J. Phytol. Res. 10 (1-2): 15-23, 1997

LIMNOLOGICAL STUDIES OF A SEMI-PERMANENT POND

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Limnological studies of a fresh water pond was carried out for a period of two years with reference to physico-chemical characteristics of water and qualitative and quantitative analysis of phytoplankton, especially algae. The water is not polluted as all the physicochemical factors are within the stipulated tolerence limits except total hardness of water. The phytoplankton density and diversity of the pond is less and the observed algal species also represent fresh water body. The pond is semi-permanent in which the water gets dried up during summer.

Keywords: Algae; Diversity; Factor; Indicator; Phytoplankton; Pollution.

Introduction

Water is one of the most vital factors in the existence of living organisms. Water covers about 70% of earth, of which more than 95% exists in oceans. A very less amount of water is present in ponds, lakes and rivers which comprise our most valuable resources. The study of fresh water biology is important since all aquatic organisms are related in one way or the other with food fishes which form one end of the aquatic food web. The present study was designed to study the periodicity and the factors affecting the distribution of different groups of algae.

Materials and Methods

The present pond is situated in Osmania University campus of Hyderabad city. Water samples were collected at monthly intervals for a period of two years. The water samples were analysed for the various physico-chemical and phycological parameters by following the standard methods[1-2]. For the quantitative estimation of algae, the drop method of Pearsall *et al.*[3] and as described by Venkateswarlu[4], was followed. To know the relative importance of various physico-chemical factors on the growth and development of different groups of algae, a statistical approach, Multiple Regression Analysis (MRA) has been employed.

Results and Discussion

The concentrations of different physico-chemical factors are given in Table 1 along with their average values. pH, bicarbonates, chlorides, dissolved oxygen and calcium are in moderate concentrations with the average values of 8, 192.4, 194.7, 6.4, 53.7 ppm respectively. Organic matter, iron and phosphates are in low concentrations whereas total hardness and silicates are in high concentration with the average values of 269.1 and 6.4 ppm respectively.

Four groups of algae were encountered. Of them, Cyanobacteria dominated over other groups of algae. Chlorophyceae occupied an intermediate position in this respect. Euglenoids are very scantily represented (Table 2).

Factors affecting the distribution of Cyanobacteria: Multiple Regression Analysis (MRA) has been revealed that pH, carbonates, bicarbonates, dissolved oxygen and calcium are the factors responsible for 5%,2%,1%, 2%,16% of algal variance respectively. However, nitrates, total solids and dissolved solids are the minimum variables required to explain the variation to the maximum extent in a statistically significant manner i.e., 58% (Equation-2,Table 3, Fig. 1).

Factors affecting the distribution of diatoms: MRA reveals that all the physico-chemical factors together could explain the variation in diatom number to the extent of 76% (Table 4). However, calcium, total solids, and total hardness, nitrates and silicates are more important as is evident from the major drop in R2 value in the step down regression analysis (Fig. 2). A unit change in calcium concentration could bring about a change of 183 units in diatom number. Nitrates account for 8% variation in diatom number.

Factors affecting the distribution of Chlorophyceae: All the physico-chemical variables together account for 98% variation in algal number in MRA (Table 5). In Simple Correlation Analysis (SCA), except chlorides, total solids and dissolved solids, all are significant individually at both 5% and 1% level. However, MRA revealed that bicarbonates, total hardness, magnesium and silicates could contribute 59% variation in algal number (Fig. 3).

In this pond, pH was always alkaline and it could bring about 5% variation in cyanobacteria. It is supported and well documented that as a group, cyanobacteria have distinct preference to alkaline waters[5]. Blue-greens and oxygen showed a direct correlation and this showed their efficiency to produce oxygen during their photosynthetic process. This is in confirmity with the observations of Esther Cynthia[6]. Temperature and total solids are responsible for a major change in the variation of blue-greens.

The highest peak of diatoms was attained during winter months and has shown a negative relationship with temperature. Two diatom peaks of considerable dimensions were observed during March 1988 and October 1988.

The diatoms were present in good numbers both before and after the pond got dried up during summer (Table 2). Roy[7] and Zafar[8] have reported larger number of diatoms during winter season when the temperatures were low in fresh waters. The present data extends support to the above investigators. Silicates are high and account for 7% variation in diatom number. It is an established fact that waters with high silicates normally give diatom maxima[9]. Diatoms prefer carbon in the form of carbonates contributing 7% or diatom variance.

Volvocales are somewhat better represented when the dissolved oxygen and pH were high. Iyengar[10] concluded that

Table 1

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

Month	Rainfall in mm	Mean atmosp 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	296.6	83.2	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	10.6	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	194.7	6.48	3.54

O.U. Campus pond (expressed in PPM)

Month	Total Hardness	Ca	Mg	PO_4	NO_2	SiO_2	Fe	Total Solids	Dissolved Solids	Suspend Solids
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	116.2	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	0.3	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	-	-	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-	-	-
June	-	-	-	-	-	-	-	-	-	-
Two Years average	269.1	53.7	32.7	0.15	0.20	6.4	0.06	438	295.1	152

Table 2

O.U. Campus Pond (expressed as no. of organisms)

Month	Cyano-phyceae	Bacillario phyceae	Volvocales	Chloroco-ccales	Desmids	Eugleno-phyceae
July 1987	68	—	—	240	60	—
August	48	—	—	—	—	—
September	48	—	—	—	—	—
October	116	—	—	—	—	—
November	220	116	—	200	52	—
December	212	—	—	—	32	—
January 1988	172	—	20	—	—	—
February	244	176	—	56	—	—
March	72	328	—	80	80	—
April	—	—	—	—	—	—
May	—		dried up			
June	—	—	—	—	—	—
July	40	168	—	64	—	—
August	64	200	—	—	160	60
September	200	112	—	100	—	—
October	136	404	—	—	—	—
November	104	—	—	88	—	—
December	236	144	—	52	20	60
January 1989	112	20	20	100	—	20
February	80	272	40	—	—	—
March	60	120	48	—	—	—
April	—	—	—	—	—	—
May	—		dried up			
June	—					
Total algae	2232	2140	128	904	404	140
% Composition	37.5%	35.9%	2.1%	15.1%	6:7%	2.3%

volvocales favour situations which offer better conditions of aeration and the optimum conditions are high dissolved oxygen and low light intensity in fresh waters.

When compared to volvocales and zygnematales (desmids), chlorococcalian flora has shown better representation. Desmids are also somewhat better represented in the present pond which is rich in calcium. This is supported by Zafar[8]. Round[11] points out that desmids are believed to favour oligotrophic waters. This is also supported by the present observation in which phosphates and nitrates are low.

The dilution of water seems to be another important factor for the distribution of diatom population. Desmids reached their maximum peak in August when the pond

Table 3

O.U. Campus Pond Multiple regression of Physico-Chemical factors on Cyanophyceae.

Maximum factors present	R^2	F	df	Equation
$X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, X_{15}$	0.98	920.2	1,15	$Y = -197.4 + 4.5X_1 + 14.7X_2 + 1.6X_3 + -0.3X_4 + -0.4X_5 + 2.7X_6 + -16.8X_7 + -12.8X_8 + 33.1X_9 + 51.2X_{10} + -19.8X_{11} + 181.0X_{12} + -6.9X_{13} + -0.7X_{14} + 1.0X_{15}$ ——(1)
factors dropped				
X_{11}	0.97	332.4$$	2,14	
X_{10}	0.97	148.3$$	3,13	
X_1	0.92	37.0$$	4,12	
X_3	0.90	21.6$$	5,11	
X_{13}	0.85	9.5$$	6,10	
X_6	0.79	4.9$	7,9	
X_2	0.78	3.6$	8,8	
X_5	0.76	2.5	9,7	
X_8	0.76	1.9	10,6	
X_4	0.75	1.4	11,5	
X_7	0.74	0.99	12,4	
X_9	0.58	0.33	13,3	
factors retained				$Y = 45.3 + 59.1X_2 + -0.12X_{14} + 0.12X_{15}$ —(2)
X_{12}, X_{14}, X_{15},				

X_1 -pH, X_2 - temp, X_3 - CO_3, 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} - NOX_{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 of Physico-Chemical factors on Bacillarophyceae.

Maximum factors present	R^2	F	df	Equation
$X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, X_{15}$	0.67	31.2	1,15	$Y = 617.0 + -10.9X_1 + -16.2X_2 + -2.7X_3 + .24X_4 + 0.29X_5 + -2.7X_6 + 6.4X_7 + -73.0X_8 + 180.9X_9 + 300.2X_{10} + -39.2X_{11} + -152.3X_{12} + 11.8X_{13} + 0.63X_{14} + 1.1X_{15}$ ——(1)
factors dropped				
X_{11}	0.66	14.2	2,14	
X_6	0.66	8.5	3,13	
X_7	0.65	5.7	4,12	
X_4	0.63	3.8	5,11	
X_5	0.61	2.6	6,10	
X_{14}	0.58	1.7	7,9	
X_2	0.56	1.3	8,8	
X_1	0.50	0.80	9,7	
factors retained				$Y = 168.4 + -0.7X_3 + -73.6X_8 + 183.5X_9 + 301.8X_{10} + -91.4X + 3.9X_{13} + -0.1X_{15}$ —— (2)
$X_3, X_8, X_9, X_{10}, X_{12}, X_{13}, X_{15}$				

X_1 -pH, X_2 - temp, X_3 - CO_3, 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_3X_{13} -SiO_2, X_{14} -T.S. X_{15} -D.S,
$$ ———— Significant at 5% level.
$ ———— Significant at 1% level.

Table 5

O.U. Campus Pond — Multiple regression of Physico-Chemical factors on Chlorophyceae.

Maximum factors present	R^2	F	df	Equation
$X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, X_{15}$	0.98	$995.4^{\$}$	1,15	$Y = 74.2 + -2.0X_1 + -0.6X_2 + -0.9X_3 + .3X_4 + 0.06X_5 + -0.6X_6 + 4.8X_7 + -11.6X_8 + 28.5X_9 + 47.5X_{10} + 72.5X_{11} + -75.2X_{12} + -2.6X_{13} + -0.09X_{14} + 0.06_{15}$ ——(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	
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},				$Y = 5.5 + 0.28X_4 + -0.2X_8 + 0.6X_{10}$ ——(2)

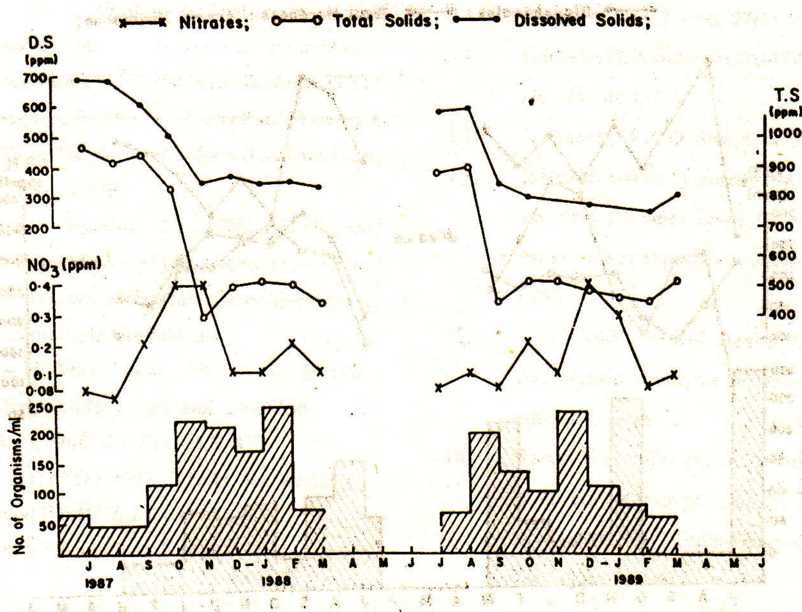
X_1 -pH, X_2 - temp, X_3 - CO_3, X_4 - HCO_3, X_5-Cl, X_6 -D.O, X_7-O.M, X_8 -T.H, X_9 -Ca, X_{10} -Mg, X_{11} -PO_4, X_{12} - NO_3 X_{13} -SiO_2, X_{14} -T.S. X_{15} -D.S,

$$ ——— Significant at 5% level.

$ ——— Significant at 1% level.

Table 6. Comparison of the Present Data with ISI, WHO & Rawal's Standards.

Factor	O.U. Pond	ISI (1982)	WHO (1971)	Rawal's Data (1978) Permissible Limits	Rawal's Data (1978) Excessive Limits
pH	8.0	65-85	70-85	6.5-8.5	6.5-8.5
Cl	194.7	-	200.0	250.0	600.0
DO	6.4	6.0	3.0	3.0	-
NO_3	0.20	20.0	10.0	10.0	-
PO_4	0.15	-	-	2.0	5.0
T.H.	269.1	300.0	100.0	150.0	500.0
Ca	53.7	200.0	75.0	75.0	200.0
Mg	32.7	100.0	30.150	50.0	50-150
T.S.	438.0	500.0	-	500.0	1500.0



Affect of Various physico-Chemical factors on Cyanophyceae O.U. Pond.

FIG.1

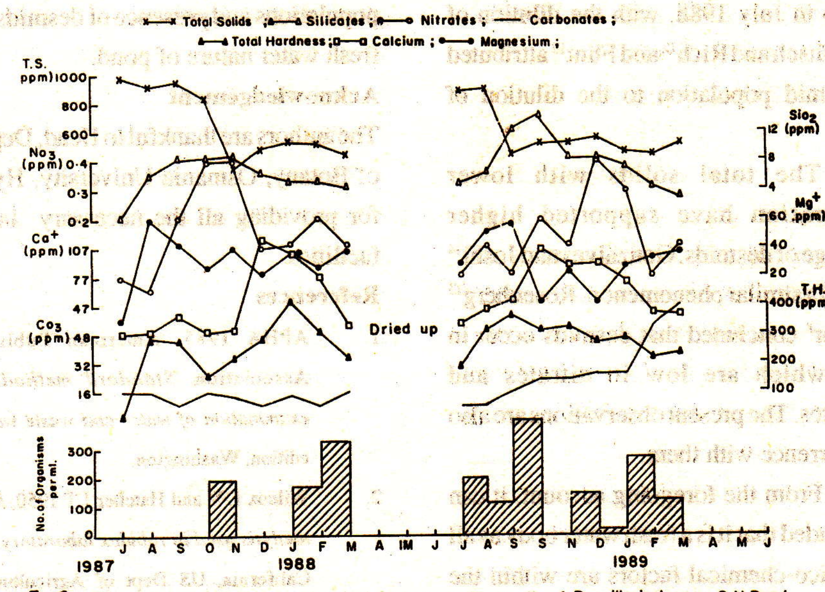


FIG.2 Affect of Various physico-Chemical factors on the growth of Bacillariophyceae O.U.Pond.

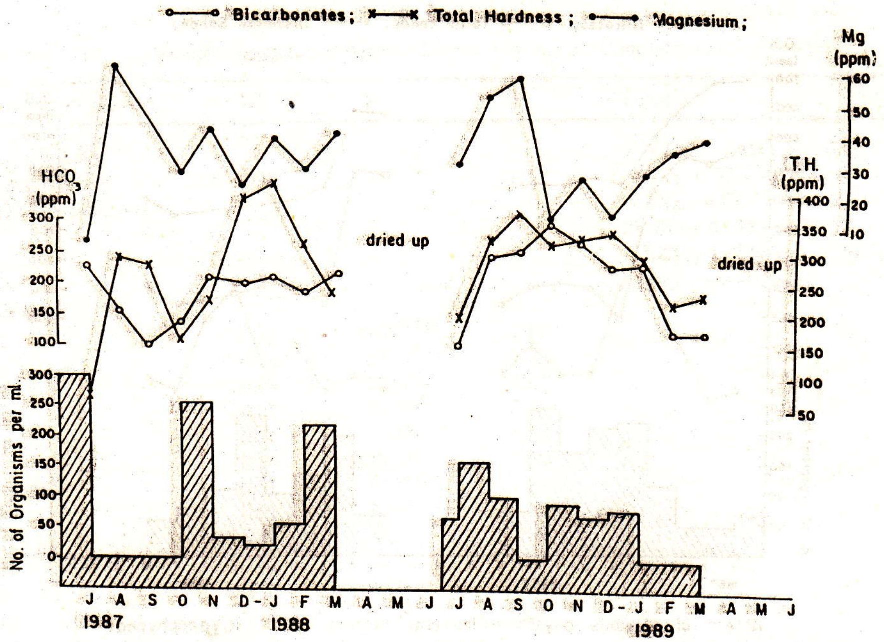


Fig.3 Affect of Various Physico-Chemical factors on Chlorophyceae in O.U Pond

filled up in July 1988, with the dilution of water. Fritsch and Rich[12] and Flint[13] attributed rich desmid population to the dilution of water.

The total solids with lower concentration have supported higher percentage of desmids. Gonzalves and Joshi[14] observed a similar phenomenon. Rosenberg[15] and Zafar[8] concluded that desmids occur in waters which are low in nitrates and phosphates. The present observations are also in concurrence with them.

From the foregoing account, it can be concluded that it is a fresh water body as all the physico-chemical factors are within the permissible limits of ISI[16], WHO[17] and Rawal's quality criteria[18] (Table 6). From the biological data, it is clear that low algal populations and presence of desmids indicate fresh water nature of pond.

Acknowledgement

The authors are thankful to Head, Department of Botany, Osmania University, Hyderabad for providing all the necessary laboratory facilities.

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