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STUDIES ON SEASONAL VARIATIONS OF CYANOPHYCEAN FLORA IN RESPONSE TO ABIOTIC FACTORS IN RANCHI LAKE OF JHARKHAND, INDIA

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The present investigation on the seasonal fluctuation of blue green algae in relation to Physico-chemical parameters of Ranchi Lake, for a period of two years from March 2009 to February 2011 were carried out. The physico-chemical parameters of water viz. temperature, pH, transparency, conductivity, turbidity, total dissolve solids, total suspended solid, total hardness, total alkalinity, chloride, free CO_2, dissolved oxygen (DO), biological oxygen demand (BOD), sulphate, phosphate, nitrate, calcium and magnesium were recorded during the study period. Altogether 29 species of blue green algae were identified belonging to 12 genera. Among the recorded species *Microcystis aeruginosa, M. stagnalis, Merismopedia* sp., *Oscillatoria* sp. were dominant. Further the study revealed that Cyanophyceae attains a maximum growth in summer months and reach to its minimum during rainy months.

Key words: *Blue green algae, seasonal variation, physico-chemical factors, Ranchi Lake*

Ranchi is the capital of the newly formed (2000) state, Jharkhand. It is located at the eastern part of the India at an elevation of approximately 2140 feet above sea level. The town has a latitude of 23^0 24' N and a longitude of 85^0 18' E. The tropic of cancer passes through northern part of the town. Ranchi has three distinct seasons, namely summer, rainy and winter. Ranchi Lake, located in the heart of the city at the base of Ranchi hill and was excavated as a lake in 1842 by a British colonel Onsely.

Water pollution is one of the foremost problems faced by mankind today (Wetzel 2001). Algae play a significant ecological task and are being widely used as indicator of water pollution (Palmer 1969). The occurrence of blue-green algae in a wide range of ecologically extreme habitats shows their high order of adaptability (Graham and Wilcox 2000). Blue green algae are important because of their potential impact on human and animal health(Ray 2006). Their high numbers often indicate high nutrient levels in water. Presence of blue green algae in high numbers reduces the water quality (Palmer1980). They are ubiquitous in waters and often form permanent blooms in water bodies in tropical region.

MATERIALS AND METHOD

Water samples were collected monthly during March 2009 to February 2011 through a vertical tow of plankton net (20 µm effective mesh size) from four selected sites of the Ranchi Lake. The plankton net was approximately 50 cm long with 26 cm diameter mouth and 10 cm diameter opening at the cod end which was tied to a 100 ml TARSON collection bottle. The sample was fixed in Lugol's (KI+I) solution and for long term storage few drops of 4% formation and few drops of glycerine were also added. Population count from the collected phytoplankton samples was done through Sedgwick Rafter fitted with an image analyzer and the counts were subsequently expressed in cell/m^3X10^3. The number of organisms per litre of the original water sample was calculated using the following formula (Adoni 1985).

Organisms/l = A x (1/L) x (n/V)
Where,
A= number of organisms per drop
L= volume of original sample (l)
n= total volume of concentrated sample (ml)
V= volume of one drop (ml)

The identification of phytoplankton up to species level in most of the cases were done with the help of standard keys and monographs (Turner 1892, Smith 1924, Desikachari 1959, Prescott 1962 and Philipose 1967).

All the physico-chemical analysis of water were taken as an average of four sites which were analyzed individually. Some of

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parameters were recorded at site like colour, temperature, pH, transparency etc. The samples were brought to the laboratory for physico-chemical analysis (conductivity, turbidity, total dissolved solids, total suspended solids, total hardness, total alkalinity, chloride, free carbon dioxide, dissolved oxygen, biological oxygen demand, sulphate, phosphate, nitrate, magnesium, calcium and silicate) following the standard methods (APHA 1998).

Table 1: List of Cyanophycean species

1. *Microcystis stagnalis*
2. *M. aeruginosa* Kuetz
3. *M. flosaquae*
4. *M. viridis*
5. *Chroococcus indicus*
6. *C. turgidus*
7. *C. minor*
8. *C. minimus*
9. *Gleocapsa punctata* Nag.
10. *G. arata* (Turp) Kuetz
11. *G. rupestris* Kuetz
12. *Aphanocapsa banarasensis*
13. *A. roseana*
14. *Aphanothece castagnei*
15. *A. naegelli* Wartm
16. *Merismopedia convulta* Breb
17. *M. marssonii* Lemmermann
18. *M. glauca*
19. *M. minima*
20. *Nostoc commune* Vaucher ex Born. Et Flah
21. *Anabaena sp.*
22. *Anabaenopsis sp.*
23. *Phormidium sp.*
24. *Oscillatoria limosa* Ag. Ex. Gomont
25. *O. tenius*
26. *O. perornata*
27. *Spirulina platensis*
28. *S. platensis* f. granulata f. no. (orig.)
29. *S. laxissima*

RESULTS

Presence of blue green algae were wide-spread in the Ranchi Lake and a total of 12 genera represented by 29 species were recorded. The recorded Cyanophycean species are listed in the table 1.

During the experimental period, water temperature varied from 19.6^{0}C to 36.6^{0}C. The highest value of water temperature is observed in April and lowest value is recorded in January. The maximum water temperature is in summer and minimum in late winter.

Transparency varied from 4.6 to 15.3cm with a maximum in summer months and minimum in rainy months. The pH value of Ranchi Lake ranges from 7.6 to 9.86, with a maximum in summer months while minimum in rainy months. The turbidity peak is observed during rainy months while minimum value is recorded in summer months.

The nutrient contents showed peak in winter season when the temperature was low while minimum was recorded during rest of the seasons. Total hardness, magnesium, calcium and chloride concentration in water showed maximum values during summer months, exhibit peaks from April to June and least value in colder months. Total hardness ranged from 144.5mg/l to 316mg/l, magnesium ranged from 8.5mg/l to 29.9mg/l calcium ranged from 34.8mg/l to 75.3mg/l, and chloride ranged from151mg/l to 214mg/l.

Conductivity is generally highest in summer months and lowest during rainy months. It varied from 300µmhos/cm to 578µmhos/cm. The total alkalinity values in the studied station ranged from 185 mg/l to 337.5mg/l.

The dissolved oxygen amount is found to be usually low in the station ranged from 3.45mg/l to 6.5mg/l. The free carbon dioxide amount shows variation throughout the season ranging from 0.2mg/l to 1.3mg/l. The amount of TDS in the station ranged from 277mg/l to 547.5mg/l showing maximum in rainy months and minimum in summer months. BOD values ranged from 12mg/l to 21mg/l. BOD showed maximum value in summer, winter months.

TSS recorded ranged from 75mg/l to 382.5mg/l with a maximum value in rainy seasons, whereas least value was recorded in summer months. The value of silicates ranged from 8.7mg/l to 29.7mg/l. The maximum value of silicates was observed during winter months.

DISCUSSION

The present study reveals the presence of 12 genera of Cyanophyceae belonging to 29 species. It is interesting to note that Guru and

Table 2: Number of cyanophycean species (organisms/litre) in the year 2009-2010

ALGAL SPECIES	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB
1. CLASS-CYANOPHYCEAE												
(A)ORDER-CHROOCOCALES												
1. Microcystis sp.	945	1080	1050	800	450	400	400	1000	538	520	750	640
2. Chroococcus sp.	250	600	750	350	300	300	250	620	500	201	273	250
3. Gleocapsa sp.	65	85	35	60	58	45	25	35	30	42	50	57
4. Aphanocapsa sp.	69	100	30	50	45	50	25	40	20	50	70	30
5. Aphanothece sp.	45	100	23	89	50	45	15	23	30	55	77	43
6. Merismopedia sp.	627	450	500	300	300	250	300	750	400	422	575	400
(B) ORDER-NOSTOCALES												
7. Oscillatoria sp.	5	8	9	5	5	5	3	5	5	8	5	5
8. Spirulina sp.	350	704	230	333	300	200	227	320	325	300	647	293
9. Anabaena sp.	95	115	100	150	50	20	53	100	75	90	100	90
10. Anabaenopsis sp.	73	50	50	45	25	7	35	5	50	40	44	50
11. Nostoc sp.	30	35	20	50	25	16	60	20	50	70	50	70
12. Phormidium sp.	38	20	5	30	15	4	75	3	50	25	25	78

Table 3: Number of cyanophycean species (organisms/litre) in the year 2010-2011

ALGAL SPECIES	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB
1. CLASS-CYANOPHYCEAE												
(A) ORDER-CHROOCOCALES												
1. Microcystis sp.	900	1000	950	600	500	410	400	600	450	500	403	485
2. Chroococcus sp.	370	700	600	450	300	245	200	350	250	350	205	221
3. Gleocapsa sp.	44	75	90	80	35	45	45	40	25	25	15	35

4. Aphanocapsa sp.	48	70	77	90	62	30	25	30	16	25	30	39
5. Aphanothece sp.	58	80	87	50	30	23	25	48	13	11	23	33
6. Merismopedia sp.	694	1000	800	600	450	300	300	340	290	260	347	415
(B) ORDER-NOSTOCALES												
7. Oscillatoria sp.	8	6	5	3	5	8	5	10	19	5	6	15
8. Spirulina sp.	322	572	593	400	200	150	154	300	192	200	201	175
9. Anabaena sp.	81	150	164	124	30	50	39	78	40	60	48	75
10. Anabaenopsis sp.	12	60	70	67	21	37	26	41	23	16	36	25
11. Nostoc sp.	85	75	68	66	20	32	35	30	32	30	65	43
12. Phormidium sp.	24	50	55	47	20	13	12	13	41	30	35	55

Table 4 : Algal species recorded (organisms/litre) in different seasons in the year 2009, 2010 & 2011

NAME OF TAXA	SUMMER SEASON		RAINY SEASON		WINTER SEASON	
	2009-10	**2010-11**	**2009-10**	**2010-11**	**2009-10**	**2010-11**
1. CLASS CYANOPHYCEAE						
(A) ORDER CHROOCOCALES						
1. Microcystis sp.	3875	3450	1920	1910	2548	1838
2. Chroococcus sp.	1950	2120	1080	1095	1580	1026
3. Gleocapsa sp.	245	289	163	165	199	100
4. Aphanocapsa sp.	249	285	160	147	180	110
5. Aphanothece sp.	257	275	133	126	188	80
6. Merismopedia sp.	1877	3094	1430	1390	1717	1312
(B) ORDER-NOSTOCALES						
7. Oscillatoria sp.	27	22	18	28	23	45
8. Spirulina sp.	1767	1887	1040	804	1390	768
9. Anabaena sp.	460	519	223	197	365	223
10. Anabaenopsis sp.	218	209	72	125	189	100
11. Nostoc sp.	135	294	121	117	240	170
12. Phormidium sp.	93	176	97	58	186	161

The data on the physico-chemical characteristics of Ranchi Lake water were taken as an [average of both the years (2009-10 and 2010-11)] is represented in Table 2.

Table 5: Physico-chemical parameters during 2009-2011.

PARAMETERS	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB
WATER TEMPERATURE(^{0}C)	32.85	36.6	34.45	34.4	28.1	28.4	28.15	27	24.95	20.85	19.6	25.4
TRANSPERANCY(cm)	13.85	14.4	15.3	10.25	5.4	4.6	6.85	10.15	11.7	11.7	13.15	13.25
TUBIDITY(NTU)	50	44.5	50	82.6	139	139.5	136.5	67.5	71.5	76	59	60.5
pH	8.58	8.695	9.86	8.95	8.34	8.195	7.66	8.5	8	8.26	8.48	8.46
SULPHATE(mg/l)	113	93	46.05	41.5	57.95	25.5	42.5	40.5	67	70	42.8	102.5
PHOSPHATE(mg/l)	0.495	0.935	1.575	2	2.55	1.455	1.305	1.85	2.67	2.495	2.05	1.7
NITRATE(mg/l)	1.74	0.89	1.33	1.98	2.5	2.25	1.4	0.8	3.4	0.705	0.365	1.45
SILICATE(mg/l)	15.35	10	9.8	8.7	12.45	11.3	13.95	22.75	25.5	29.75	16.55	10.85
CALCIUM(mg/l)	66.65	73.9	75.3	62.65	46.65	34.85	45.35	37.95	40.75	42.75	53.15	41.4
MAGNESIUM(mg/l)	25.1	29.95	28.65	27.8	20.85	18.85	8.5	11.05	10.25	19.75	14.8	19.6
TOTAL HARDNESS($CaCo_3$mg/l)	272.5	316	260	144.5	155	185	187.5	224.5	250	247.5	213	207.5
CHLORIDE(mg/l)	181	193.5	214	200.5	179	167	159.5	167	155	158	151	165
CONDUCTIVITY(µmhos/cm)	505	510	578.5	498.5	418	325.5	426	460	405.5	300	404.5	460
TOTAL ALKALINITY(mg/l)	242.5	265.5	337.5	237.5	245	245	185	243	272	190	209	227.5
FREE CO2(mg/l)	0.91	0.945	0.205	0.225	0.43	0.43	1.33	1.22	1.21	0.215	0.29	0.74
DISSOLVED OXYGEN(mg/l)	5.05	5.05	3.45	4.5	4.5	5.25	6.15	5.4	4.75	6.5	5	4.5
BOD(mg/l)	15.5	19	21	16.5	15.5	18	16.5	12	19	15.5	16	13.5
TDS(mg/l)	295	277	320.5	448	547.5	517	445	364.5	340	338	380	357
TSS(mg/l)	84.5	75	97	210	382.5	310.1	302.35	203.3	238.9	144.5	95	91.5

Kumari (2012) have recorded only 4 species of blue green algae from another water body near the Ranchi Lake. During the study period the lake was found to be dominated by *Microcystis* sp., *Oscillatoria* sp. and *Merismopedia* sp. Cyanophyceae occurred as permanent bloom throughout the year with a maximum in summer and minimum during rainy season.(Table 4)

Physico-chemical parameters played a very important role in regulating Cyanophycean diversity. In Ranchi Lake also the authors have recorded two peaks of Cyanophycean population, first in summer months prior to rain and second was witnessed at the end of the rainy season, i.e., the onset of winter. We are of the view that the two peaks are contributed by the cumulative effect of temperature, turbidity, pH and higher concentration of nutrients like carbonates, bicarbonates, hardness, chlorides, etc. (Table 5) during these months.

During the study period the blooms of

Microcystis and *Spirulina* were observed throughout the year which can be attributed to the availability of nutrients through sewage disposal, favourable alkalinity, chlorides, phosphates and high pH. According to Venkateshwarlu *et al*. (1981), *Microcystis* sp. prefers highly polluted alkaline (pH 9.6) habitats rich in chlorides, nitrates and organic matter. Marathe and Nandkar (1976) recorded *Oscillatoria* as dominant genera in sewage polluted water similar to the present observation on Ranchi Lake.

The highest value of phytoplankton density during summer-autumn period was reported by Kozhova (1987). The seasonality of Cyanophyceae is more closely related to ups and downs of temperature as temperature regulates various biological activities and algal growth. Temperature due to light intensity stimulates the growth of Cyanophyceae. High value of pH, temperature and CO_2 are favourable for high growth of Cyanophyceae which has been reported by Patil (1982). Relatively high temperature, pH, bicarbonate, silicates, ammoniacal nitrogen, organic matter, salts of calcium and magnesium and stagnation of water of Ranchi Lake are important factors in the development of cyanophycean blooms. This view is in conformity with the observation of Ganpati (1960) and Singh (1960).

During the study period the lake was found to be dominant with *Microcystis* sp., *Oscillatoria* sp. and, *Merismopedia* sp.and *Spirulina* sp. The alga like *Microcystis aeruginosa* is used as the best single indicator of pollution and it is associated with the highest degree of civic pollution (Nandan and Aher 2005). In the present study similar phytoplankton was recorded in Ranchi Lake. In the current study, the occurrence of *Oscillatoria* indicating pollutants of biological origin is similar to the earlier report (Gadag *et al*. 2005). Cyanophyceae occurred as a permanent bloom throughout the year with a maximum in summer and minimum in rainy season. Venkateshwarlu *et al*. (1981) found *Microcystis* sp. prefer highly polluted alkaline (pH 9.6), habitats rich in chlorides, nitrates and organic matter. The existence of higher values of oxygen/organic matter is suggestive of a lesser degree of eutrophication and that *Oscillatoria* may indicate a higher degree of eutrophication in the water (Rao 1972). *Oscillatoria* was the dominant genera in sewage polluted water of Ranchi Lake which is in the conformity with Marathe and Nandkar (1976).

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