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Survey of Epilithic Blue Green Algae (Cyanobacteria) from the Temples of Tamilnadu, India

S. Madhavan*, S. Bhuvaneswari and V. Dhivaharan

PG & Research Department of Microbiology, Sengamala Thayaar Educational Trust Women's College, Sundarakkottai, Mannargudi – 614 001, India.

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Members of Cyanobacteria formed blackish-brown crusts/tufts on the surface of the exposed wall of the temples and monuments of Thanjavur and Thiruvarur districts in Tamil Nadu. Nineteen species of Cyanobacteria belonged to *Gloeocapsopsis, Lyngbya, Phormidium, Chroococcus, Nostoc* and *Tolypothrix* were identified. Among them *Lyngbya* and *Phormidium* were the major components of the crusts/tufts of different temples. The organisms grew slowly and possessed a well-defined sheath around their cells/trichome and survived in the extreme climatic conditions prevailed during the summer months.

Key words: Epilithic blue green algae, *Gloeocapsopsis, Lyngbya, Phormidium, Chroococcus*.

Cyanobacteria are also termed as blue-green algae due to the presence of characteristic pigments. Their morphology ranges from single cell to filamentous forms with or without branching. They are prokaryotic in nature, hence very close to bacteria rather than the higher plants. All Cyanobacteria are photosynthetic and synthesize their organic carbon using carbon dioxide, light and water. Certain Cyanobacteria however, convert atmospheric nitrogen into ammonia and are subsequently converted to various amino acids through nitrogenase and glutamine or glutamate synthetase enzyme system. Nitrogenase enzyme is oxygen sensitive and always located in modified cells called heterocyst.

Species of Cyanobacteria formed blackish-brown crusts/tufts on the exposed rock surface of temples and monuments found in India. Growth of Cyanobacteria on the walls of the temples of archaeological importance creates problem for their conservation. In the recent years, considerable corrosion of rocks and deterioration of fine architectural carvings have been observed in many temples due to the growth of Cyanobacteria and algae (Satapathy and Adhikary, 1993; Tripathy *et al.,* 1999).

During the months (March-May) of mid-summer the temperature of the temple wall surface goes beyond 60°C, due to high intensity of light, which leads to extreme dryness. In such environment, certain species of Cyanobacteria were found on the walls of the temples and formed characteristic black-brown crust or tuft (Tripathy *et al.,* 1997; Roy *et al.,* 1997). The present paper deals with the epilithic blue green algae on the exposed walls and rocks of five different temples of Thanjavur and Thiruvarur districts of Tamil Nadu, India.

* To whom all correspondence should be addressed.
E-mail: madhu_atthi@yahoo.co.in

Table 1. Distributional pattern of Cyanobacteria in walls and rocks of different temples

S. No.	Name of the algae	Shiva Temple Thanjavur		Shiva Temple Thiruvarur		Vishnu Temple Thanjavur		Vishnu Temple Thiruvarur		Mariyamman temple Kandithampetei	
		Occurrence*	Rated scocre (%)	Occurrence*	Rated scocre (%)	Occurrence*	Rated scocre (%)	Occurrence*	Rated scocre (%)	Occurrence*	Rated scocre (%)
1.	*Chroococcus limneticus*	+	60	-	-	-	-	-	-	-	-
2.	*Lyngbya spiralis*	+++	90	+++	90	+++	90	+++	90	+++	90
3.	*L.aeruginocoerulea*	+++	90	+++	90	+++	90	+++	90	+++	90
4.	L. *cevlanica*	+	60	-	-	-	-	-	-	+++	90
5.	*Phormidium anomala*	+++	90	+++	90	+++	90	+++	90	+++	90
6.	*P. bohneri*	+	60	-	-	-	-	+	60	+	60
7.	*P. corium*	-	-	-	-	-	-	+	60	-	-
8.	*P. feveolarum*	-	-	-	-	+	60	-	-	-	-
9.	*P. fragile*	++	80	+	60	-	-	-	-	-	-
10.	*P. molle*	-	-	++	80	-	-	-	-	-	-
11.	*P. tenue*	-	-	-	-	+	60	-	-	-	-
12.	*P. subincrustatum*	-	-	-	-	+	60	-			
13.	*Gloeocapsopsis sp..*	+	60	-	-	+	60	-	-	-	-
14.	*Cylindrospermum musicola*	-	-	+	60	-	-	-	-	-	-
15.	*Nostoc microscopium*	+	60	+++	90	+++	90	+++	90	-	-
16.	*N. paludosum*	-	-	-	-	-	-	-	-	+	60
17.	*Calothrix fusca*	++	80	-	-	-	-	-	-	-	-
18.	*C. marchica*	++	80	-	-	-	-	-	-	-	-
19.	*Tolypothrix*	+	60	-	-	-	-	-	-	-	-

* = - Absent, + Very rare, ++ Dominant, +++ Common

MATERIAL AND METHODS

Samples were collected from the walls of five different temples from Thanjavur and Thiruvarur districts during the winter and summer seasons (October-March) and brought to the laboratory. Organisms were isolated with the help of brush and needle and semi permanent slides were prepared by using a preservative consisting of formalin: glycerine. For deciphering the algal component of the samples, enrichment cultures were raised in BG11 medium inoculated with 500 mg of the algal sample. They were incubated for 15 days at 29 ± 1°C and 2000 lux light intensity. The blue-green algal forms appearing in the culture flasks were categorized as dominant, very common and very rare, depending upon the visual observation on growth in the flasks and microscopical examination of 5-7 slides from each flask. The taxonomic identification was done following the keys given by Desikachary (1959) and photomicrographs of the organisms were made.

RESULTS AND DISCUSSION

Altogether nineteen species of Cyanobacteria belonged to eight genera were identified and reported for the first time from the walls and rocks of Shiva, Vishnu and Mariamman temples of Thanjavur and Thiruvarur districts of Tamil Nadu, India. Among the eight genera *Phormidium* was the predominant genus followed by *Lyngbya*.

The distribution pattern of Cyanobacteria was also categorized into very rare, dominant and common on the basis of rated score percentage. The distribution pattern of *Lyngbya spiralis*, *L. aeroginosa-coerulea* and *Phormidium anomala* on the surface of the walls and rocks of all the study temples has been categorized as common, whereas *Nostoc microscopium*, *Chroococcus linmeticus* and *Calothrix fusca* were found only on the walls and rocks of Shiva temple at Thanjavur. While *Phormidium fragile* and *Cylindrospermum muscicola* were found in Shiva temple of Thiruvarur. *Phormidium fevelaurum*, *P. tenue* and *P. subincrustatum* were found only on the surface of the rocks in Vishnu temple at Mannargudi. *Phormidium bohneri* and *P. corium* were found only on the walls and rocks of Vishnu temple at Koradacheri. *Calothrix fusca*, *C. marchica* and *Tolypothrix* were found only on the walls and rocks of Shiva temple at Thanjavur. *Nostoc paludosum* was found only in Mariyamman temple at Kandithampettai.

There are large numbers of studies on Indian algae (Desikachary, 1959; Anand and Revathi, 1987). The blue green algae have a high affinity for phosphorus and can not compete with other algae when low levels of nutrients are present (Shapiro, 1973). Moreover, these algae grow at high temperatures when the organic matter availability is high and the dissolved oxygen is low. The microbial communities developed in and on stonewall are of major concern, as they cause deterioration of the wall, which include bacteria, cyanobacteria, algae and fungi (Bravery, 1981).

Their role on the surface disfiguration has been often reported and control of these organisms as a measure of maintenance has also been emphasized (Anagnostidis *et al*., 1983). Withering pattern of the walls and rocks of the temples monuments and sculptures and the role of Cyanobacteria and algae have also been reported (Danin, 1993).

It has been established that the damaging effect on stones is produced by epi, endo and chasmolithic species of Cyanobacteria (Krumbein, 1987). The extra cellular polymeric substances (EPS) produced by these organisms cause changes in volume during drying and rewetting cycles and thus loosening the stone grains (Subbaraman, 1993). Further, excretion of acids and production of metabolic end products by certain microorganisms have been reported to cause severe corrosion of the substrate (Direcks *et al.,* 1991) and play an indirect role by supporting the growth of other organisms such as fungi and bacteria with higher corrosive potential (Dela Torre, 1991).

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