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Biodiversity of cyanobacteria from paddy fields soils of Bhuvanagiri and Srimushnam Taluk, Cuddalore district, Tamil Nadu, India

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Abstract
Blue Green Algae which are also called as cyanobacteria are one of the most important nitrogen fixing photoautotrophs present on the eart`h since 3.5 billion years. They are known to be found in almost all photic habitats including water bodies, glaciers as well as all terrestrial ecosystems. Paddy fields represent one such habitat. Because of their autotrophic and diazotrophic nature they flourish in rice fields and known to sustain the fertility of this ecosystem. They very in their morphology. Some of them are unicellular while some are multicellular filamentous. An attempt has been made to document cyanobacteria from rice fields of Bhuvanagiri and Srimushnam Taluk, Cuddalore District, Tamilnadu, India. As many as 18 species of cyanobacteria were recorded from the study area. Order has been reported by nine of genera and 18 species. The genera Aphanocapsa, Aphanothece and Gloeocapsa were frequently reported.

Keywords: biodiversity, cyanobacteria, soils, rice fields of Bhuvanagiri and Srimushnam Taluk

Introduction

The Blue Green Algae are unicellular or filamentous that sometimes form structures recognizable with naked eye, but usually requires a microscope for identification, they differ from other groups in this flora in that they are prokaryotes. Their cell contents are not differentiated in to membrane bound structures such as the nucleus, chloroplast, and mitochondria. The popular name for the group Blue Green Algae comes from the color of the cells seen under the microscope. The pigments in their cells like chlorophyll-a, phycocyanin, phycoerythrin express their colour (Kondo and Yasuda 2003).

This is because many species have a sheath around individual cells or the whole filament and this sheath is often golden or dark brown, though sometimes a shade of red. The capacity of several cyanobacteria to fix the atmospheric nitrogen is a significant biological process of economic importance (Anand 1989) [1]. These prokaryotic organisms are capable of fixing nitrogen. Cyanobacteria play an important role in maintenance and build-up of soil fertility (Board 2004) [2], consequently increasing rice growth and act as a natural bio fertilizer (Song *et al*. 2005).

The paddy field ecosystem provides a favorable environment for the growth of cyanobacteria with respect to their requirements for light, water, high temperature and nutrient availability. This could be the reason for more abundant cyanobacteria growth in paddy soils than in uplands soils (Konda and Yasuda 2003, Roger and Reynaud 1982) [21]. Information on the diversity of blue greens is essential to understand the algal dynamics and interaction with other microorganisms. Studies on Cyanobacteria have gained much importance especially after the recognition of their role in the natural environment and their ability to provide an alternate source of energy (Uheda 1980) [25].

The aim of the present work is to identify the cyanobacteria enriched in the paddy fields of chosen area. Observations revealed that most of them were from the orders Nostocales, and Stigonematals (Fritsch 1907 A, B).

Rice is one of the food as well as cash crops of the Indian subcontinent. The rice sharing the 11 percent cropped land of the Bhuvanagiri and Srimushnam Taluk, cuddalore district, Tamilnadu, India. Out of the total rice crop area maximum area under rice cultivation is in Patan tahasil which occupies the 33 percent and Phaltan occupies the lowest area of the cropping area of the rice of the district (Khot 2016).

Materials and Methods

Phytoplankton studies

A 6.5 cm acrylic plastic core (1.5 cm diameter) with both ends open was gently pressed into the sediment. The top 1.0 cm of the sediment core was retained. From this core, 2 g of sample was taken and the plankton were separated by shaking with 25 ml water collected from the sampling stations. After setting of the heavier particles the supernatants from repeated shakings containing all the phytoplankton were pooled and centrifuged for 15 min at 800 rpm. The sample was preserved in 5% neutralized formalin and Lugol's iodine solution used for qualitative/quantitative analysis.

The preserved sample for further analysis is again centrifuged. To this pellet, 3 to 5 ml of concentrated nitric acid and a pinch of crystalline potassium dichromate were added and transferred to the boiling tube containing 10-15 ml of concentrated nitric acid. The boiling tube was then placed on a water bath at 60° for 15 min. The acid cleaned phytoplankton were repeatedly washed free of acid with

distilled water and finally made up to a volume of 2 ml with distilled water.

Fig 1

Materials Preparation for Light Microscopic Studies

Blue green algae were removed from this substratum using sharp blades, epiphytic algae were collected with their hosts and shells of snails were scrapped to collect episodic algae. To collect cyanobacterial one liter of water was collected from its locality, to which was added lugol's iodine (to get the final concentration of 1%) and left undisturbed for 24 hours. The latter was prepared by mixing 5 ml of formalin, 10 ml of glycerine is 85 ml of distilled water. Macroscopic and microscopic forms of algae brought to the laboratory were preserved in 4% formalin all the samples were given serial number and deposited in the Laboratory of Botany, Department of Botany, Government Arts collage Chidambaram, Tamil Nadu.

Algal samples were examined immediately after collection whenever possible. Other samples were examined after some time. Cyanobacteria that had lost their colour due to preservation were examined after staining with cotton blue in lacto-phenol and other suitable stains, samples were examined using calibrated student research microscope and measurements were taken. Photomicrographs were taken using Nikon, automatic photo-micrographic unit. Phytoplankton was identified by the workers of Desikachary (1959) [4]; Prescott (1964); Anand (1998) [1] and Cox (1996). Species diversity index (H′) was calculated using Shannon and Weiner's (SR) was calculated as described by Simpson index (Simpson, 1949).

Study Area

The study area Station I: Nalanthethu 11.47°N 79.63°E) which is selected for the present investigation were located in the Bhuvanagiri Taluk and Station II Srineduchery: 11° 45′ 0″ Latitude N and 79° 45′ 0″ Longitude) which is located in Srimushnam Taluk Cuddalore District of Tamilnadu, India. Station I: Nalanthathu is a small Village/hamlet in Melbhuvanagiri Block in Cuddalore District of Tamil Nadu State, India. It comes under Azhichikudi Panchayath. It is located 45 KM towards South from District headquarters Cuddalore. 4 KM from Melbhuvanagiri. 227 KM from State capital Chennai. Azhichikudi is a small Village/ hamlet in Melbhuvanagiri Block in Cuddalore District of Tamil Nadu State, India.

It comes under Azhichikudi Panchayath. It is located 45 KM towards South from District headquarters Cuddalore.4 KM from Melbhuvanagiri. 227 KM from State capital Chennai. Bhuvanagiri is a Taluk in the Cuddalore District of the Indian state of Tamilnadu. It is the birthplace of a South Indian saint, SriRaghavendra Swami and is close to Maruthur, the birthplace of Saint Ramalinga Adigalar. Bhuvanagiri is located at 11.47°N 79.63°E. It has an average elevation of 11 meters (36 feet). It is located seven kilometers (4.35 miles) away from the temple town, Chidambaram. The River Vellaaru (a tributary of River Cauvery) is the main source of water for irrigation and other purposes. A road bridge over the River Vellaaru in Bhuvanagiri, which connects the roadway between Cuddalore and Chidambaram, is quite prominent.

The study area Station II: Srineduchery is a Village in Srimushnam Taluk in Cuddalore District of Tamil Nadu State, India. It is located 59 KM towards South from District headquarters Cuddalore. 05 KM from Srimushnam 238 KM from State capital Chennai. Srineduchery is surrounded by Kammapuram Block towards North, Andimadam Block towards west, Kattumannarkoil Block towards South, Melbhuvanagiri Block towards East. Neyveli, Viruddhachalam, Chidambaram, Sirkali are the nearby Cities to Srineduchery. The River Vellaaru (a tributary of River Cauvery) is the main source of water for irrigation and other purposes in Srimushnam Taluk. This Place is in the border of the Cuddalore District and Nagapattinam District. Nagapattinam District Sirkazhi is east towards this place.

Collection and storage of soil samples

Soil samples were collected from the ten different sites within the Bhuvanagiri and Srimushnam Taluk, Cuddalore District, Tamilnadu, Samples were collected by removing the surface debris from randomly selected spots and scrapping about 20 gm of soil from upper 1 cm soil layers. After thorough mixing, these were air-dried (25-350 C; relative humidity 30-60%), sieved and 200 gm. of sample, representing each spot were stored in poly bags for further observation. The soil samples from different parts of the paddy fields were also collected by lifting the soil-algal biomass floating in and on water during crop season.

Algae growing on soil surface were also carefully scrapped with a scalpel, from an area of few cm2 in each sampling. The samples were preserved in 4% Formaldehyde and Lugol's iodine solution. All the samples were deposited in laboratory. Algal samples were then examined immediately using binocular research microscope whenever possible. Identification was done by using keys and monographs (Desikachary1959 and Anand 1989) [4, 1]. Microphotographs were taken using webcam companion unit.

Frequency distribution of different genera in the study area was calculated by using formula:

B/A x 100

Where A= Total number of samples collected

B= Number of samples in which species was present.

Results and Discussions

Bhuvanagiri and Srimushnam Taluk, Cuddalore District is one of the important rice producing districts from Tamilnadu. Rice fields serves as a natural habitat for different types of cyanobacteria. An extensive study made to find out the diversity and occurrence of cyanobacterial population in different study sites of Bhuvanagiri and Srimushnam Taluk, Cuddalore District, Tamilnadu, India.

Total of 18 species of cyanobacteria belonging family of order were recorded from different localities within study area as shown in Table 1 (Plate I and Plate II)

As per the percentage frequency of cyanobacteria, the members of genus Aphanothece, Aphanocapsa and Gleocapsa were most abundant forms (Desikachary 1959) [4]. Our observations are similar to the reports of Srinivas and Aruna (2016) [23].

Table 1: List of cyanobacterial taxa recorded from study area

S. No.	Name of Cyanobacterium	Locality	No. of times encounter	Frequency %
1	*Microcystis aeruginosa* (Kutzing) Kutzing	Azhichikudi, Naalanththu, Vandurayanpattu	25	50
2	*Gleocapsa punctata* Nageli,	Udaiyur sitheri	7	14
3	*Gleothece rupestris* (Lyngb) Bornet	Srineducheri Koodalaiyathur, kavalakkudi	20	40
4	*Aphanothece conferta* Richter	Azhichikudi, Naalanththu	13	26
5	*Chroococcus turgidus* (Kutzing) Nageli, (Kutz)	Srineducheri Koodalaiyathur, Kavalakkudi kanur	40	80
6	*Chroococcus limneticus* Lemmermann	Azhichikudi, Naalanththu	15	30
7	*Chroococcus minutus* (Kutz.) Nageli	Srineducheri Koodalaiyathur	13	26
8	*Chroococcus minor*	kavalakkudi	8	16
9	*Spirulina laxissima* G.S.West	kanur Koodalaiyathur,	14	28
10	*Synechocystis aquatilis* Sauv	Srineducheri Koodalaiyathur, Kavalakkudi	18	36
11	*Aphanocapsa crassa* Ghose	Azhichikudi, Naalanththu, Vandurayanpattu	9	18
12	*Merismopedia punctata* Meyen	Koodalaiyathur, Kavalakkudi	3	6
13	*Merismopedia glauca* (Ehrenb.) Nag	Srineducheri,	13	26
14	*Nostoc punctiforme* (Kuz.) Hariot	Azhichikudi, Naalanththu	15	30
15	*Nostoc padulosum* Kutzing ex Born.et Flah	Kanur, Kavalakkudi	7	14
16	*Nostoc linckia* (Roth) Bornet ex Born.Flah	Srineducheri Koodalaiyathur,	10	20
17	*Nostoc spongiaeforme* Agardh ex Born.et Flah	Azhichikudi, Naalanththu	5	10
18	*Nostoc carneum* Ag.ex Born.et Flah	Srineducheri Koodalaiyathur, Kavalakudi	5	10

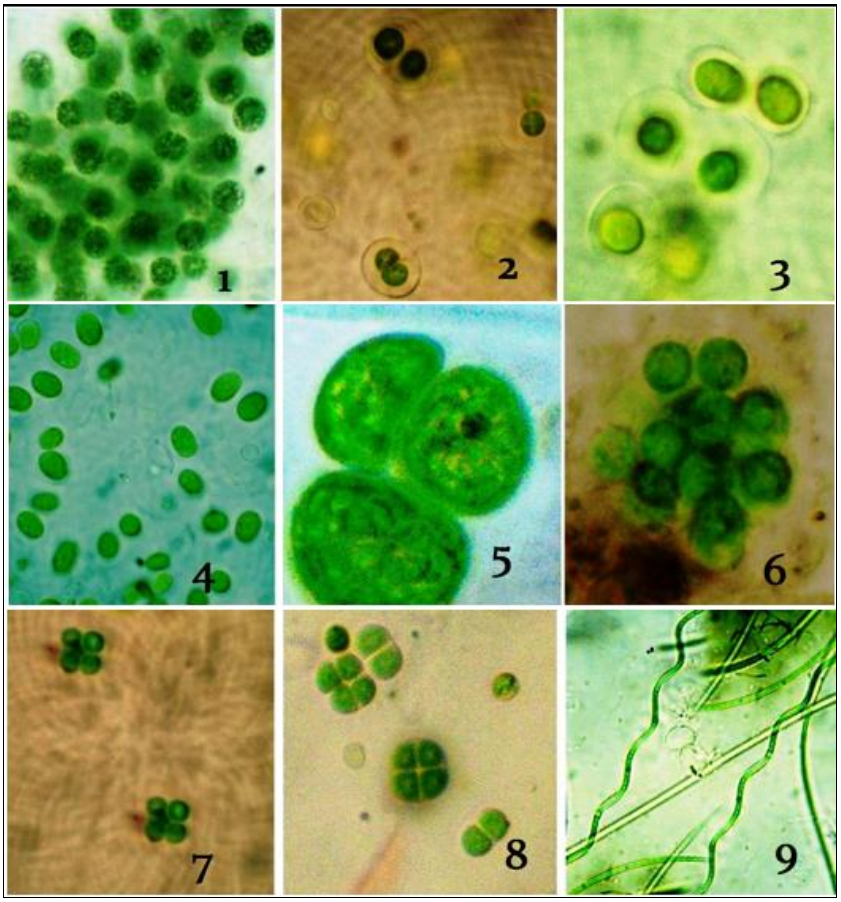

Plate 1: 1. *Microcystis aeruginosa* (Kutzing) Kutzing, 2. *Gleocapsa punctata* Nageli, 3. *Gleothece rupestris* (Lyngb) Bornet, 4. *Aphanothece conferta* Richter, 5. *Chroococcus turgidus* (Kutzing) Nageli, (Kutz) 6. *Chroococcus limneticus* Lemmermann, 7. *Chroococcus minutus* (Kutz.) Nageli, 8. *Chroococcus minor*, 9. *Spirulina laxissima* G.S.West

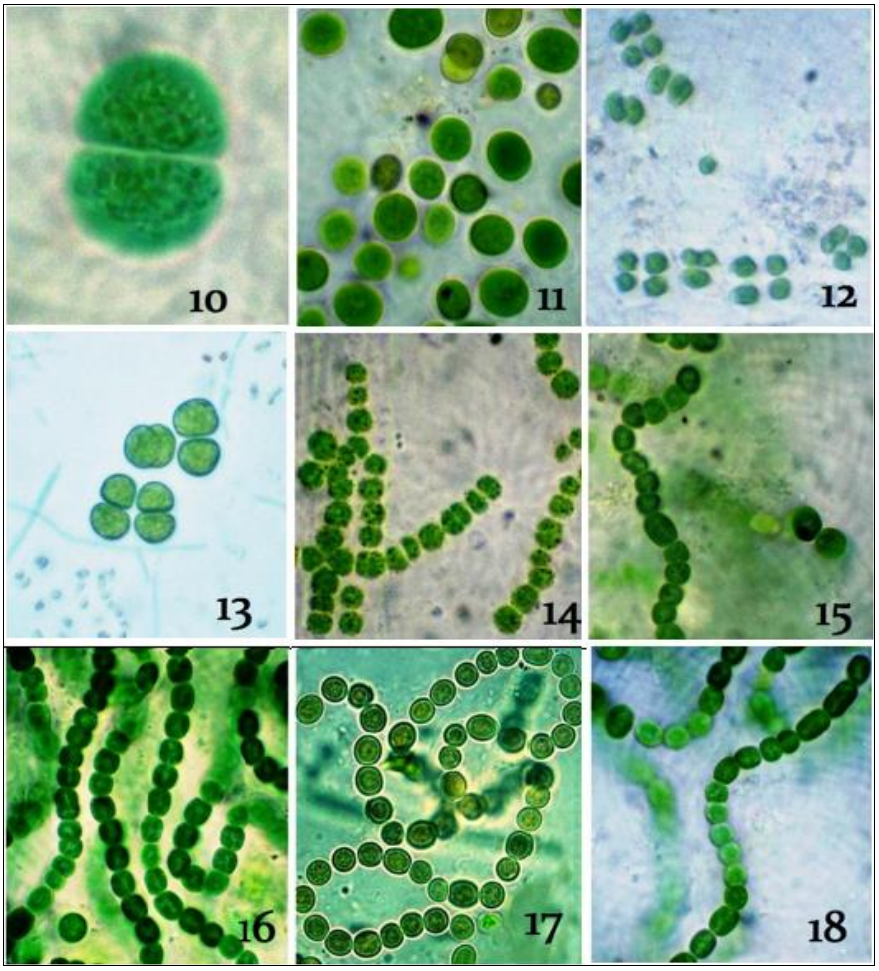

Plate 2: 10. *Synechocystis aquatilis* Sauv, 11. *Aphanocapsa crassa* Ghose, 12. *Merismopedia punctata* Meyen 13. *Merismopedia glauca* (Ehrenb.) Nag, 14. *Nostoc punctiforme* (Kuz.) Hariot, 15. *Nostoc padulosum* Kutzing ex Born.et Flah, 16. *Nostoc linckia* (Roth) Bornet ex Born. Flah, 17. *Nostoc spongiaeforme* Agardh ex Born.et Flah, 18. *Nostoc carneum* Ag.ex Born.et Flah

Conclusion

From the present study, it could be concluded that rice field soil harbors the impressive cyanobacterial diversity in different sites within study area. Further studies are necessary for culturing and biochemical characterization of these species.

As rice is cultivation widely in the studied region, emphasis can be given for the association of mineral and nitrogen supplemental with the nitrogen fixing cyanobacteria for increasing the agricultural yield of the region. This paper highlights the importance of morphological characterization and identification of the cyanobacterial strains for their application in the rice fields for management of nitrogen fertilizer can be used for sustainable agricultural practices.

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