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Studies on ecological non-heterocrystous nitrogen fixing filamentous Cyanoprocaryota of specific Gangetic zone in West Bengal

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Abstract

In the present communication, the studies on ecological diversity of non heterocystous nitrogen fixing filamentous Cyanoprocaryorota (BGA) in different rice growing and other fields of specific Gangetic zone in West Bengal has been under taken. Several perennial lentic and lotic water bodies are found in relation to seasonal variation in the area however, the algal species occurring there has not yet been surveyed in this manner. A total of 226 algal taxa belonging to Cyanoprocaryorota under the order Nostocales, in which 69 species and 33 variety and forma are in rice fields areas and out of 124 taxa in which 90 species and 34 variety and forma are in all habitats. The increasing range of soil pH was the important factor for the development of BGA more up to certain limits. Comparatively very common and maximum number of non heterocystous nitrogen fixing filamentous genera is Oscillatoria Vaucher, *Phormidium* Kuetzing, *Lyngbya* Agardh, *Arthospira* Stizenberger and minimum forms are Schizothrix Kuetzing and *Spirulina* Turpin em. Gardner developed in August to September in different rice growing areas and September to October in all habitats. When water level was minimum and normal i.e. 9 cm or more, starting the crop season the rice growing fields developed mainly filamentous forms and colonial forms developed after 10 to 15 days.

Keywords: Cyanoprocaryorota, ecology, filamentous, non-heterocystous.

Introduction

Cyanoprocaryorota (BGA) or Cyanobacteria are gram negative prokaryotic organisms. They are largest oxygen donor amongst plants, Proterozoic oil deposits are due to the activity of Cyanobacteria. They are also nitrogen fixing potential of diazotrophic microorganism, which is of great significance for enriching of nitrogen level in soil. They are aquatic and photosynthetic live in the water and can manufacture their own food. Cyanobacteria exhibit a great morphological diversity and their broad spectrum of physiological properties reflects their widespread distribution and tolerance to environmental stress (Tandeau de Marsac and Howard, 1993). Zhang (2010) and Halder (2015) observed some problem for the cyanobacterial distribution and its peculiarity to proper identification. They are relatives of

the bacteria, not eukaryotes and it is only the chloroplast in eukaryotic algae to which the cyanobacteria are related depending upon the species, cyanobacteria can occur as a single filament or colonies. Algal diversity is considered at themselves of richness of species and higher taxonomic ranks and as the variety of habitats algae dominate and their functional importance in processes they mediate. Some of the non heterocystous nitrogen fixing filamentous BGA of the family Oscillatoriaceae is not known to be pathogenic but some of its species are secreting an anatoxins and mycrocystins. Anatoxins, interfere with the neuron signaling and mycrocystins, cause liver bleeding (Behere and Deore, 2005). Except this, the cyanobacterial biofertilizer technology is well proven but still it is facing problem of availability of proper identification. Therefore, it is very essential to intensive observations and studied the filamentous non heterocystous groups undertake extensive survey to rice fields to explore the unexplored flora especially nitrogen fixing and medicinally valued species along with ecology and physiochemical properties of different rice growing areas and all other fields.

Materials and Methods

This study is based on different rice growing areas of tank, ponds, jheels, etc. and all other fields, laboratory worked on literature survey, valuable data based on identification, distribution pattern and on field observation. All the species collected during the field work were processed for the following work. Cyanobacteria samples along with soil and water were collected from major rice growing and non-rice growing places of different districts in Gangetic Alluvial Zone of West Bengal. During the collection, prominently visible growths of blue green algae were collected in plastic and polythene containers for direct observation with the help of Motic Trino-oculer microscope imaging system and the heterogeneous suspension was diluted with the liquid culture BG11 Medium (Stanier et al., 1971). Field and macroscopic photographs of algal strains are taken by using a Digital cameraIn the beginning the following culture media i.e., Bold's Basal Medium (Bischoff and Bold 1963), Chu No 10 (CHU 1942) and BG11 Medium (Stanier et al., 1972) have been used. Among these, BG11 medium supported the better growth of the cultures. The final pH was adjusted at 7.5. During the study, all the experiments performed in BG11 medium (liquid and solid, with or without Nitrate nitrogen) and strains were maintained in stock cultures in this medium with in sterile soils and incubated for 25-30 days at 30^0C ± 2 and 4000-5000 Lux light intensity under 14/10 LD cycle. All the isolated strains of cyanobacteria are being maintained in culture collection in the Department of Botany, Uluberia College (University of Calcutta), Howrah, West Bengal, Pin –711315.The available soil temperature, conductivity and pH were determined by using soil thermometer, conductivity meter and digital pH meter respectively.

The identification of the selected isolates for morphological studies have been made using standard monographs of Geitler, 1932; Desikachary, 1959; Komarek and Anagnostidis, 2005, Komárek (1988 & 2013), N. Anand (1989) and our present observations. Creation of Semi-permanent and permanent slides were prepared by using glycerin-gel technique for further observation.

Results and Discussion

West Bengal is one of the most important parts of the Eastern India. It is located between 20°31' and 29°14' N latitude and 84°59' E longitude. Inthis state three important rice growing zone have chains of

rivers, i.e., the Ganga, Padma, Mahanandi and Mahananda mostly under Indo Gangetic basins which are intersected with so many Canals, beels, Jheels, low-lying areas and also some tributaries. Generally these have developed a semi-saucer and saucer-shaped wetland ecosystem bounded by different short and long villages and lands, which are mostly waterlogged during the year, either permanently, semi permanently or temporarily. This condition depends upon the topographical and geomorphological situation of the textural and land class of the soil condition.

On the vivid pattern of soil type and topographical situation of land, out of six zones, Gangetic - Alluvial Zone is one of the best zone for the growth and development of BGA due to its soil class and weather variability, temperature, rainfall, humid to semi-arid situation, varied from highly fertile to degraded land situation. During the surveyed Kharif crop season i.e., July to October and Rabi crop season i.e., November to June in rice cropping seasons studied the physico-chemical characters in different rice growing localities showed that the character of soil color mostly bright grayish to blackish. Types ofsoil was sandy to loamy and clayey. Average temperature was in summer at23^{0}C to 43.7 ± 2^{0}C. But minimum were in December to January i.e., 6.5 to 29.5 ± 1^{0}C; the range of pH were from 5.35 to 9.5 ± 0.50 in Kharif crop season i.e., July to October and November to July i.e., in Rabi crop season.

Discussion and Conclusion

During surveyed microscopic observations in all together 226 algal samples were collected from the various localities of diverse habitats from the different rice growing and all other habitats of Gangetic Zones in West Bengal. There were upland irrigated fields, low land rice fields and usar land areas. Total 226 taxa under the order Nostocales under the family Oscillatoriaceae of non heterocystous nitrogen fixing filamentous Cyanoprocaryorota (BGA) were collected, from which 124 taxa in all types of habitats and 102species were present in rice fields respectively. There were found that 69 Species and 33 varieties and with forma i.e., 45.13% of cyanobacteia (BGA) were more common in rice fields. These were generally found in most of all habitats and also in low and upland rice growing areas. There were 90 Species and 34variety and with forma and total 124 taxa were present i.e., 54.87% colonial and filamentous BGA were present in all habitats. In general non-heterocystous blue green algal formswere always more than the heterocystous forms. The increasing range of soil pH was certainly the important factor for the development of BGA more up to certain limits. Comparatively more common and maximum genera were *Oscillatoria* Vaucher, *Phormidium* Kuetzing, *Arthospira* Stizenberger, *Spirulina* Turpin em. Gardner, *Lyngbya* Agardh and *Schizothrix* Kuetzing forms were developed in July to September and less number of filamentous forms were in November to January. When water level was lowlevel, starting the crop season the rice growing fields developed mainly filamentous and colonial forms of cyanoprocaryorota on heterocystous members are however better adapted to environment conditions and can tolerate odds including the summer although unable to survive in extreme dry months in vegetative condition Surajit Roy and Jai Prakash Keshri (2014).

Rice fields of surveyed localities particularly showed abundant occurrence of Nostocacean flora by Y. P. Singh, Rama Kant, N. C. Halder and G.L. Tiwari, 2010; N. C. Halder (2015, 2016) observed that the growth of free floating separate and distinct colonies of BGA

Table 1. Habitat wise distribution pattern of Cyanobacterial succession during rice cropping seasons and all habitats.

Groups of Cyanobacteria	Family	Name of The Cyanobacteria	Taxa from rice cropping seasons			Taxa from All habitats		
			sp	V+f	Total	sp	V+f	Total
Non-heterocystous Filamentous BGA Under the order Nostocales	Oscillatoriaceae	*Oscillatoria* Vaucher	15	9	24	22	8	30
		Phormidium Kuetzing	11	6	17	16	6	22
		Arthospira Stizenberger	5	2	7	6	3	9
		Spirulina Turpin em. Gardner	6	2	8	7	3	10
		Lyngbya Agardh	26	11	37	30	11	41
		Schizothrix Kuetzing	6	3	9	9	3	12
		TOTAL	**69**	**33**	**102**	**90**	**34**	**124**
		TOTAL No. of genus = 06	Percentage of taxa = 45.13%			Percentage of taxa = 54.87%		

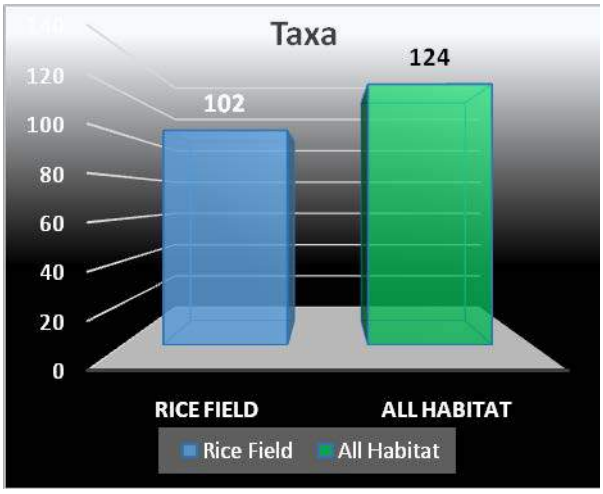


Fig 1. Habitat wise distribution pattern of cyanobacterial succession during rice cropping seasons and all habitats.

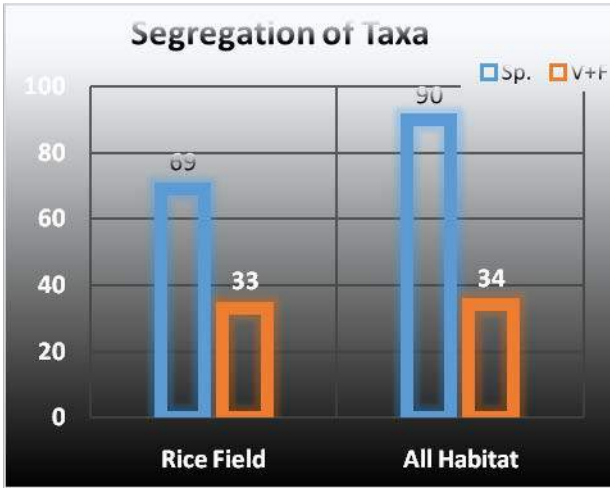


Fig 2. Habitat wise distribution pattern percentage (%) cyanobacterial succession during rice cropping seasons and all habitats.

largely dependent on water level. Reddy et al., (1986) documented two species of *Nostoc* and one species of *Cylindrospermum* from the rice fields. Oinam et al., (2010) and Devi et al., (2010) recorded five cyanophytes, e.g., *Anabaena doliolum* Bharadwaja, *Phormidium tenue* (Menegh.) Gomont, *Oscillatorialae vittae* Buell, *Plectonema nostocorum* Bornet ex Gomont and *Calothrix marchica* Lemmerm, from the soil surfaces area. The favourable balance of soil nitrogen of rice fields wherein rice can be grown on the same land even without any addition of fertilizers and without any reduction in yield, confirms to the

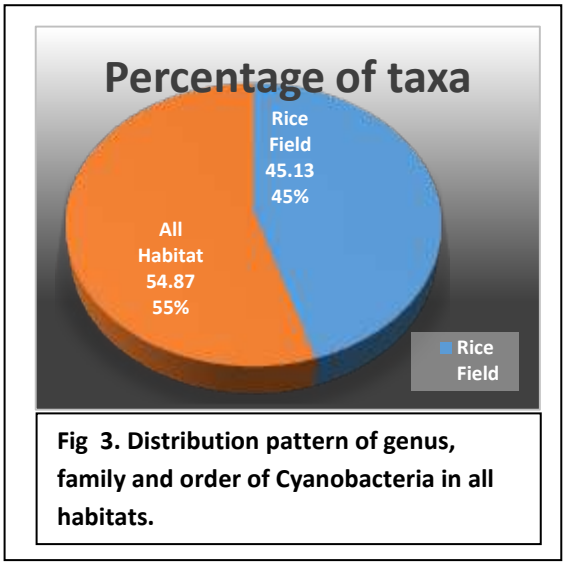
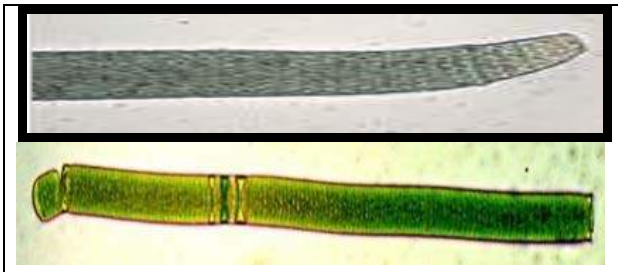
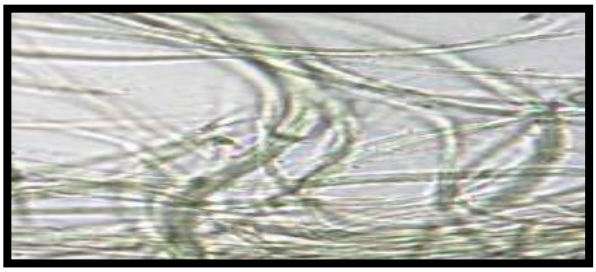


Fig 3. Distribution pattern of genus, family and order of Cyanobacteria in all habitats.



1. *Oscillatoria sp.*

2. Lyngbyea sp.



3. *Phormedium* sp.

4. BGA in natural habitat

significance of cyanobacterial nitrogen fixation (Venkatraman, 1972; Nayak et al., 2001; Song et al., 2005). Cyanobacteria have been found not only to grow in highly alkali soils but also improve the physio-chemical properties of soils enriching them with carbon, nitrogen and available phosphorus Kaushik, B. D.(1994). They generally grow on soil surfaceor water surface areas. These forms grow singly in larger quantities and usually do not allow growth of other BGA. Similar variations from rice fields had also been reported by other workers Deka and Bordoloi, 1992; Saikia and Bordoloi, 1994; Tiwari, G. L., Y. P. Singh, Rama Kantand Halder, N. C., 2008. The abundance of cyanobacteria in paddy fields was first observed by Fritsch, 1907. Exorbitant use of agrochemicals to increase soil fertility and crop productivity are reported to substantially reduce or eliminate cyanobaterial flora from paddy fields (Stewart et al., 1972; Susheela and Goyal, 1995). *Oscillatoria* Vaucher, *Phormidium* Kuetzing, *Arthospira* Stizenberger, *Spirulina* Turpin em. Gardner, *Lyngbya* Agardh and *Schizothrix* Kuetzing forms were more sensitive due to environmental changes i.e., temperature, nutrients, pH level and water level.

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