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PHYTOPLANKTONOLOGY OF CHHINDA DAM AT SIMDEGA, JHARKHAND

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Keeping in view status evaluation as the corner stone of environmental management, present investigation has been aimed at study the present status of the phytoplankton dynamics, which constitute the main fraction of food of the aquatic fauna, of Chhinda dam water at Simdega, Jharkhand. Seasonal fluctuation, percentage composition and yearly averages were computed taking monthly observation data from June, 2008 to May, 2010 in relation to abiotic spectrum of the dam water. Simple correlation as well as multiple correlation analysis was computed .Coefficient of determination (R2) in the present investigation was computed as 0.948 which indicated that 94.8 % fluctuation in phytoplankton standing crop of the dam was dependent on the physico-chemical regime of the dam water considered for the present investigation and 5.2% to other factors which were not taken into account in the investigation understudy.

Key words: Phytoplankton dynamics, Physico-chemical characteristics

Phytoplankton constitutes the main food fraction for most of the aquatic fauna .Seasonal fluctuation in phytoplankton community is completely under the grip of physic-chemical regime of water bodies. InIndia, several investigators studied the limno-biology of lentic as well as lotic water bodies particularly of phytoplankton community (Zutschi and Khan 1977, Mishra and Yadav 1978, Saha and Singh 1980, Prasad and Saxena 1980, Singh *et al*.1983,Reddy and Venkateshwarlu 1986,Bharti and Krishnamurthy 1991, Singh 1993, Bose and Gorai 1993).So far as the phytoplanktonology of Chhinda dam at Simdega (Chhota Nagpur) is concerned, no record of such study is available.Therefore,the present investigation has been aimed at to study the phytoplankton standing crop variation in relation to physico-chemical characteristics of Chhinda dam water at Simdega.

MATERIALS AND METHODS

Samples of the surface water of the dam were collected at monthly intervals from June, 2008 to May, 2010.The water temperature was recorded by mercury centigrade thermometer . pH was determined by Lobi bond pHcomparator using indicators of different pH range. Transparency of dam water was measured by secchi disc method described by Welch(1948).Dissolved oxygen content, free CO_2,NO_3-N,PO_4-P,SiO_3-Si,chloride and total solids of the dam water were determined by the methods described by Trivedi and Goel(1986).Carbonate and bicarbonate alkalinity were evaluated by titrimetric method as described by Welch(1948).For the phytoplankton standing crop, 100 litres of surface water was filtered through Bolting

Silk net (20XXX) having 173 meshes per linear inch and samples were preserved in 4% Formalin and Lugol's solution. The counting of phytoplankton was done by the method of Lackey (1938) modified by Edmondson (1974).

RESULT AND DISCUSSION

Results (fig.-1) indicate that phytoplankton standing crop constitute peaks twice in a year i.e., one in May and other in November but the peak of greater magnitude was observed in May. Similar findings were reported by Singh *et al*.(1983). During rainy season, the phytoplankton density declined considerably which may possibly be due to flooding of rain water into the dam from suburbs coupled with

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unfavourable spectrum of environmental condition. It, however, increased gradually in the latter part of the year and in November constituted a secondary peak of somewhat lesser magnitude. So far as the percentage composition of different groups of phytoplankton flora is concerned, Chlorophytes with 39.64% outnumbered the other groups followed by Cyanophytes (35.18%)and Bacillariophytes (25.18%). Chlorophytes were recorded maximum during summer while the Cyanophytes and Bacillariophytes during the last part of the rainy season.

The water temperature ranged between 16.0 to 35.5 ^{o}C during the course of investigation with an average of 25.1±4^{0}C(Table-1).Similar fluctuation rage of water temperature was also reported by Bose and Gorai(1993) when they were studying the seasonal fluctuation of phytoplankton in relation to physic-chemical parameters of fresh water tanks of Dhanbad, India.

The maximum and minimum values oftemperature were recorded in May and January respectively. The water temperature exhibited negative correlation with dissolved oxygen, transparency and pH but positive correlation with free CO_2, NO_3-N, PO_4-P and chloride contents of the dam water. The quantity of dissolved oxygen decreased with the rise of mercury and vice versa (Bose and Gorai 1993, Singh 1993) thereby showing negative correlation (Table-2). The bacterial activity increased at higher temperature which led to increase in the nutrient status leading to positive correlation .Phytoplankton standing crop exhibited insignificant negative correlation with water temperature. The present finding is also in agreement with Jana(1979).This may be possibly due to interference of higher bacterial decomposition at higher temperature and cloudy weather condition during rainy season which directly or indirectly influenced the correlation. The maximum density of phytoplankton was recorded in May when the water temperature was also quite high (fig.-1). Many investigators correlated it with higher phytoplankton productivity during summer. A slight decline in density in December was noticed which again culminated in May. This was the indication that winter and summer temperature was probably suitable for the growth of phytoplanktons.Padhi (1995) also recorded the dominance of Chlorophytes followed by Cyanophytes and Bacillariophytes (fig.-1).

Penetration of light in an aquatic system is dependent upon turbidity. Turbidity and transparencies in an aquatic system are inversely correlated. In the present investigation transparency in dam water fluctuated between 40 to 71.5 cm with an average of 58.45cm(Table-1).Lower values of transparency were recorded during rainy season which may be possibly due to entry of allochthonous muddy water in to the dam during the aforesaid season which decreased the transparency of the water of the system. The present observation is also inconformity to that of Singh(1962),Singh *et al*. (1983) and Singh(1993).During the period of low transparency ,phytoplankton density declined to minimum and also the number of species decreased considerably. It showed strongly significant positive correlation (Table-2) with phytoplankton standing crop (Saha *et al*. 1985, Singh 1993).Transparency was found to be positively related with carbonate alkalinity ,hydrogen ion concentration and dissolved oxygen content whereas it was negatively correlated with nutrients of the water system (Table-2).

DO_2 content of the water varied from 6.8 to 9.6ppm with an average of 7.862 (Table-1). Its maximum valuewas estimated when the water temperature was minimum. On the whole during winter season, its value was recorded greater in comparison to summer and rainy seasons. It showed strongly negative correlation with water temperature (Saha *et al*.1985, Tanti and Saha 1993). During monsoon ,low oxygen content estimation was possibly due to entry of allochthonous materials from the suburbswith high oxygen demand. Dissolved oxygen showed strongly positive correlation with transparency of system water and phytoplankton standing crop. It showed

negative correlation with silicate-silica, nitrate-nitrogen, phosphate-phosphorus and free carbon dioxide (Table-2).

Hydrogen ion concentration in dam water ranged between 7.6 -8.9 during the course of two years investigation, the maximum being May and minimum in October (Table-1).The average value was recorded to be 8.308.The dam water under study showed alkaline nature throughout the period of investigation (Sharma1984, Singh 1993).Hydrogen ion concentration values were slightly higher from December onwards to May. Its higher values during winter and summer may be correlated with the higher standing crop values during the aforesaid period (Table-2).

Free carbon dioxide was recorded only in those months during investigation when carbonate alkalinity was found absent. It was reported during monsoon. Its presence during monsoon may be possibly due to decreased rate of photosynthesis and increased rate of decomposition (Sreenivasan *et al.* 1977).Its absence during active period of phytoplankton growth may be attributed to its rapid utilization for phytoplanktonmetabolic activities which led to its exhaustion.

Carbonate alkalinity was recorded during winter and summer and varied from 2-13ppm.It was found maximum during January and Minimum during May. Its biennial average was computed as 8.33 ppm. Simple correlation analysis revealed negative correlation with nutrients like silicate-silica, phosphate-phosphorus and nitrate- nitrogen.

Bicarbonate alkalinity fluctuated between 127-160 ppm being maximum in June and minimum in July. Its average value was 140.833 ppm.Simple correlation analysisshowed negative correlation with the nutrients (Table-2).

Nitrate-nitrogen varied from 527µg /litre to 609 µg /litre during the courseof biennial investigation with an arithmetic mean of 556.708 µg /litre. During monsoon, nitrate-nitrogen content was detected to be higher in comparison to winter and summer which may possibly be attributed to slower rate of consumption and increased organic load from the surroundings along with rain water. Simple correlation analysis showed negative correlation with transparency, dissolved oxygen, hydrogen ion concentration, carbonate and bicarbonate alkalinity, chloride content and phytoplankton density whereas positive correlation with water temperature, free carbon dioxide, total solids, silicate-silica and phosphate-phosphorus .

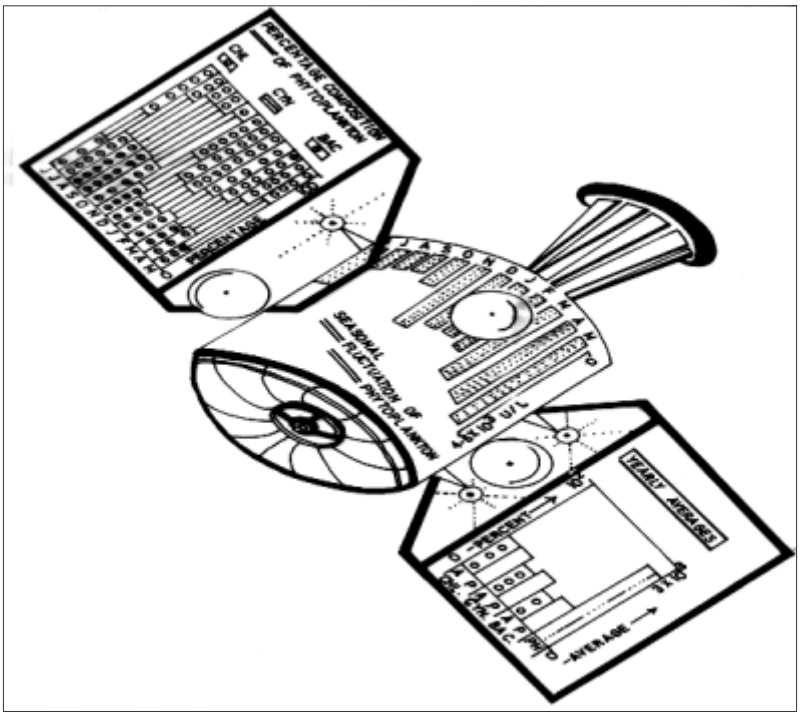
Phosphorus is supposed to be one of the most important nutrientsfor algalgrowth. Its concentration ranged between 0.016 -0.234ppm with an arithmetic mean of 0.079ppm.It showed strongly negative correlation with phytoplankton density, transparency and hydrogen ion concentration whereas positive correlation with other nutrients (Table-2)

Silicate-silica is an essential constituent of the wall of diatoms. Its concentration varied from 9.00-13.45ppm with an average of 11.685ppm.Its concentration was estimated to be higher during monsoon when the density of diatoms is not much pronounced. Because of high turbidity and cloudy sky conditions which is not favourable or congenial environmental conditions for the growth of diatoms, may be attributed to the high concentration of silicate-silica during monsoon when the consumption of silica remained low leading to increased concentration. Simple correlation analysis exhibited negative correlation with phytoplankton density, transparency, dissolved oxygen, hydrogen ion concentration, carbonate alkalinity whereas positive correlation with total solids, water temperature, nitrate-nitrogen and phosphate-phosphorus.

CONCLUSION

Actually in an aquatic system, the variation in phytoplankton density cannot solely becorrelated with any single factor. It is impossible to correlate phytoplankton density to any single factor keeping all other factors constant. In fact phytoplankton density or abundance is the reflection of collective response of numerous factors. Therefore, multiple correlation and regression analysis

Figure-1 Seasonal Fluctuation, Percentage Composition
And Yearly Average Of Phytoplankton (Chhinda Dam Water)



From June, 2008 to May, 2010

TABLE-1 PHYSICO-CHEMICAL CHARACTERISTICS OF CHHINDA DAM WATER

Month	Atm. Temp. (^{0}C)	Water Temp. (^{0}C)	Trans (cm)	DO (ppm)	pH	Free CO_2 (ppm)	CO_3 (ppm)	HCO_3 (ppm)	NO_3-N (µg/l)	PO_4-P (ppm)	SiO_3-Si (ppm)	Total Sol. (ppm)	Chloride (ppm)
2008 June	32.0	29.0	65.0	7.8	8.4	-	4.0	158.0	533	0.091	11.39	800	61.4
July	30.0	29.0	47.0	7.6	8.0	2.5	-	130.0	538	0.169	13.21	835	59.3
Aug.	30.0	28.0	44.3	7.0	7.8	4.5	-	133.0	603	0.234	13.41	760	60.0
Sept.	30.0	29.0	44.7	7.0	7.8	4.8	-	133.0	600	0.234	13.41	750	58.3
Oct.	32.0	30.0	47.3	6.8	7.6	6.4	-	140.0	597	0.078	12.50	640	50.0
Nov.	25.0	22.0	58.0	8.5	8.4	-	2.0	158.0	547	0.021	12.34	700	56.0
Dec.	23.0	20.0	60.3	8.8	8.6	-	10.0	140.0	551	0.035	12.00	697	55.0
2009 Jan.	20.0	18.0	65.0	9.5	8.7	-	11.0	140.0	543	0.039	11.37	671	56.0
Feb.	20.0	19.0	66.0	8.0	8.5	-	12.0	137.0	549	0.024	11.00	650	59.4
Mar.	24.0	22.0	71.0	7.8	8.8	-	11.0	140.0	533	0.020	10.00	673	63.2
April	30.0	25.0	70.0	7.5	8.7	-	11.0	142.0	539	0.019	9.37	679	67.0
May	34.0	30.5	71.5	7.2	8.9	-	13.0	135.0	530	0.016	9.00	675	70.0
June	36.0	27.0	55.0	7.6	8.4	-	3.0	160.0	541	0.091	11.00	690	65.3
July	30.0	29.0	46.0	7.5	8.0	3.8	-	127.0	572	0.124	13.00	697	66.2
Aug.	30.0	28.0	44.3	7.0	7.8	4.0	-	130.0	600	0.233	13.45	700	65.0
Sept.	30.0	29.0	40.0	7.0	7.8	4.0	-	129.0	609	0.123	13.00	690	63.0
Oct.	31.0	30.0	44.0	7.0	7.6	6.0	-	133.0	597	0.078	13.15	691	64.5
Nov.	28.0	25.0	56.4	7.5	7.9	4.0	-	126.0	567	0.032	12.11	725	56.0
Dec.	26.0	20.0	60.0	8.0	8.4	-	3.0	155.0	541	0.041	12.00	690	48.3
2010 Jan.	17.0	16.0	67.0	9.6	8.5	-	6.0	150.0	540	0.053	11.97	680	45.0
Feb.	17.0	18.0	68.0	9.3	8.7	-	8.0	147.0	535	0.053	11.00	687	50.0
Mar.	26.0	24.0	70.0	8.6	8.6	-	7.0	149.0	535	0.041	11.10	689	54.0
April	29.0	25.0	71.0	8.3	8.7	-	9.7	145.0	530	0.035	10.23	700	64.0
May	33.0	30.0	71.0	7.8	8.8	-	10.0	143.0	527	0.016	9.44	711	69.6
Aver.	27.625	25.104	58.45	7.86	8.30	4.38	8.03	140.8	556.70	0.0787	11.685	703.33	59.458
Max.	36.00	30.5	71.5	9.6	8.9	6.4	13.0	160.00	609.00	0.234	13.45	835.00	70.00
Min.	17.0	16.0	40.0	6.8	7.6	2.5	2.0	127.0	527.0	0.016	9.00	640.00	50.00

Table-2 SCA OF CHHINDA DAM WATER CHARACTERISTICS

	PD	Cl^-	Sio_3-Si	Totalsolids	PO_4-P	NO_3-N	HCO_3	CO_3	Free CO_2	pH	DO	Trans.
Temp.	-0.388 (1.976)	0.673 (3.885)	0.178 (0.895)	0.376 (1.908)	0.465 (2.465)	0.434 (2.259)	-0.379 (1.922)	-0.469 (2.497)	0.585 (3.389)	-0.515 (2.808)	-0853 (7.676)	-0.505 (2.751)
	0.928 (11.708)	-0.030 (0.144)	0.890 (9.189)	-0.287 (1.406)	-0.776 (5.775)	-0.876 (8.525)	0.504 (2.738)	0.880 (8.719)	-0.848 (7.518)	0.935 (12.46)	0.607 (3.585)	
	0.456 (2.408)	-0.536 (2.961)	-0.275 (1.342)	-0.187 (0.895)	-0.500 (2.709)	-0.625 (3.758)	0.486 (2.609)	0.507 (2.763)	-0.694 (4.529)	0.633 (3.892)		
	0.892 (9.279)	0.073 (0.342)	-0.865 (8.118)	-0.257 (1.249)	-0.703 (4.641)	-0.891 (9.249)	0.504 (2.738)	0.904 (9.971)	-0.940 (12.99)			
0_2	0.778 (5.806)	0.016 (0.079)	0.717 (4.825)	0.132 (0.629)	0.629 (3.198)	0.904 (9.923)	-0.635 (3.864)	-0.765 (5.581)				
	0.828 (6.902)	0.146 (0.697)	-0.863 (8.018)	-0.415 (2.142)	-0.686 (4.433)	-0.710 (4.729)	0.253 (1.228)					
	0.437 (2.282)	-0.305 (1.506)	-0.366 (1.840)	-0.096 (0.455)	-0.418 (2.159)	-0.581 (3.354)						
	-0.806 (6.391)	0.020 (9.424)	0.763 (5.540)	0.005 (2.763)	0.691 (4.487)							
	-0.814 (6.675)	0.095 (0.448)	0.737 (5.125)	0.525 (2.894)								
lids	-0.378 (1.919)	0.110 (0.521)	0.353 (1.772)									
	-0.923 (11.308)	-0.310 (1.533)										
	0.095 (0.51)											

N.B. (i) Table value of t at 10%,5% and 1% level of significance is 1.7171,2.074 and 2.319 respectively
(II) Parenthesis value is observed t –value

TABLE-3 Multiple Correlation And Regression Analysis Of Chhinda Dam Water Characteristics

MAXIMUM FACTORS	R^2	MULTIPLE REGRESSION EQUATION
X1,X2,X3,X4,X5,X6,X7,X8,X9,X10 X11,X12,	0.948	$Y=-21224-50.0761X_1+58.28230X_2$ $297.974X_3+3151.057X_4+169.2444X_5$ $-158.977X_6-9.12774X_7+6.628579X_8$ $-4199.57X_9-311.637X_{10}-0.49948X_{11}$ $+5.951699X_{12}$

Standard error of Y-estimate =442.5090
No.of observations =24
DF =11
Standard error of co-efficient =70.29277; 41.24866; 350.6187; 1880.414; 268.668; 72.40389; 18.38807; 13.70668; 2893.790; 401.7191; 4.2819; 34.57910

N.B.:- Y= Phytoplankton standing crop
X1=Water temperature
X2=Transparency
X3=Dissolved Oxygen
X4=pH
X5= Free CO2
X7=Bicarbonate
X8= Nitrate nitrogen
X9= Phosphate phosphorus
X10= Silicate silica
X11=Total solids
X12=Chloride

(Table-3), the testimony of the generalization were computed which revealed the value of coefficient of determination as 0.948.It means 94.8% variation in phytoplankton density is influenced by physico-chemical parameters considered in this text and only 5.2% by other factors which were not taken into consideration in the present investigation. Multiple regression equation may be utilized for prediction of phytoplankton density at any time if we have the values of physico-chemical factors understudy.

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