Paper III

Seaweed Res. Utiln., 29 (1 & 2) : 263 - 271, 2007

Seasonal variation of cyanobacteria at Muthupet mangrove environs, Tamilnadu, South India

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ABSTRACT

Biodiversity of cyanobacterial flora and physico-chemical parameters in Muthupet backwater were studied in the year 2002 and 2003 at three months interval. A total number of 63 species belonging to 21 genera and 9 families were recorded. Among these, 37 species were non-heterocystous trichomatous, 20 species were unicellular / colonial and 6 species were heterocystous forms. The members of the Family Oscillatoriaceae and Chroococcaceae were predominant and co-domiment respectively. Three species namely *Oscillatoria acuminata, O. fomosa* and *Phormidium tenue* were common in all the four seasons during both the years.

Introduction

Cyanobacteria (blue green algae) are oxygenic photosynthetic prokaryotes and widely distributed in the natural ecosystems such as land soil, freshwater, oceans, estuaries, saline backwaters, estuarine salt lakes, salt marshes and also in hyper saline salt pans (Fogg *et. al.*, 1973). Cyanobacteria in general and marine cyanobacteria in particular, are getting importance in the area of biotechnology (Bakus, 1991; Patterson and Smith, 1991; Borowitzka, 1994 and Burja *et al.*, 2001). The basic and fundamental requirement for initiating marine cyanobacterial biotechnology is first to enumerate the natural biodiversity and to understand their innate properties which could be useful for a variety of purposes. Many workers studied the cyanobacterial flora occurring in the backwaters of India (Anand *et al.*, 1986; Subramanian *et al.*, 1989; Raman *et al.*, 1990; Thajuddin and Subramanian 1991, 1992 and 1994). In the present study, the cyanobacterial biodiversity of Muthupet estuarine backwater in Thiruvarur District, Tamilnadu in relation to the physico-chemical parameters have been investigated.

Materials and Methods

Cyanobacterial samples and water samples were collected from the Muthupet mangrove estuarine ecosystem located at Lat. 10°20′ N and Long. 79°35′ E in Tamil Nadu, India (Fig. 1.) covering an area of 20,000 ha and ultimately opens into Palk Bay.

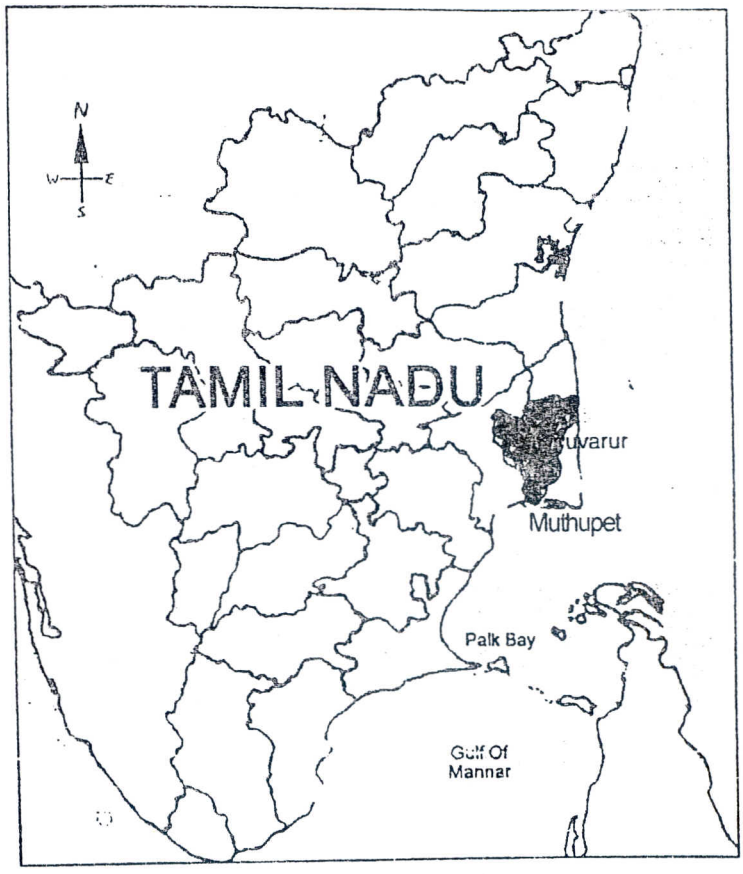

Fig. 1. *Map showing the study area*

Cyanobacterial mats floating over the water column, attached with the pneumatophores and trunks of the mangroves were hand picked and kept in plastic vials and were later transferred to Erlenmeyer flasks containing enriched seawater medium (Sweeny, 1954) with 30 ppt of salinity. Plankton samples were also collected using plankton net (mesh size of 42 µm). Identification of specimens were made by refering the taxonomic publications of Geitler (1932), Starmach (1966) and Desikachary (1959). Photomicrographs were taken using Leitz Diaplan Model (Germany) photo micrographic unit. The physico-chemical parameters of water samples were analysed following the standard methods (El-Wakeel and Riley, 1957; Barnes, 1959; Strickland and Parsons, 1972). The diversity of cyanobacterial flora was correlated with physico –chemical parameters of water.

Results and Discussion

The physico-chemical characteristics of water samples analysed in four seasons for two consecutive years in 2002 and 2003 are given in Table-1. Totally 63 species of cyanobacteria belonging to 21 genera were recorded in the two years period. Among them, 41 species were non-heterocystous trichomatous forms, 18 species were

unicellular forms and 4 species were heterocystous forms. Thus non-heterocystous and trichomatous forms were dominant over the other forms. Out of these, only 3 species belonging to 2 genera were found to occur in all four seasons during the years 2002 and 2003 (Table-2). Nine species viz., *Chrococcus minutus, C. minor, Oscillatoria subtilissima, O. tenuis, O. animalis, O.laetevirens, O. willei, Phormidium corium* and *Lyngbya majuscula* were recorded in all the seasons during 2002, but they were not found during certain seasons in the year 2003 (Table-2). Four species viz., *Calothrix crustaceae, C. contarenii, C. scopulorum* and *Hapalosiphon welwitschii* were absent in monsoon and postmonsoon season of both the years whereas they were present in premonsoon season in 2002 and summer as well as premonsoon season in 2003. Totally 48 species were recorded during premonsoon season in the year 2003, whereas 45 species during summer season in 2002. Moderate diversity (30-35 species) was found in premonsoon and monsoon season of 2002. The lowest diversity of 22 species was observed only in monsoon season of 2003 (Table-2).

There are some reports on the occurrence of cyanobacteria in marine and esturine environments of India (Cleve, 1901; Biswas, 1926; Gopala Iyer and Sankara Menon 1937; Venkataraman, 1957; Anand, 1982; Ramachandran, 1982; Anand and Venkatesan, 1985; Anand *et al.*, 1986; Raman *et al.*, 1990). Thajuddin (1991) reported 196 species of cyanobacteria belonging to 51 genera and 14 families from Tirakol coast of Goa to Kanyakumari coast of Tamil Nadu and from Kanyakumari to Bhimnipatnam (Andhra Pradesh) encomposing the regions namely Arabian sea, Indian Ocean, Gulf of Mannar, Palk Bay, Palk Strait and Bay of Bengal. But no information is available on the cyanobacterial flora of Muthupet estuary in Thiruvarur District, Tamil Nadu.Nine species viz., *Oscillatoria willei, O. nigroviridis, O.minnesotensis, O. cortiana, Oscillatoria* sp.

Table 1. *Physico-chemical parameters of Muthupet estuarine water during 2002 and 2003*

Parameters	2002				2003			
	Po.M	Su	Pr.M	M	Po.M	Su	Pr.M	M
Rainfall(mm)	376.8	378.9	55.5	519.3	27.9	185.9	190.5	606.9
Atmospheric temperature (°C)	23	34	31	22	28	34	30	21
Surface Water temperature (°C)	24	35	32	23	29	36	32	22
Salinity (ppt)	22	26	24	21	23	24	23	20
pH	7.6	7.8	8.2	7.8	8	8.1	8	7.8
Dissolved oxygen (mg/l)	6.5	6.2	5	6.8	8.3	5.2	5.4	7.8
Dissolved inorganic Nitrate (mg/l)	47.5	48.5	40.2	46.6	40	37.5	30.5	49.6
Dissolved inorganic Nitrite (mg/l)	2.7	2.4	2	2.9	2.6	1.4	2.9	3
Silicate (mg/l)	192	103	147	185	178	155	176	190
Copper (mg/l)	0.42	0.4	0.34	0.56	0.28	0.32	0.34	0.43
Zinc (mg/l)	1.16	1.04	0.98	1.18	0.94	0.92	1.12	1.23
Ferrous (mg/l)	1.12	0.99	0.45	0.95	2.67	1.92	2.1	3.5
Calcium (mg/l)	868	988	996	863	846	894	901	840
Magnesium (mg/l)	299	310	322	295	302	315	327	300

Po.M – Post monsoon(Jan-March); Su – Summer(April-June); Pr.M – Premonsoon(July-Sep); M- Monsoon(Oct-Dec)

Table 2. *Cyanobacteria recorded in Muthupet estuary in different seasons*

Species	2002				2003			
	PO.M	SU	PR.M	M	PO.M	SU	PR.M	M
CHROOCOCCACEAE								
Microcystis littoralis (Hansg) Forti	-	-	+	-	+	+	+	-
Chroococcus turgidus (Küetz.) Näg.	+	-	+	-	+	-	+	-
C. minutus (Küetz.) Näg.	+	+	+	+	+	-	+	-
C. minor (Küetz.) Näg	+	+	+	+	+	+	-	-
Gloeocapsa aeruginosa (Carm.) Küetz	+	-	+	-	+	+	-	-
G. stegophila (Itzigs.) Rabenh	+	-	+	-	+	+	-	-
G. crepidinum Thuret	-	-	+	-	+	-	+	-
G. granosa (Berk) Küetz.	-	-	+	-	+	-	+	-
Aphanocapsa littoralis (Hansgirg)	+	-	+	+	+	-	+	+
A. pulchra (Küetz.) Rabenh	+	-	+	+	+	-	+	+
Aphanotheca microscopica Näg	-	+	+	+	+	-	+	+
Synechococcus elongatus Näg	-	+	-	-	+	-	+	-
Synechocystis pevalekii Ercegovic	-	+	-	-	-	+	-	-
ENTOPHYSALIDACEAE								
Johannesbaptistia pellucida (Dickie)Taylor et Drouet	-	+	-	-	-	-	+	-
DERMOCARPACEAE								
Dermocarpa sphaerica Setchell et Gardner	-	-	+	-	-	-	+	-
D. leibleinea (Reinsch) Born et Thur.	+	-	+	-	-	-	+	-
PLEUROCAPSACEAE								
Myxosarcina burmensis Skuja	+	-	-	+	+	+	-	+
M. concinna Printz	+	-	-	+	+	+	-	+
HYELLACEAE								
Xenococcus acervatus Stechell et Gardner	+	-	-	-	-	-	-	-
Hyella caespitosa Born et. Flah	-	+	-	-	-	-	+	-
OSCILLATORIACEAE								
Spirulina subsalsa Oerst. ex. Gomont	+	+	-	-	+	-	-	-
S. labyrinthiformis (Menegh.) Gomont	+	+	-	-	+	-	-	-

Table 2. *Continued...*

Species	2002				2003			
	PO.M	SU	PR.M	M	PO.M	SU	PR.M	M
Oscillatoria subtilissima Küetz.	+	+	+	+	+	-	+	-
O. tenuis Ag. ex. Gomont	+	+	+	+	+	-	+	-
O. animalis Ag. ex. Gomont	+	+	+	+	+	-	+	-
O. salina Biswas	+	+	-	-	-	+	+	-
O. proboscidea Gomont	+	+	-	+	-	+	+	-
O. brevis (Küetz.) Gomont	+	+	-	-	-	+	+	+
O. annae Van Goor	+	+	-	+	+	+	+	+
O. subbrevis Schmidle	+	+	+	+	+	+	+	+
O. acuminata Gomont	+	+	-	-	+	+	+	+
O. formosa Bory ex Gomont	+	+	+	+	+	+	+	+
O. laetevirens (Crouan) Gomont	+	+	+	+	+	+	+	-
O. willei Gardner ex Drouet	+	+	+	+	+	-	+	-
O. nigroviridis Thwaites ex Gomont	+	+	-	+	+	-	+	-
O. minnesotensis Tilden	+	+	-	+	+	-	+	-
O. cortiana Meneghini ex Gomont	+	+	-	+	+	-	+	-
Phormidium angustissimum W.et G.S. West	+	+	+	-	+	-	+	-
P. fragile (Meneghini) Gomont	+	+	+	-	+	+	+	-
P. tennue (Meneghini) Gomont	+	-	+	-	+	+	+	+
P. corium (Ag.) Gomont	+	+	+	+	+	+	+	-
P. cebennense Gomont	-	+	-	-	+	-	+	+
Lyngbya martensiana Meneghini ex. Gomont	+	+	+	-	+	+	+	-
L. confervoides C. Ag. ex Gomont	+	+	+	-	+	+	+	-
L. semiplena (C. Ag.) J. Ag. ex. Gomont	-	+	+	-	+	-	+	-
L. chaetomorphae Iyengar et Desikachary	+	+	+	-	+	+	+	-
L. majuscula **Harvey ex Gomont**	+	+	+	+	+	+	-	+
L. aesturii **Liebm. ex Gomont**	-	+	+	+	+	-	-	+
L. lutea **(Ag.) Gomont**	-	+	+	+	+	-	-	+
L. acuminata (Ag.) Gomont	+	+	-	+	+	-	+	+
L. gardneri (Setchell et Gardner) Geitler	+	+	-	+	+	-	+	+
Lyngbya **sp.**	+	-	-	+	+	-	+	+
Schizothrix friesii (Ag.) Gomont	-	+	-	+	+	-	-	+
Microcoleus chthonoplastes **Thuret ex Gomont**	+	+	-	+	+	-	-	+
M. acutissimus **Gardner**	+	+	-	+	+	-	+	+

Table 2. *Continued...*

Species	2002				2003			
	PO.M	SU	PR.M	M	PO.M	SU	PR.M	M
NOSTACOCEAE								
Nostoc sp.	-	+	-	-	-	+	+	-
Nodularia spumigena Mertens ex Born et. Flah	+	+	-	-	-	+	-	-
Pseudoanabaena schmidlei Jaag. O.	-	+	-	-	-	+	-	-
SCYTONEMATACEAE								
Plectonema terebrans Born. ex Gomont	+	-	+	-	+	-	+	-
RIVULARIACEAE								
Calothrix crustacean Thuret	-	+	+	-	-	+	+	-
C. contarenii (Zanard) Bornet ex. Flah	-	-	+	-	-	+	+	-
C. scopulorum (Weber et Mohr.) Ag Ex.Born et Flah	-	-	+	-	-	+	+	-
STIGONEMATACEAE								
Hapalosiphon welwitschii W. et. G.S. West.	-	-	+	-	-	+	+	-

PO.M. - Post monsoon; SU – Summer; PR.M.- Premonsoon; M – Monsoon; (+) present; (-) absent

Microcoleus chthonoplastes, *M. acutissimus*, *Lyngbya acuminata* and *L. gardneri* were recorded in post monsoon seasons in both the years and their presence and/or absence varied in the other seasons. Three species viz., *Nostoc* sp., *Nodularia spumigena* and *Pseudoanabaena schmidlei* were found in summer of both the years and absent during premonsoon and monsoon in 2002. In 2003, they were absent during postmonsoon and monsoon season.

The significant positive and negative correlation ($p<0.05$ and $p<0.01$) were observed between the nutrients. But the correlation co-efficient analysis between physico-chemical characteristics of water and cyanobacterial diversity revealed no significant relationship between them. It shows that no individual factor is responsible for the diversity of cyanobacteria (Table-3). The present investigation reveals the cyanobacterial flora in Muthupet mangrove ecosystem and the seasonal changes in their occurrence. Future work on the identification of useful secondary metabolites from the selected cyanobacterial isolates is necessary.

Acknowledgements

We thank Prof. G. Subramanian, Director, National Facility for Marine Cyanobacteria, Bharathidasan University, Tiruchirappalli for providing facilities to carry out this investigation.

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Table 3. *Correlation co-efficient of physico-chemical parameters of water and total cyanobacterial diversity of Muthupet environs*

Rainfall	Rainfall	A.Temp	S.Temp	Salinity	pH	DO	Nitrate	Nitrite	Silicate	Cu	Zn	Fe	Ca	Mg	TCB
Rainfall	1														
A.Temp	-0.643	1													
S.Temp	-0.6408	0.99729**	1												
Salinity	-0.9022**	0.72188*	0.74501*	1											
pH	-0.749	0.62354	0.63295	0.84718**	1										
DO	0.3257	-0.6129	-0.6337	-0.4332	-0.4595	1									
Nitrate	0.71902*	-0.5661	-0.551	-0.8889**	-0.6988	0.46785	1								
Nitrite	0.5256	-0.7342*	-0.7345	-0.5769	-0.6123	0.5877	0.28333	1							
Silicate	0.22706	-0.8057**	-0.7713*	-0.2119	-0.2787	0.43015	-0.0365	0.50422	1						
Cu	0.83516**	-0.6398	-0.6455	-0.8545**	-0.6314	0.16277	0.62378	0.48999	0.23065	1					
Zn	0.8546**	-0.8014**	-0.7894*	-0.7982*	-0.7204*	0.29432	0.46462	0.80581**	0.50465	0.7563*	1				
Fe	0.17198	-0.2926	-0.2649	0.04521	-0.0393	0.60462	-0.0611	0.30523	0.44387	-0.2541	0.17537	1			
Ca	-0.3363	0.70478*	0.67263	0.25201	0.39371	-0.6823	-0.0981	-0.4576	-0.854	-0.1956	-0.3967	-0.6815	1		
Mg	-0.0054	0.72709*	0.75*	0.75631*	0.71296*	-0.7715*	-0.7799*	-0.4214	-0.4165	-0.5933	-0.4336	-0.1802	0.61768	1	
TCB	-0.5081	0.35766	0.34662	0.3418	-0.047	-0.0288	-0.3632	0.1748	-0.2381	-0.4113	-0.2612	-0.213	0.23822	0.28851	1

* $p < 0.05$; ** $p < 0.01$

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