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## RESEARCH ARTICLE

### SYSTEMATIC ACCOUNTS OF NON-HETEROCYSTOUS CYANOBACTERIA FROM PADDY FIELDS OF CUDDALORE DISTRICT OF TAMILNADU

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#### ABSTRACT

Cyanobacterial diversity occurring in some local rice fields of Cuddalore District of Tamilnadu, India has been studied. 25 taxa belonging to 10 genera were obtained and characterized are non-heterocystous, unicellular, colonial and filamentous forms. This study is aimed to describe the abundance of cyanobacteria in various rice fields of Vallampadugai and Keerapalayam areas. This paper documented total of 25 species representing 10 genera of 2 families and 2 orders. Highest abundance of cyanobacteria was found in order Nostocales which was represented by 17 species. Morphological features were described for each species systematically. The present study indicates ubiquitous distribution of cyanobacteria in rice fields and could be exploited for biofertilizer in agriculture.

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#### INTRODUCTION

Cyanobacteria (Blue-Green Algae) are one of the major components of the nitrogen fixing biomass in paddy fields. The agricultural importance of cyanobacteria in rice cultivation is directly related with their ability to fix nitrogen and other positive effects for plants and soil. They find a highly favorable residence in the waterlogged conditions of rice fields (Thamizh Selvi and Sivakumar, 2011). In addition their ecological significance, cyanobacteria are great potential tools as organisms for the biotechnological attention (Subramanian and Uma, 1996). There are no reports on the systematic enumeration of cyanobacteria from rice field of Cuddalore District of Tamilnadu. Therefore, the present work was carried out in paddy fields of Cuddalore District in Tamilnadu.

#### MATERIALS AND METHODS

##### Study area

Vallampadugai which is located 5 Km from Chidambaram towards West (11°24'N Latitude and 79°44'E Longitude) and Keerapalayam is located 4 Km from Chidambaram towards East (11°24'N Latitude and 79°44'E Longitude) Cuddalore District of Tamilnadu.

##### Collection, preservation, and identification of samples

Samples were collected in two different sites of Cuddalore District. The samplings were done randomly from both soil and water of the paddy fields. The algal samples were preserved in 4% formalin and slides were prepared by staining with methylene blue and mounted in glycerine.

Detail studies were made by examining specimens under a compound microscope with Nikon E-200 photo micrographic attachment. The strains were identified based on their morphological features and cell structure following the monograph of Desikachary (1959), Prescott (1951) and Wehr and Sheath, (2003).

#### OBSERVATIONS

Description of all the taxa is as follows:

##### *Chroococcus macrococcus* (kutz.) rabenh (Pl.1 Fig.a)

Order: *Chroococcales*

Family: *Chroococcaceae*

Desikachary 1959.P.101. Pl. 27, Figs. 3,9,10.

Thallus mucilaginous, somewhat broad, yellowish brown; cells spherical, single, 25-50 µm diameter, with sheath 30-80 µm diameter; sheath thick, colourless, lamellated.

##### *Chroococcus minor* (kützing) Nägeli (Pl.1, Fig.b)

Order: *Chroococcales*

Family: *Chroococcaceae*

Desikachary 1959, p.105, pl.24, Fig. 1.

Prescott 1951, p.449, pl.100 Fig.12.

Thallus slimy-gelatinous, dirty blue green; cells spherical, 3-4 µ in diameter, irregularly scattered, singly; sheath thin and colourless, hardly visible.

##### *Aphanothece bullosa* (Menegh.) rabenh. (Pl.1 Fig. c)

Order: *Chroococcales*

Family: *Chroococcaceae*

Desikachary 1959, p.142, pl.22, Fig.12.

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Thallus more or less spherical, irregularly lobed, up to 15cm diameter, greenish to yellow, soft; cells cylindrical, 3.5-5.  $\mu$  broad, without individual envelopes, blue green in colour.

***Aphanothece microscopica* Nag. (Pl.1, Fig. d)**

Order: *Chroococcales*

Family: *Chroococcaceae*

Desikachary 1959, P.142. Pl. 22, Figs.4,5,9.

Thallus small, gelatinous, at first rounded later amorphous, upto 2mm diameter; cells oblong cylindrical, more or less 4.5  $\mu$  broad, 1½-2 times as long as broad, with sometimes distinct, individual sheath, blue green, colourless nonocyst present.

***Arthrospira jenneri* Stizenb. Ex Gomont (Pl.1, Fig. e)**

Order: *Nostocales*

Family: *Oscillatoriaceae*

Desikachary, 1959, P.192, Pl. 35, Fig.3.

Prescott 1951, p.32, pl.108, Figs.22,23.

Trichome blue green, unconstructed at the cross walls or only very little constricted, 5-8 $\mu$ m broad, more or less regularly spirally coiled, spirals 7-13  $\mu$ m broad, distance between two spirals 31  $\mu$ m ; end cells broadly rounded and cross wall granulated.

***Spirulina meneghiniana* zanard.ex Gomont (Pl.1, Fig.f)**

Order: *Nostocales*

Family: *Oscillatoriaceae*

Desikachary 1959, p.195, pl.36, Fig.8.

Trichome 1-2 $\mu$ m broad flexible, irregularly spirally coiled, bright blue green, forming a thick blue green thallus; spirals 4-5  $\mu$ m broad and 4  $\mu$ m distant from each other.

***Merismopedia Punctata* meyen (Pl.1, Fig. g)**

Order: *Chroococcales*

Family: *Chroococcaceae*

Desikachary 1959, P. 311, Pl. 23, Fig .5 Pl.29, Fig.6.

Prescott 1951, p.67, pl.102, Fig.10.

Colonies small, 4-64 cells about 60  $\mu$ m broad; cells not closely packed, ovoid, 2.5-3.5  $\mu$ m broad, pale blue green. Groups widely separated within a broad gelatinous envelope, cell content homogenous, blue green.

***Merismopedia minima* Beck (Pl.1, Fig. h)**

Order: *Chroococcales*

Family: *Chroococcaceae*

Desikachary 1959, P. 154, Pl. 29, Fig 11.

Cells 0.5  $\mu$ m broad, pale blue green, four to many cells constitute small colonies that freely float in the water.

***Spirulina gigantea* Schmidle (Pl.1, Fig. i)**

Order: *Nostocales*

Family: *Oscillatoriaceae*

Desikachary 1959, p.197, pl.36, Figs. 12,14-17.

Trichome 3-4  $\mu$ m broad, deep blue green, regularly spirally coiled, at the end conical attenuated, spirals 11-16  $\mu$ m broad.

***Gloeocapsa Punctata* nag. (Pl.2, Fig a)**

Order: *Chroococcales*

Family: *Chroococcaceae*

Desikachary 1959, p115, pl.23, Fig. 2.

Prescott 1951, p.452, pl.101, Fig.7.

Thallus gelatinous, light blue green; cells without sheath 0.7 - 1.5  $\mu$ m diameter, with sheath 3.5-5  $\mu$ m broad, blue green; sheath thick, colourless, cells 2-4 in groups, about 25  $\mu$ m diameter.

***Arthrospira platensis* (Nordst.) Gomont (Pl.2, Fig. b)**

Order: *Nostocales*

Family: *Oscillatoriaceae*

Desikachary, 1959, P.190, Pl. 35, Fig.3.

Hehr and Sheath,2003,p139, Fig.9B(b)

Thallus blue green; Trichome slightly constricted at the cross walls, 6-8  $\mu$ m broad, not attenuated at the ends. Regularly spirally coiled; spirals 26-36  $\mu$ m broad, distance between the spirals 43-57  $\mu$ m; sheath are absent, end cells broadly rounded.

***Lyngbya aestuarii* Liebm. Ex Gomont (Pl.2, Fig.c)**

Order: *Nostocales*

Family: *Oscillatoriaceae*

Desikachary 1959, P. 305, Pl. 52, Fig 8.

Prescott 1951, p.499, pl. 111, Figs. 8.

Filaments single or forming a brown or dull blue green thallus, nearly straight or coiled, sometimes with calcium incrustations; sheath at first thin later thick, yellow brown, lamellated; cells 8-24  $\mu$ m, ordinarily 10-16  $\mu$ m broad, 1/3-1/6 times broad, 2.7-5.6  $\mu$  long, not constricted at the cross walls, cross walls often granulated, contents with gas vacuoles; end cells flat with thickened membrane, slightly attenuated.

***Synechococcus aeruginosus* Nag (Pl.2, Fig.d)**

Order: *Chroococcales*

Family: *Chroococcaceae*

Desikachary 1959, p 143, pl.25, Fig.6,12.

Prescott 1951, p.461, pl.102, Figs.6-8.

Cells cylindrical, 5-16 $\mu$ m broad, up to 30 $\mu$ m long, single, or 2-4 together, pale blue green.

***Lyngbya martensiana* Menegh.ex Gomont (Pl.2, Fig. e)**

Order: *Nostocales*

Family: *Oscillatoriaceae*

Desikachary 1959, P. 318, Pl. 52, Fig. 6.

Thallus caespitose, blue green, when dried violet, filament long, flexible; sheath colourless, thick, trichome 6-10  $\mu$ m broad, not constricted at the cross walls, cross wall granulated, apices not attenuated, pale blue green; cells ½-¼ times as long as broad, 1.75-3.3  $\mu$ m in length; end cell without calyptra.

***Oscillatoria curviceps* Ag. ex Gomont (Pl.2, Fig. f)**

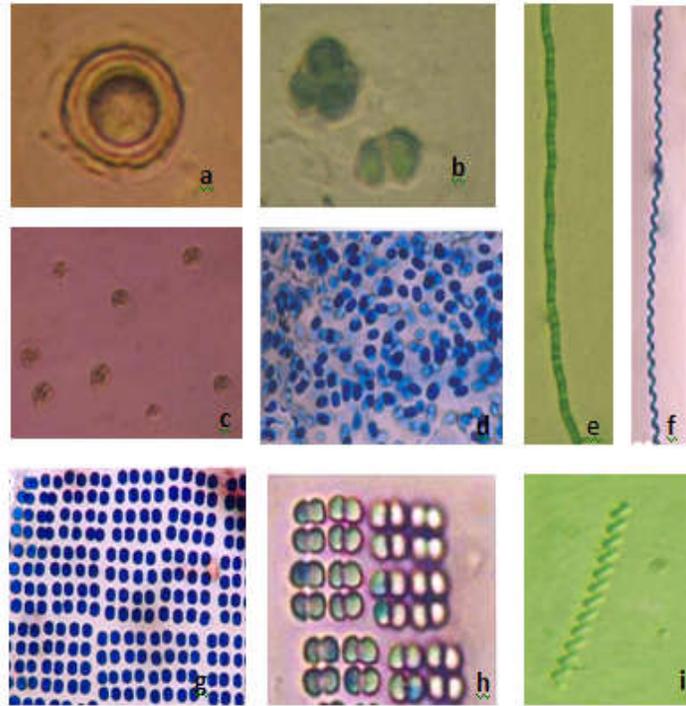
Order: *Nostocales*,

Family: *Oscillatoriaceae*

Desikachary, 1959, P.209, Pl.38, Fig.2.

Prescott, 1951, P. 487, Pl. 108, Fig. 17,18.

Thallus light blue-green; trichomes more or less straight, bent at the end, not attenuated, not constricted at the cross-walls, 10-17  $\mu$ m broad, 2-5  $\mu$  long, cross-walls granulated; end-cells flat rounded, not capitate.



Figs. a-e 100  $\mu$ m

Plate 1: Fig. a. *Chroococcus macrococcus* (kutz.) rabenh, b. *Chroococcus minor* (kützing) Nägeli, c. *Aphanothece bullosa* (Menegh.) rabenh, d. *Aphanothece microscopica* Nag., e. *Arthrospira jenneri* Stizenb. Ex Gomont , f. *Spirulina meneghiniana* zanard.ex Gomont, g. *Merismopedia Punctata* meyen, h. *Merismopedia minima* Bec, i. *Spirulina gigantea* Schmidle



Figs. b,c,e,f,g & h 200  $\mu$ m; Figs. a & d 100  $\mu$ m

Plate 2. Fig. a. *Gloeocapsa Punctata* nag, b. *Arthrospira platensis* (Nordst.) Gomont, c. *Lyngbya aestuarii* Liebm. Ex Gomont, d. *Synchaococcus aeruginosus* Nag, e. *Lyngbya martensiana* Menegh ex, f. *Oscillatoria curvicans* Ag. ex

***Spirulina major* kuetzing (Pl.2, Fig. g)**Order: *Nostocales*Family: *Oscillatoriaceae*

Desikachary, 1959, P.196, Pl. 36, Fig.13.

Prescott 1951, p.480, pl.108, Fig. 12.

Trichomes loosely spiraled, scattered among other algae, blue green mass; trichome 1.2-1.7  $\mu\text{m}$  in diameter, spiral 2.5-4  $\mu\text{m}$  wide; distance between spirals 2.7-5  $\mu\text{m}$ .***Lyngbya versicolor* (Wartm.) Gom (Pl.2, Fig. h)**Order: *Nostocales*Family: *Oscillatoriaceae*

Desikachary 1959, P.311, Pl. 53, Fig.6.

Prescott 1951, p.504, pl. 113, Fig.4.

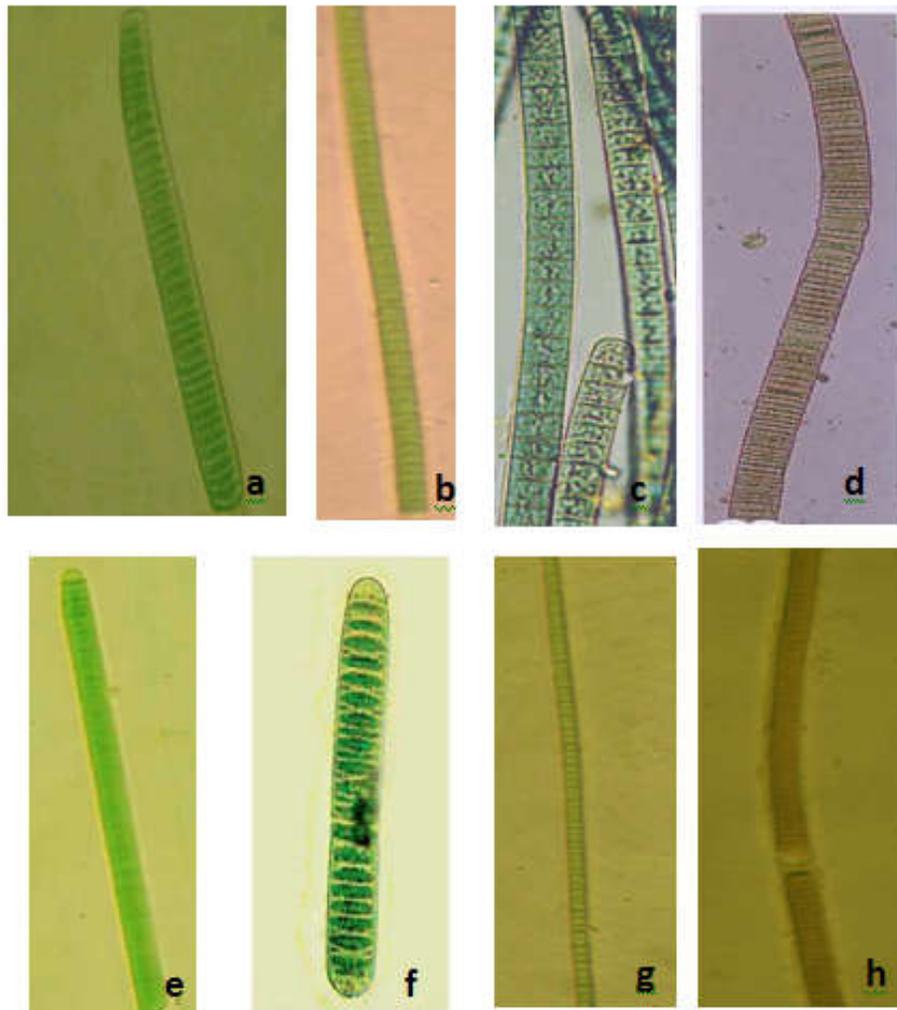
Thallus at first adherent, later free floating, lubricous, somewhat soft, rusty on the outside and inside olive green; filaments long, tortuous, closely entangled; sheath colourless, slightly mucilaginous, upto 2  $\mu\text{m}$  thick, trichomes not constricted at the cross walls, 2.8-3.2  $\mu\text{m}$  broad, apices not attenuated, not capitates, cross walls not granulated; cells blue green, 2-6.4  $\mu\text{m}$  long, end cells rounded, calyptra absent.***Oscillatoria princeps* Vaucher ex Gomont (Pl.3, Fig. a)**Order: *Nostocales*,Family: *Oscillatoriaceae*

Desikachary, 1959, p.210, Pl.37, Figs. 1, 10, 11, 13, 14.

Prescott 1951, p.190, pl.110, Fig.1.

Trichomes blue-green, not constricted at the cross-walls, 16-60  $\mu\text{m}$  broad, blue-green to dirty green, slightly attenuated at the apices and bent; trichome 27-32.5  $\mu\text{m}$  broad, tip 20-75  $\mu\text{m}$ ; end-cells flatly rounded, with slightly thickened membrane.***Oscillatoria pseudogeminata* G. Schmid (Pl.3, Fig. b)**Order: *Nostocales*Family: *Oscillatoriaceae*

Desikachary, 1959, p.228, Pl.41, Fig. 10.

Thallus pale blue-green, ends not attenuated, 1.3-2.2  $\mu\text{m}$  broad; cells as long as broad, about 2.6  $\mu\text{m}$  long, not constricted at the cross-walls, cross-wall thick, not granulated, end cell rounded, calyptra absent.Figs. a-h: 100 $\mu\text{m}$ 

**Plate 3:** Fig.a. *Oscillatoria princeps* Vaucher ex Gomont, b. *Oscillatoria pseudogeminata* G. Schmid, c. *Phormidium pachydermaticum* Frey, d. *Oscillatoria margaritifera* (kutz.) Gomont. e. *Oscillatoria vizagapatensis* Rao, C.B., f. *Oscillatoria tenuis* Ag. ex Gomont, g. *Oscillatoria laetevirens* (Grouan) Gomont, h. *Phormidium papyraceum* (Ag.) Gomont

***Phormidium pachydermaticum* Fremy (Pl.3, Fig. c)**Order: *Nostocales*Family: *Oscillatoriaceae*

Desikachary, 1959, P.267, Pl. 43, Figs. 8-10.

Thallus outer surface dull blue green, inside brown; filaments 6-9  $\mu\text{m}$  broad, straight or undulating; sheath at first thin, later thick, irregularly lamellated, lamellae short, irregularly disposed, trichome blue green, 6-7.5  $\mu\text{m}$  broad, not constricted at the cross walls, cells 5.7  $\mu\text{m}$  in length; end cells slightly obtuse conical, with slightly thickened outer membrane.

***Oscillatoria margaritifera* (kutz.) Gomont. (Pl.3, Fig. d)**Order: *Nostocales*,Family: *Oscillatoriaceae*

Desikachary, 1959, P.202, Pl.42, Fig.8.

Trichome olive green, 20-32  $\mu\text{m}$  broad, constricted at the cross walls, cells 19-30  $\mu\text{m}$  broad and 5-8  $\mu\text{m}$  long, cross walls granulated, end cells capitates with slightly convex calyptra.

***Oscillatoria vizagapatensis* Rao, C.B. (Pl.3 Fig e)**Order: *Nostocales*Family: *Oscillatoriaceae*

Desikachary, 1959, p.205, Pl.39, Figs.16, 18.

Thallus blue-green; trichomes straight, pale blue-green, uniformly broad except at the extreme apex, 8-10  $\mu\text{m}$  broad, without constrictions at the cross-walls; cells much shorter than broad, 1.6 - 2.0  $\mu\text{m}$ . long, contents granular; end cell broadly rounded forming a cap with a slightly thickened outer wall.

***Oscillatoria tenuis* Ag. ex Gomont. (Pl.3, Fig. f)**Order: *Nostocales*Family: *Oscillatoriaceae*

Desikachary 1959, P. 222, Pl. 42, Fig.15.

Prescott 1951, p.221, pl. 110, Figs. 10, 11.

Thallus thin blue green, slimy; trichome straight, fragile slightly constricted at the cross walls, 4-10  $\mu\text{m}$  broad, not attenuated at the apices, not capitates; cells up to 1/3 broad, 2.6-5  $\mu\text{m}$  long, apex convex, end cells more or less hemispherical with thickened outer membrane.

***Oscillatoria laetevirens* (Grouan) Gomont. (Pl.3, Fig. g)**Order: *Nostocales*Family: *Oscillatoriaceae*

Desikachary, 1959, P.213, Pl.39, Fig.2,3.

Thallus thin, membranous, green; trichome yellowish green, straight, slightly constricted at the cross walls, 3-5  $\mu\text{m}$  broad, apices attenuated, bent; cells nearly as long as broad, 2.5-5  $\mu\text{m}$  long, more or less conical, end cells not capitates, without calyptra.

***Phormidium papyraceum* (Ag.) Gomont (Pl.3, Fig. h)**Order: *Nostocales*Family: *Oscillatoriaceae*

Desikachary, 1959, P.271, Pl. 35, Fig.3.

Thallus dark green, listening, expanding, thin, leathery, when dry fragile; filaments elongate, very flexuous, densely entangled; sheath thin, papery, persistent, coloured violet by

chloro-zic-iodide; trichomes blue green, not constricted at the cross walls, 3-5  $\mu\text{m}$  broad, ends straight, briefly attenuated not capitates; cells subquadrate or mostly shorter than broad, 2-4  $\mu\text{m}$  long; cross walls conspicuous, not granulated, end cell obtuse conical, calyptra absent.

**DISCUSSION**

In the present study rich diversity of non heterocystous cyanobacteria was recorded from rice fields of Cuddalore District. Twenty five species, represented with 10 genera comes under two order and two families have been reported from this area. Genus *Oscillatoria* occur dominant followed by *spirulina* and *lyngbya* in both the areas. Genus *Gloeocapsa* are in rare form. The occurrence of cyanobacteria in the rice fields may be attributable to favourable environment with respect to their requirement which is in confirmation with the earlier finding (Konda and Yasuda 2003). The present study shows predominance of non-heterocystous forms of cyanobacteria distributed in paddy fields of Vallampadugai and Keerapalayam. The distribution of these cyanobacteria forms might be indicating the lower nitrogen status in rice fields. Nayak and Prasanna (2007) recorded more heterocystous forms while studying cyanobacterial abundance and diversity in rice field soils of India. Choudhary (2009) observed that the enumeration of cyanobacteria revealed the maximum diversity during the mid cultivation cycle of the rice fields. Agawin *et al.*, (2007) reported that the documentation on cyanobacteria may enhance the understanding of the nutrient status of the field and might be applied for sustainable agricultural practices by reducing the application of chemical fertilizer to avoid the appearance of non-nitrogen fixers in the soil that might compete with nitrogen fixers for nutrients. In conclusion, the present study documented a remarkable biodiversity of cyanobacteria. The abundance of non-heterocystous forms indicates suitable environmental conditions for their growth which could be explored through future perception.

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