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Diversity of Non-heterocystous Cyanobacteria in Paddy Field Soil

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ABSTRACT

Paddy field soil is a natural habitat for many Cyanobacteria. Generally Heterocystous form dominate the nitrogen deficient soil. Non-heterocystous forms are also known to fix nitrogen. The diversity and the distribution of these forms vary. 20 Soil samples were serial diluted in BG-11 devoid of nitrogen supplement. Later the colonies were streaked to obtain axenic culture. The soil pH was also determined to study the effect on the diversity. The relative abundance of the BGA species was determined. Diversity of non-heterocystous form in the paddy field was found to be dominated by filamentous BGA, Lynbgya by 21%, *Oscillatoria* and *Phormidium* by 17% and colonial form *Chrococcus sp* by 12.5% Followed by *Myxosarcina sp.,* 8%, while *Aphanocapsa sp., Chlorogloea sp., Crinaluim sp.*, *Gleocapsa sp, Plectonema sp.* and *Schizothrix sp*., were 4%. A majority of the non-heterocystous BGA were found in the soil which had a pH ranging between 8.2-8.6. Diversity study of non-heterocystous BGA can help in understanding the distribution and further aid in the study of nitrogen fixation in these forms.

Key words: Cyanobacteria, Diversity, Non-heterocystous, Paddy field soil, pH.

INTRODUCTION

Cyanobacteria represent cosmopolitan prokaryotes. They forms a large group of structurally complex and ecologically significant gram negative prokaryotes which flourish in rice fields and also known to sustain the fertility of this ecosystem (Annie *et al*., 2011).The agricultural importance of Cyanobacteria in rice cultivation is directly related with their ability to fix nitrogen and other positive effects on plants and soil (Saadatnia and Riahi, 2009). The relative occurrence in the paddy fields varies from 0 to 76-85%. Although it is believed that nitrogen fixing forms are rarely present in tropical soils. In contrary many rice fields in India contain a high density of Cyanobacteria and over 50% are heterocystous filamentous forms (ThamizhSelvi and Sivakumar, 2011). All heterocystous forms of cyanobacteria fix nitrogen both under aerobic and anaerobic conditions. The ability to fix nitrogen is restricted to only 27 genera of blue-green algae.

It was earlier believed that non heterocystous form cannot fix nitrogen. However, later reports suggested that certain non-heterocystous form can fix nitrogen in aerobic condition (Burman *et al*., 1997) and are also known to be symbiotically associated. Currently strains of non-heterocystous Cyanobacteria that can fix nitrogen are about 17 genera containing over 70 strains. Most non-heterocystous form produce hydrogen at night which is industrially valuable. They are also known to contribute to the nitrogen cycle in marine ecosystem. They are on par with the heterocystous form in contributing to the nitrogen cycle. The literature on the diversity and distribution of non-heterocystous Cyanobacteria are scarce and hence this work was carried out.

MATERIALS AND METHODS

Collection of soil sample

The soil samples containing Cyanobacteria were collected from different paddy fields in and around Chennai during Oct-Jan 2015. About 20 samples were collected from different locations and utilized for enrichment studies in BG-11 medium without nitrogen supplementation.

Diversity of cyanobacteria

Enumeration of populations was carried out by MPN (Most Probable Number) technique. The BG-11 plates were regularly monitored for growth and observed microscopically. Standard plating/streaking techniques were used for isolation and purification of Cyanobacterial strains. Blue green algal identification was carried out at Centre for Advanced studies in Botany, University of Madras using the keys given by Anand (1989) and Biswal and Das (2004). The relative abundance studies of blue green algae of different genera was calculated by the following formula.

$$\text{Relative abundance} = (X/Y)\ 100$$

Where

X = number of individual Cyanobacterial isolates and Y = total number of Cyanobacterial isolates.

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Determination of soil pH

The soil samples were suspended in deionized water and stirred well until no sediments settled. The pH of the aqueous solution was determined by using a pH meter. The pH meter was calibrated with a standard buffer prior to the usage.

RESULTS AND DISCUSSION

The isolated BGA were purified and maintained as auxenic culture. About 24 strains of non-heterocystous BGA were recorded from the different soil samples collected from paddy fields. They were *Aphanocapsa biformis, Chlorgloea fritschii,*

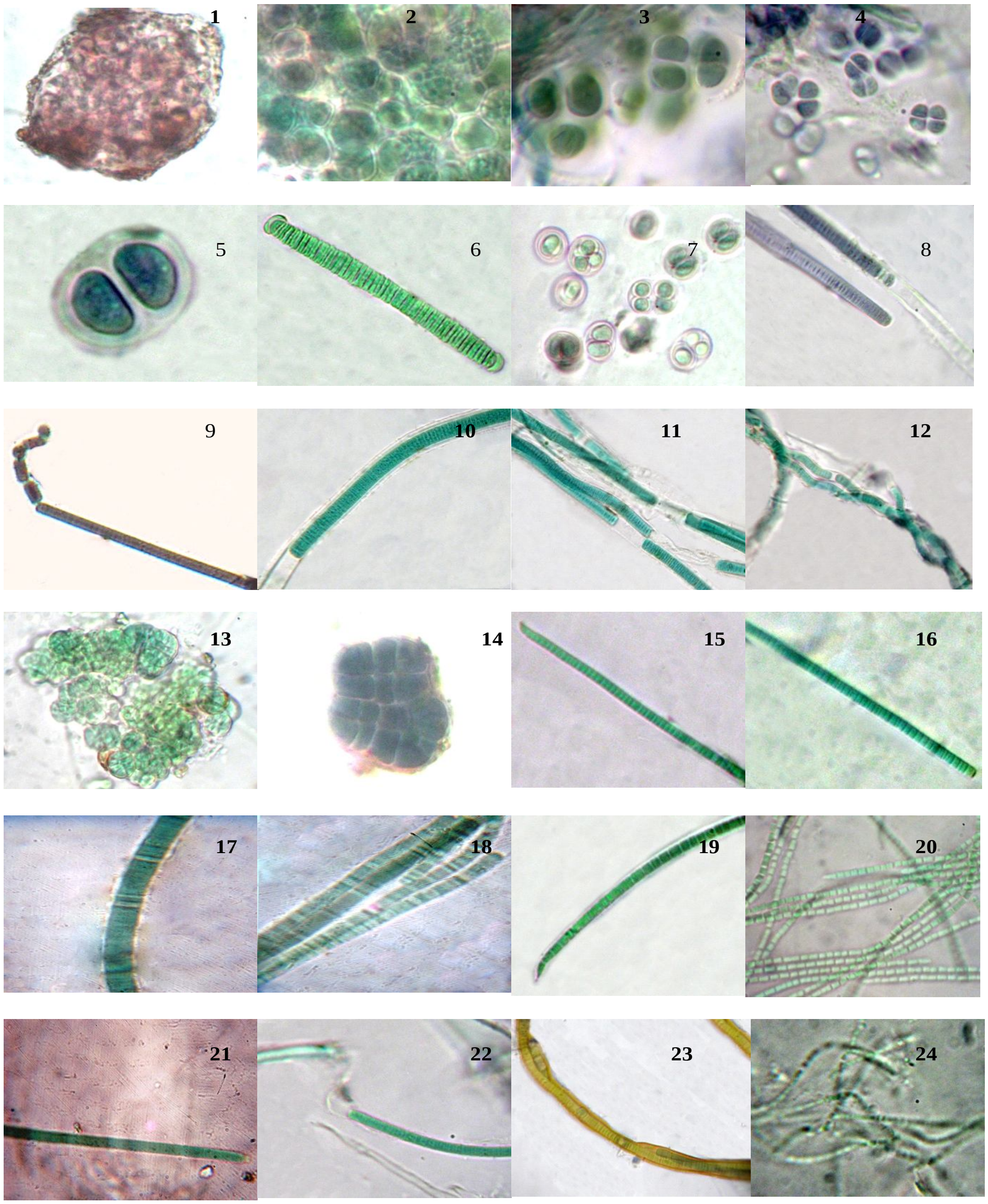

Fig 1: 1) *Aphanocapsa biformis* A.Br. 2) *Chlorogloea fritschii* Mitra 3) *Chroococcus limneticus var. carneus* (Chod). Lammerann. 4) *Chroococcus minutus* (Kutz) Nag. 5) *Chroococcus turgitus* (Kutz) Nag.6) *Crinalium magnum* Fritsch et John 7) *Gleocapsa polydermatica* Kutz. 8) *Lyngbya aestuarii* Liebm. Ex Gomont 9) *Lyngbya confervoides* C.Ag. ex Gomont 10) *Lyngbya cryptovaginata* Schkorbatow 11) *Lyngbya sp.,* Ag. 12) *Lyngbya spiralis* Weitler *13) Myxosarcina burmensis* Skuja. 14) *Myxosarcina spectabilis* Gietler 15) *Oscillatoria acuminata* Gomont 16) *Oscillatoria limosa* Ag. ex Gomont 17) *Oscillatoria sp*. Vaucher 18) *Oscillatoria subbrevis* Schimidle 19) *Phormidium ambiguum* Gomont 20) *Phormidium fragile* (Menegh.) Gomont*. 21) Phormidium sp.,* Kutz. 22) *Phormidium stagnina* Rao. G.B. 23) *Plectonema sp.,* Thuret 24) *Schizothrix sp.,* Kutz. Magnification-100X.

Chroococcus limneticus, Chroococcus minutus, Chroococcus turgidus, Crinalium magnum, Gleocapsa polydermatica, Lyngbya aestuari, Lyngbya confervoides, Lyngbya cryptovaginata, Lyngbya spiralis, Lyngbya sp., Myxosarcina spectabilis, Myxosarcina burmensis, Oscillatoria acuminata, Oscillatoria limosa, Oscillatoria sp., Oscillatoria subbrevis, Phormidium amiguum, Phormidium fragile, Phormidium sp., Phormidium stagnina, Plectonema sp., Schizothrix sp,. Among the 11 genera of BGA recorded, filamentous algae were most prevalent in distribution. The occurrence of Lynbgya was 21%, followed by *Oscillatoria* and *Phormidium* which were 17%. Among the Colonial form *Chrococcus sp* dominated 12.5%, followed by *Myxosarcina sp.,* 8%, while *Aphanocapsa sp., Chlorogloea sp.,Crinaluim sp.*, *Gleocapsa sp, Plectonema sp.* and *Schizothrix sp*., were 4%. Nayak and Prasanna (2004) reported that non-heterocystous forms exhibited 5-32% abundance. *Phormidium, Oscillatoria, Lyngbya and Aphanocapsa* were the cosmopolitan non-heterocystous cyanobacteria. Aruna and Srinivas (2016) reported non-heterocystous forms *Oscillatoria, Lyngbya, Chroococcus* and *Gleocapsa* were most abundant forms present in the soil. In the present study a similar observation was made (Fig 1).

Soil pH is known to have a selective effect on the succession and abundance of Cyanobacteria in soil. Generally several species of heterocystous form such as *Tolypothrix, Aulosira, Cylindrospermum, Scytonema, Nostoc, Anabaena* and *Westiellopsis* are widespread in Indian rice field soils and are known to contribute significantly to their fertility (Kaushik 1994). Cyanobacteria generally preferneutral to slightly alkaline pH for optimal growth (Domnic and Madhusoodanan 1999). Acidic soils do not encourage these organisms and hence they are normally absent at pH values below 4 or 5. Among the recorded 11 different genera of non-heterocystous blue green alga, all were found to occur in soil pH ranging from 7.8–9.1. *Lyngbya* sp., was observed in a wide range of soil pH from 7.8–8.6; *Crinalium magnum* was observed in soil whose pH was 9.1. By and large majority of the BGA were present in between 8.2–8.6 pH. in contrary to the reports of Nayak and Prasanna (2007) where the non-heterocystous forms isolated from soil samples with pH of 7.4 and 9.3 recorded highest % abundance. Non –heterocystous Cynobacteria were reported at pH between 6.8- 8.0 in floating, stagnant water bodies (Dey and Chakraborty, 2020) About 27 genera of Blue-green algae are known to fix nitrogen and are reported on wide range of soil both on the surface (aerobic) and below the surface of soil (anaerobic) (Upasana and Sunil, 2004). Non heterocystous form can fix nitrogen in anoxic or micro-oxic conditions and paddy fields with stagnated water provides the suitable condition. The aerotolerant forms do so at night time. Therefore, efforts need to be focused towards understanding the nitrogen fixation in these non heterocystous Cyanobacteria.

CONCLUSION

Non heterocystous Cyanobacteria contribute immensely to the plant ecosystem and the distribution and diversity of these forms play a pivotal role in the ecosystem. Further investigation of the candidature of non- heterocystous Cyanobacteria as biofertilizer may prove to be valuable to the plant environment.

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