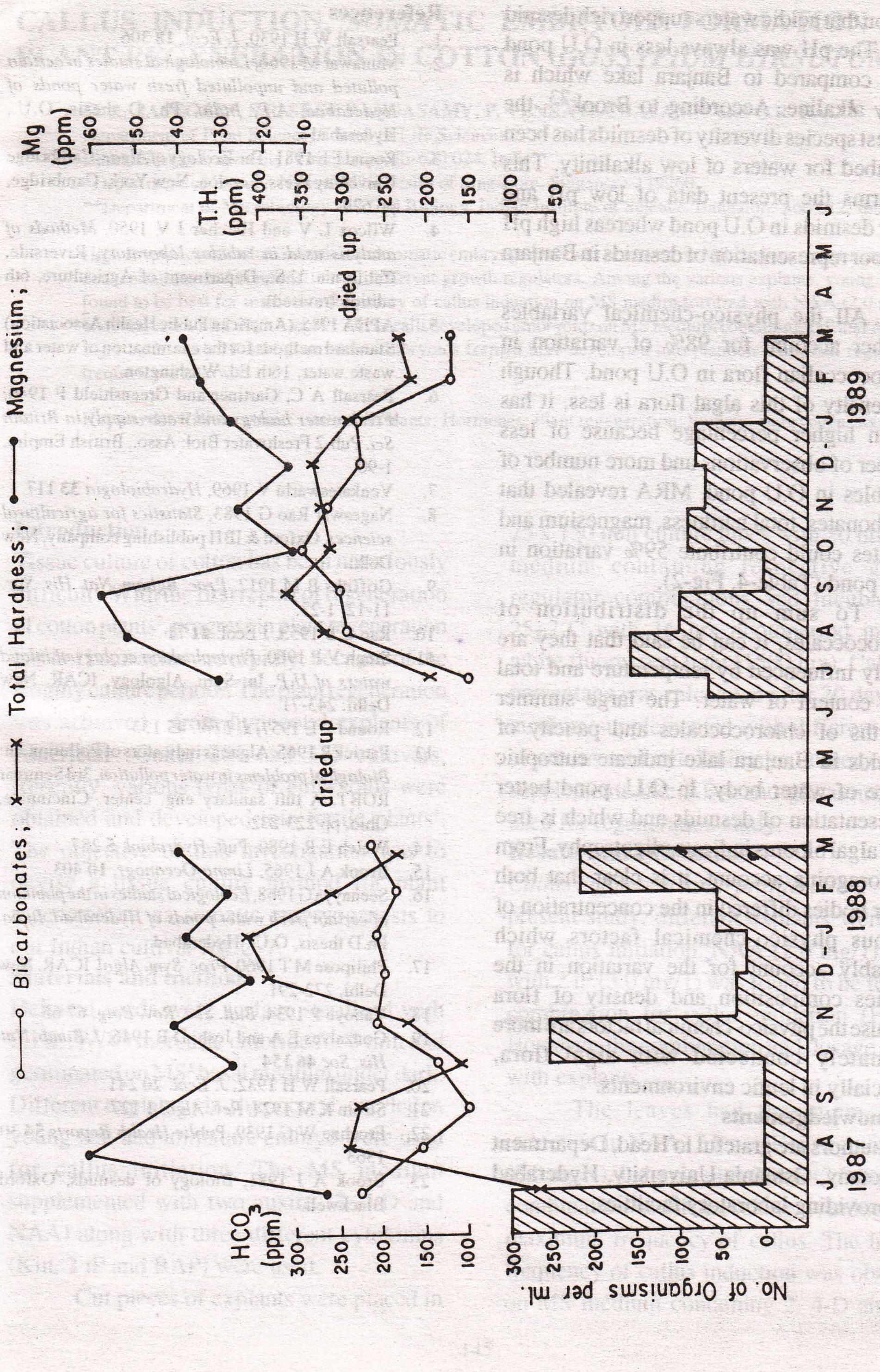

Fig. 2. Affect of Various Physico-Chemical factors on Chlorophyceae in O.U Pond

opinion that acidic waters support rich desmid flora. The pH was always less in O.U pond when compared to Banjara lake which is highly alkaline. According to Brook[23], the greatest species diversity of desmids has been described for waters of low alkalinity. This conforms the present data of low pH and better desmids in O.U pond whereas high pH and poor representation of desmids in Banjara lake.

All the physico-chemical variables together account for 98% of variation in chlorococcalian flora in O.U pond. Though the density of this algal flora is less, it has shown higher percentage because of less number of observations and more number of variables in O.U pond. MRA revealed that bicarbonates, total hardness, magnesium and silicates could contribute 59% variation in O.U. pond (Table-4, Fig-2).

To sum up the distribution of chlorococcales, it can be said that they are mainly influenced by temperature and total solid content of water. The large summer growths of chlorococcales and paucity of desmids in Banjara lake indicate eutrophic nature of water body. In O.U. pond better representation of desmids and which is free from algal blooms indicate oligotrophy. From the foregoing account, it is clear that both water bodies differed in the concentration of various physico-chemical factors which probably account for the variation in the species composition and density of flora because the physico-chemical factors are more intimately connected with algal flora, especially in lentic environments.

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