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Physico-chemical and biological factors in the distribution of cyanobacteria population in three different sampling sites of South India

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The current work was involved in the distributional analysis of the cyanobacteria strains present in the predominant water outlets present in the city, for analysing the types of strains found during the different seasonal interims. The cyanobacteria distribution in water from two different stations of Southern India were analysed at four months interval during the period of July 2002 to June 2004. The cyanobacteria population in the vicinity was analyzed using the physico-chemical factors like pH, temperature, electrical conductivity, carbonate, bicarbonate, chloride, calcium, magnesium, total phosphorus, inorganic phosphorus, sulphate, sulphite, ammoniacal nitrogen, nitrate, nitrite, silicate, iron, zinc, copper and manganese and algal flora (qualitative) were also studied and compared their variations among the three different freshwater bodies. In addition, biological parameters such as primary production gross primary productivity, net primary productivity and community respiration rate were also studied. Totally 64 taxa of cyanobacteria belonging to 7 families were isolated. The members of the families Oscillatoriaceae and Chroococcaceae were found to be predominant in all the three sampling sites. It was observed that the distributional patterns of the cyanobacteria were related with that of the physico-chemical parameters of the water sample. Since there was no significant difference in the parameters of the sampling sites, a few cyanobacterial strains were found to be dominating, followed by co-dominating and peripheral species which were found to be common in all the sampling sites. This ultimately shows that there is no significant changes in the distribution of the cyanobacterial strains in the current area of study under the same equatorial region.

Key words: Cyanobacterial population, physico-chemical properties, cyanobacterial distribution, algal distribution, chroococcaceae, oscillatoriaceae.

INTRODUCTION

Cyanobacteria (blue-green algae) are photosynthetic prokaryotes, Gram negative bacteria; diversity ranges from unicellular to multicellular, branched filamentous, slight to intense pigmentation, autotrophic to heterotrophic, free living to symbiotic, aquatic to terrestrial, psychrophilic to thermophilic, acidophilic to alkylophilic, planktonic to

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epiphytic, freshwater to marine including hyper saline. Algae are the principal food producer and also support the aquatic environment and aquatic life. Some workers have emphasized the importance of phyto planktons of fish ponds, lakes, etc. (Alikhuni, 1952; Chacko et al., 1954; Philipose, 1959; Singh, 1960; Gupta and Ahmed, 1966; Alam et al., 1989).

Cyanobacteria have been an unexplored arena for biological researchers at large. Mostly the microbial analysis was done taking the bacterial and fungal strains into account, leaving behind the mostly notable autotrophic microbial strains in the name of algae. Cyanobacterial strains which do possess the character of nitrogen fixation adds up to value addition of these microbial strains mainly in the field of Mari culture, food, feed, fuel, fertilizer, medicine and combating pollution (Muthukumar et al., 2007).

The ecological significance of these bloom formation have been discussed in which *Spirulina* showed maximum pollution tolerance as it appeared as successful genus to flourish in waste water with a high load of nutrient level and organic pollution. Primary production is an important biological phenomenon in the aquatic environment in which phytoplankton act as a primary producer, their physiological activities greatly controlled by physico-chemical characters of the water body (Sahu et al., 1995; Kumar, 1997). Cyanobacteria commonly produce heavy growth, termed blooms in natural and man-made bodies of water. The bloom-forming blue-green algae can form thick scums, especially around the margins of lakes and reservoirs. It is notable that the toxin-forming blue-green algal species often predominate in these surface scums (Skulberg, 1964; Rodhe, 1969; Straskrata and Straskrabova, 1969; Thomas, 1969; Stewart et al., 1975).

In the present investigation water samples were analyzed from two different stations at different seasonal intervals. Cyanobacteria were isolated and diversity study was carried out during the study period. Further the physio-chemical parameters of the samples were also analyzed, their variations were interpreted and the results are discussed in detail in this paper.

MATERIALS AND METHODS

Study area

The study was carried out in three different stations representing two main cities of Southern India (Figure 1) namely Botanical Garden Pond and Singanallur Lake in Coimbatore, Tamil Nadu (Latitude 11° N; Longtitude 77° E) and Theneri Lake in Pallakad, Kerala (Latitude 10° 46' N; Longtitude 76° 42' E).

Sample collection, isolation and identification of cyanobacteria

Planktonic samples were collected at four months interval during July 2002 to June 2004 from the three different freshwater bodies namely Botanical Garden Pond, Singanallur Lake and Theneri Lake. Cyanobacterial species were isolated using BG11 medium by streak plate method and spread plate method and the plates were incubated at 25°C under continuous illumination (2,000-3,000 lux). The isolates were identified microscopically.

Analysis of water samples

Physico-chemical analysis

Water samples were also taken from each site for analysing the physico-chemical using standard methods (APHA, 1992). Various physico-chemical parameters analysed were pH, temperature, electrical conductivity, carbonate, bicarbonate, chloride, calcium, magnesium, total phosphorus, inorganic phosphorus, sulphate, sulphite, ammoniacal nitrogen, nitrate, nitrite, silicate, iron, zinc, copper and manganese.

Biological analysis

The biological primary production analyses such as gross primary productivity, net primary productivity and community respiration rate were measured using light and dark bottle technique and dissolved oxygen was estimated using Winkler's method (APHA, 1992).

RESULTS

Cyanobacterial diversity

Totally, 64 taxa of cyanobacteria belonging to 7 families namely Chroococcaceae, Entophysalidaceae, Pleurocapsaceae, Oscillatoriaceae, Microchaetaceae, Rivulariaceae and Scytonemataceae were isolated from the three different freshwater bodies. The members of the families Oscillatoriaceae and Chroococcaceae were found to be predominant flora in all the sampling sites (Table 1). The microscopic observation of cyanobacterial isolates from three different sampling sites is presented in Figure 2.

Seasonal distribution of cyanobacterial species

During the 1st sampling period (July – October 2002), a maximum of 29 species were recorded in Botanical Garden Pond, followed by 19 species and 20 species in Singanallur Lake and Theneri Lake. Similarly, during the 2nd (November 2002 – Feburary 2003) and 3rd (March – June 2003) sampling periods, as many as 23, 19 and 27 species and 23, 22 and 20 species respectively were isolated from Botanical Garden Pond, Singanallur Lake and Theneri Lake respectively. Similar pattern of results were obtained in the 4th (July to October 2003 - 22, 16 and 18 species), 5th (November 2003 to Feburary 2004 - 21, 17 and 22 species) and 6th (March to June 2004 - 19, 16 and 19 species) sampling periods in all the three fresh water bodies respectively. The results show that there were no distinct variations in the occurrence of cyanobacteria in all the three sampling areas (Table 1). The members of the families Chroococcaceae and

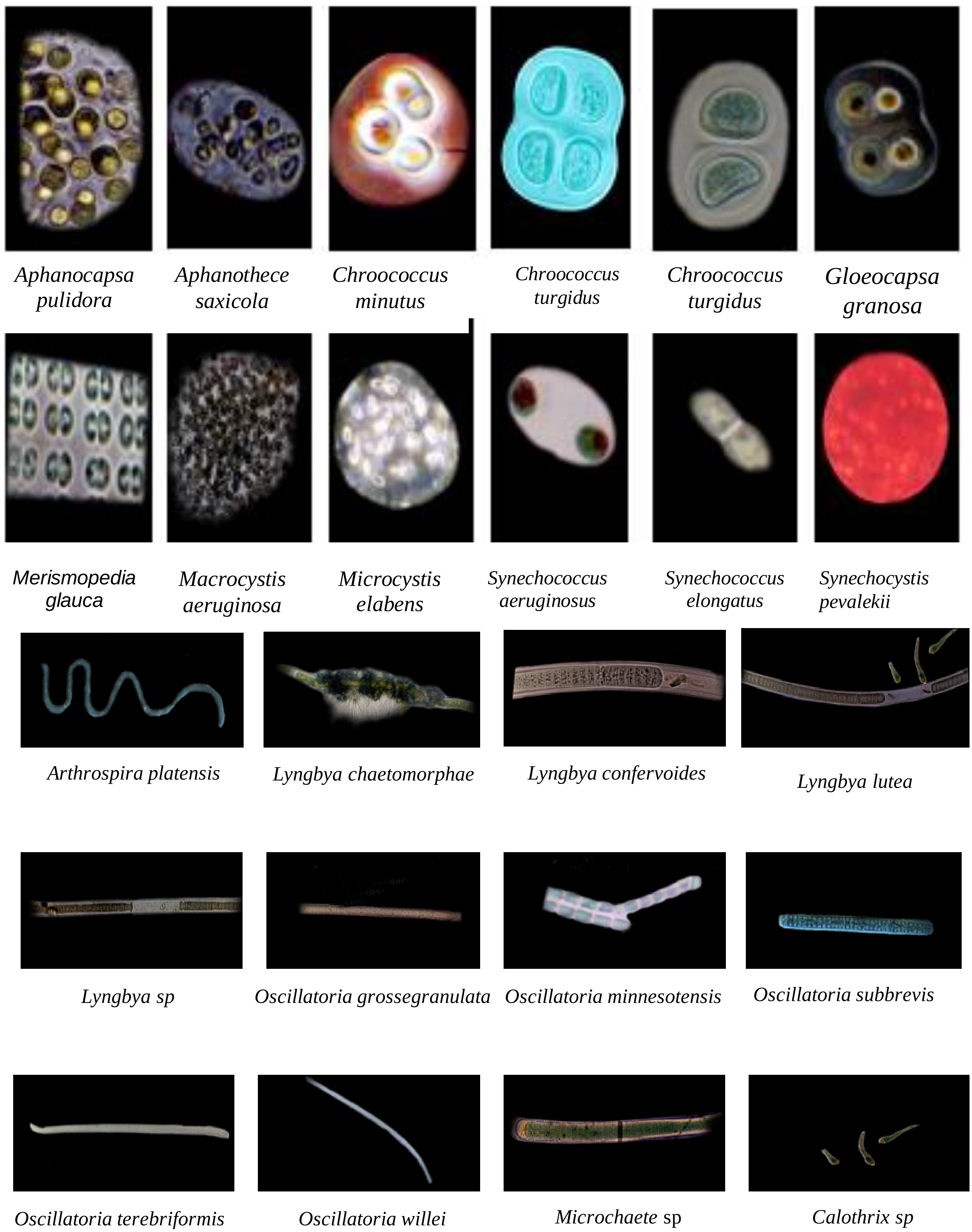

Figure 2. Microscopic observation of cyanobacterial isolates from three different sampling sites.

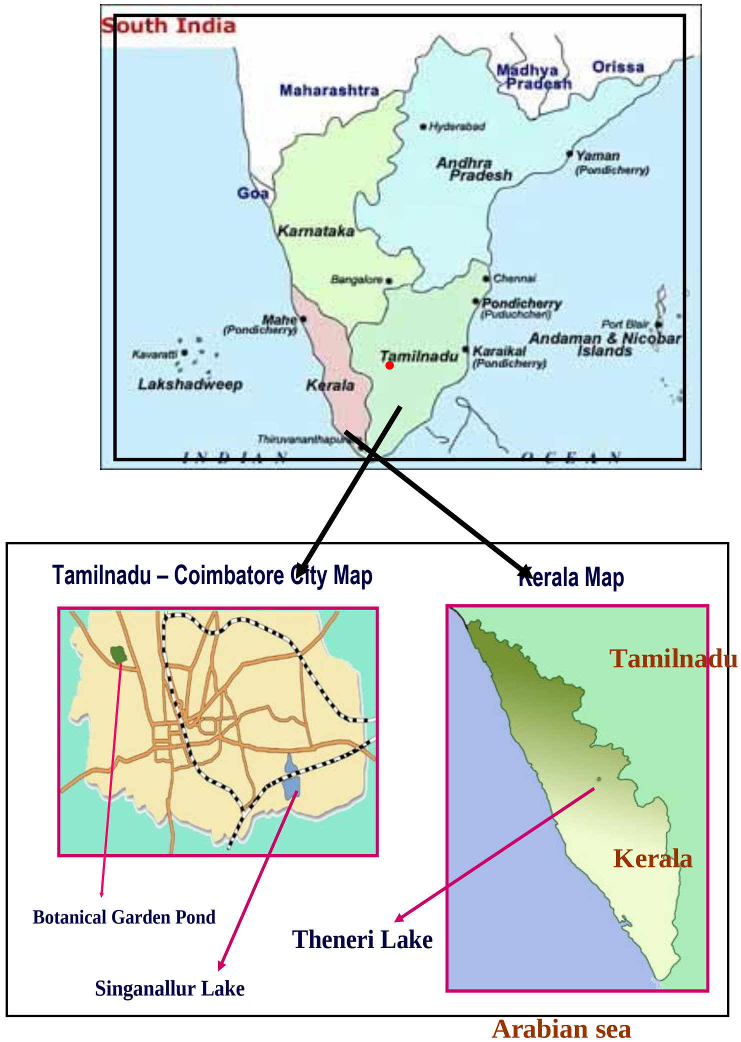

Figure 1. Map depicting the study area of Southern India.

Oscillatoriaceae were the predominant flora in all the sampling periods in all areas, whereas the members of Entophysalidaceae, Pleurocapsaceae, Microchaetaceae, Rivulariaceae and Scytonemataceae families were found in very meger or even absent in certain sampling periods.

Physico-chemical analysis

Physico-chemical analysis of water showed that the pH range from 7.3 to 8.4, temperature from 27 to 30°C, electrical conductivity from 507.5 to 3760.0, alkalinity (carbonate from 12 to 94.5 mg/l and bicarbonate from 73.0 to 565.9 mg/l), chloride from 61.9 to 808.2 mg/l, calcium from 46.0 to 131.3 mg/l, magnesium from 18.2 to 114.0 mg/l, total phosphorus from 0.25 to 2.55 mg/l, inorganic phosphate from 0.02 to 5.40 mg/l, ammoniacal nitrogen from 2.5 to 22.7 mg/l, nitrate from 0 to 41.6 mg/l, nitrite from 0 to 18.5 mg/l, sulphate from 0 to 27.4 mg/l, sulphite from 0.05 to 11.85 mg/l, silicate from 10.2 to 135.0 mg/l, iron from 0 to 27.5 mg/l, zinc from 0 to 0.5 mg/l, copper from 0 to 0.80 mg/l and manganese from 0 to 0.62 mg/l respectively throughout all the sampling periods and areas (Table 2).

Biological analysis

Biological analysis of water revealed that the net production range from 27.77 to –99.96 mg $cm^{3-1}h^{-1}$, gross production from 111.08 to –41.66 mg $cm^{3-1}h^{-1}$ and community respiration rate from 250.00 to –16.66 mg $cm^{3-1}h^{-1}$, respectively in all the sampling sites.

DISCUSSION

Cyanobacteria are capable of both carbon assimilation and nitrogen fixation thereby enhancing productivity in

Table 1. Biodiversity of cyanobacteria from three different sampling sites.

Name	BG	SN	TN
FAMILY : CHROOCOCCACEAE			
Aphanocaspsa pulchra (Kutz.) Rabenh.	-	+	+
Aphanocapsa sp	-	+	-
Aphanothece microscopica Nag.	+	+	+
Aphanothece saxicola Nag.	-	+	-
Aphanothece sp	+	-	-
Chroococcus minor (Kutz.) Nag.	+	+	+
Chroococcus minutus (Kutz.) Nag.	+	-	+
Chroococcus turgidus (Kutz.) Nag.	+	-	-
Chroococcus sp	+	-	+
Gloeocapsa aeruginosa (Carm.) Kutz.	+	-	+
Gloeocapsa atrata (Turp.) Kutz.	+	-	+
Gloeocapsa granosa (berk.) Kutz.	+	+	+
Gloeocapsa sp	+	+	+
Gloeocapsa stegophila (Itzigs.) Rabenh.	-	+	+
Gloeothece rupestris (Lyngb.) Bornet.	-	-	+
Gloeothece sp	-	+	+
Merismopedia glauca (Ehrenb.) Nag.	+	-	-
Microcystis aeruginosa Kutz.	+	+	+
Microcystis elabens (Breb.) Kutz.	+	-	-
Microcystis flos-aquae (Wittr.) Kirchner.	-	+	+
Synechococcus aeruginosus Nag.	-	-	+
Synechococcus elongatus Nag.	+	+	+
Synechocystis aquatilis Sauv.	+	-	-
Synechocystis pevalekii Ercegovic.	+	+	+
FAMILY : ENTOPHYSALIDACEAE			
Johannesbaptistia pellucida (Dickie.) Taylor et Drouet.	+	-	-
FAMILY : PLEUROCAPSACEAE			
Myxosarcina spectabilis Geitler.	-	+	+
FAMILY : OSCILLATORIACEAE			
Arthrospira platensis (Nordst.) Gomont.	-	+	+
Lyngbya chaetomorphae Iyengar et Desikachary.	+	-	-
Lyngbya confervoides C. Ag.ex Gomont.	+	+	-
Lyngbya dendrobia Bruhl et Biswas.	-	+	-
Lyngbya infixa Fremy.	+	-	+
Lyngbya lutea (Ag.) Gom.	+	+	+
Lyngbya martensiana Menegh.ex Gomont.	+	+	+
Lyngbya mucicola Lemmermann	+	+	+
Lyngbya polysiphoniae Fremy.	-	-	+
Lyngbya sp	+	+	+
Oscillatoria animalis Ag.ex Gomont.	-	+	-
Oscillatoria boryana Bory. ex Gomont.	-	-	+
Oscillatoria curviceps Ag.ex Gomont.	+	+	-
Oscillatoria earlei Gardner.	+	+	+
Oscillatoria grossegranulata Skuja.	-	+	-
Oscillatoria laete-virens (Crouan) Gomont.	+	-	+
Oscillatoria limnetica Lemm.	-	-	+
Oscillatoria minnesotensis Tilden.	-	+	+

Table 1. Contd.

Name	BG	SN	TN
FAMILY : CHROOCOCCACEAE			
Oscillatoria nigroviridis Thwaites. ex Gomont.	-	+	-
Oscillatoria subbrevis Schmidle.	+	+	+
Oscillatoria tenuis Ag.ex Gomont.	+	+	-
Oscillatoria terebriformis Ag.ex Gomont.	+	+	-
Oscillatoria willei Gardner em Drouet.	+	+	+
Phormidium angustissimum W. et G.S. West.	-	-	+
Phormidium corium (Ag.) Gomont.	+	+	+
Phormidium fragile (Menegh.) Gomont.	+	+	+
Phormidium tenue (Menegh.) Gomont.	+	+	+
Phormidium sp	+	+	+
Spirulina labyrinthiformis (Menegh.) Gomont.	+	+	+
Spirulina laxissima West, G. S.	-	-	+
Spirulina sp	+	-	+
FAMILY : MICROCHAETACEAE			
Microchaete sp.	+	-	-
FAMILY : RIVULARIACEAE			
Calothrix sp	-	+	+
Homoeothrix hansgirgi (Schmidle.) Lemm.	-	+	-
FAMILY : SCYTONEMATACEAE			
Plectonema sp	+	-	+
Plectonema terebrans Bron.ex Gomont	-	-	+
Scytonema sp	-	+	-
Tolypothrix sp	-	-	+

\+ Presence of specific organism; - Absence not identified; TN -Theneri Lake; SN- Singanallur Lake; BG-Botanical Garden Pond.

variety of environments. Apart from fixing atmospheric nitrogen, they secrete a number of biologically active substances. Tropical conditions such as those in India provide favourable environment for the luxuriant growth of these organisms in the natural ecosystems such as different types of soil, freshwater bodies, oceans, saline backwaters, estuaries and also hyper saline saltpans.

The work of Anand and Hopper (1995), Dwivedi et al. (2005), Matsuzaki et al. (2004) and Parikh et al. (2006) showed similar type of results showing differnces in the distribution of the cyanobacterial population based on the physico-chemical parameters. Pandey et al. (2004) reported that among the cyanobacterial population, Oscillatoria, Phormidium and Nostoc commune were the predominant flora in most of the habitats. Total alkalinity is an important parameter of the fish ponds for fish growth as per the work done by Harish and Gajaria, 1997.

Tarar and Bodkhe (1991) reported that 50 species of cyanobacteria were identified in four polluted drains of Nagpur city. The members of the families Oscillatoriaceae and Chlorococcaceae were found to be predominant. The electrical conductivity concentration in the water of River Yamuna flowing through Haryana was found to be low ranged from 128 to 192 mg/l (Ravindra et al., 2003). Similarly, in the present study, the Ec concentration was found to be lower in Theneri Lake when compared to Singanallur Lake and Botanical Garden Pond.

Also according to the work of Ravindra et al. (2003) who reported that agricultural runoff containing phosphate fertilizers as well as waste water containing detergents, etc tend to increase phosphate pollution in Delhi downstream water. Waste water from tanneries, paper mills and textile mills usually contributes to the sulphate in natural water along with some agricultural run-off containing leachates of gypsum which was evidently the case in Delhi downstream.

The results of Murty et al. (1986) reported the data on the gross production, respiratory consumption and depth integrated production of the three fresh water bodies.

Conclusion

In the present study, it was observed that there was no

Table 2. Physico-chemical analysis of water samples from three different sampling sites.

Physical and Chemical Parameters	July'2002 - June'2003									July'2003- June'2004								
	I			II			III			I			II			III		
	BG	SN	TN	BG	SN	TN	BG	SN	TN	BG	SN	TN	BG	SN	TN	BG	SN	TN
pH	7.9	7.9	7.8	7.7	7.8	8.4	7.8	8.2	7.8	7.6	7.8	7.8	7.3	7.7	8.0	7.5	7.8	8.1
Temperature	29.5	30.5	27	27	27	27	30	29.5	29	29	29	30	28.5	27.5	27.5	29	29	28
Electrical conductivity	2858	3760	550	1880.5	1362	513	1897.5	1860	677.5	2533	3009	811	1515	1572	507.5	1737.5	1682	670.5
Carbonate	30	60	42	28.7	35	12	27.1	39.6	22	24.5	55	30	31.7	32.5	16	52	94.5	34
Bicarbonate	565.9	387.3	275	148.3	97.1	137.9	231.5	174.1	152.2	445.7	391.8	212.6	134.8	73	175.8	160.9	215	155.4
Chloride	389.9	808.2	205.6	352.4	263.9	61.9	270.8	427.7	92.9	197.3	542.4	170	344.1	277.3	72.6	501.6	449	91.65
Calcium	131.3	112	46	109	83.5	72	108	96	53.5	130	112	54	103.7	84.5	85	93	89	53
Magnesium	76	114	33	51.4	92.6	41	57.3	76.3	18.2	73.9	101.1	26.9	66.8	97.2	33.8	88.4	80.5	24.7
Total phosphorus	0.5	1.45	0.55	0.25	0.4	0.6	0.3	2.55	0.65	0.65	0.75	0.25	0.3	1.75	0.35	2.4	2.35	0.6
Inorganic phosphate	0.35	1.3	0.25	0.5	5.4	0.85	0.26	3.1	5.1	0.02	0.4	0.2	1.15	5.2	2.5	2.7	1.85	5.05
Sulphate	20.9	24.85	1.75	7.9	27.4	1.4	14.9	16.3	1.5	6.55	18.95	0.4	14.9	22.65	0	10.8	19	1.4
Sulphite	1.2	1.3	0.05	6.05	7.6	5.95	5.05	11.85	10.2	1.6	1.2	0.05	7.15	4.95	5.1	7.4	2.7	0.05
Ammoniacal nitrogen	3.6	10.8	5.4	5.9	7.3	2.5	4.9	8.3	3.3	22.7	11.6	4.1	9.15	8.25	3.2	5.85	7.55	2.8
Nitrate	32.6	21.7	41.6	10	6	10.6	14.1	9.2	29.8	29.8	18.4	32.1	0	0	10.1	6.45	9.55	30.3
Nitrite	3.15	4.5	5.65	14.6	4.35	18.5	1.15	2.75	4.12	4.35	4	0	8.1	2.55	9.1	3.95	2.9	10.1
Silicate	115	135	65	11	90	10.6	43.1	109	13.2	90	127.5	13.6	67	67.5	10.2	35.5	70.5	14.4
Iron	0	0.95	0	0.1	0.7	0.05	0.01	0.4	0.1	0.9	0	0.05	0.2	0.3	0.1	0	0.05	0
Zinc	0.15	0.21	0.5	0.1	0.1	0.4	0.01	0.05	0.15	0.11	0.01	0	0.05	0.15	0.15	0.01	0.01	0.15
Copper	0.15	0.8	0.51	0.05	0.3	0.15	0.1	0.1	0.15	0.1	0.75	0.45	0.1	0.1	0.05	0.05	0	0.15
Manganese	0.35	0.35	0.62	0.2	0.2	0.2	0	0	0	0.2	0.4	0.5	0.2	0.35	0.2	0.2	0.05	0

Sampling periods: I, July - October; II, November - February ; III, March – June; BG - Botanical Garden Pond; SN - Singanallur Lake; TN - Theneri Lake.

significant variation in the occurrence and distribution of cyanobacteria and it was correlated with the physico-chemical parameters of water. The eco-biological analysis revealed the occurrence of several dominant, co-dominant and ephimeral species from all the three sampling sites. The physico-chemical analysis revealed that there was no much variation in the values and these factors does not specifically influence the occurrence and distribution of cyanobacterial population. The biological parameters showed that there was a slight variation in the gross productivity compared to net productivity and community respiration rate in all the sampling sites.

REFERENCES

Alam MJ, M Habib, B Habib, M Begum (1989). Effect of water quality and dominance genera of phytoplankton on the abundance of available genera. Pak. J. Sci. Ind. Res. 32:194-200.

Alikhuni KH (1952). On the fed of young carp fry. J. Zoologic. Soc. India. 4:77-84.

Anand N, RS Hopper (1995). Distribution of blue-green algae in rice fields of Kerala State, India. Phykos. 34:55-64.

APHA (1992). Standard methods for examination of water and waste water APHA, AWWA, AWWA WPCF, Washington DC.

Chacko DI, B Krishnamurthy, S George (1954). A hydrobiological survey of the Ramesamudram Lake at Karkal, South Kandra with a view to fishery development. Ind. Comm. J., 9:15-18.

Dwivedi S, PK Misra, UN Rai, RD Tripathi, MR Suseela et al., (2005). Fresh water blue green algae from three agro-climatic zones of Uttar Pradesh, India: Distribution pattern with seasonal variation. J. Environ. Biol., 26:21-30.

Gupta AB, MR Ahmed (1966). Studies on the effect of feeding some fresh water fishes with Scenedesmus obliqus (Turpin) Kuetz. Hydrobiologia, 28:42-48.

Harish K, SC Gajaria (1997). Hydrobiological characterization of Matar village fish pond for rural aquaculture. Freshwater Biol., 9:1-3.

Kumar A (1997). Comparative hydrological studies of tropical water bodies with special reference to sewage pollution in South Bihar. J. Ecobiol., 9: 255-262.

Matsuzaki M, JL Mucci, AA Rocha (2004). Phytoplankton community in a recreational fishing Lake, Brazil. Rev. Saude. Publica. 38:679-686.

Murty KSN, TSN Murty, P Venu, Seshavatharam (1986). Primary production in three fresh water bodies of Andhra Pradesh. Phykos, 25:68-74.

Muthukumar C, G Muralitharan, R Vijayakumar, A Panneerselvam, N Thajuddin (2007). Cyanobacterial biodiversity from different freshwater ponds of Thanjavur, Tamil Nadu (India). Acta Bot. Malacitana, 32:17-25.

Pandey KD, SP Shukla, PN Shukla, DD Giri, JS Singh, P Singh, AK Kashyap (2004). Cyanobacteria in Antarctica: Ecology, physiology and cold adaptation. Cell Mol. Biol., 50:575-584.

Parikh A, V Shah, D Madamwar (2006). Cyanobacterial flora from polluted industrial effluents. Environ. Monitor. Assess. 116:91-102.

Philipose M T (1959). Freshwater phytoplankton of inland fisheries. *Proceedings of the Symposium on Algology*, December 1959, ICAR, *New Delhi*, India, pp:272-291.

Ravindra K, A Meenakshi, M Rani, A Kaushik (2003). Seasonal variations in physico-chemical characteristics of River Yamuna in Haryana and its ecological best-designated use. J. Environ. Monit., 5:419-426.

Rodhe W (1969). *Eutrophication*, *Causes*, *Consequences*, Correctives. Natl. Acad. Sci. Press, Washington, DC USA., pp:50-64.

Sahu BK, RJ Rao, SK Behera, RK Pandit (1995). Phytoplankton and primary production in the river Ganga from Rishikesh to Kanpur. J. Ecobiol., 7:219-224.

Singh VP (1960). Phytoplankton ecology of the inland waters of Uttar Pradesh. Proceedings of the Symposium on Algology, January 1, 1960, New Delhi, India.

Skulberg OM (1964). Algae and Man. Plenum Press, New York, USA., pp:269-299.

Stewart WDP, SD Tuckwell, E May (1975). The Ecology of Resource Renewal. Blackwell, Oxford, UK., pp:57-80.

Straskrata M, V Straskrabova (1969). Eutrophication-Causes, Consequences, Correctives. Natl. Acad. Sci., USA., pp. 65-97.

Tarar JL, S Bodkhe (1991). Cyanobacteria from the Polluted Habitat of Nagpur City. In: Cyanobacterial Biotechnology, Subramanian, G., B.D. Kaushik and G.S. Venkaataraman (Eds.). Oxford and IBH Publishing, New Delhi, India, pp. 149-157.

Thomas EA (1969). Eutrophication-Causess, Consequences, Correctives. National Academy of Sciences, Washington DC USA., pp. 29-49.