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DISTRIBUTION OF BLUE-GREEN ALGAE IN SOILS OF CHITTAGONG UNIVERSITY CAMPUS AND THEIR NITROGEN FIXING CAPACITY

M.A. GAFUR AND SOLTANA PARVIN

Department of Botany, University of Chittagong, Chittagong-4331, Bangladesh

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Abstract

Occurrence of blue-green algae in plain land, pond side, hilly area and dry rice field soils of Chittagong University Campus and N_2 fixation of some of them have been studied. Twenty four species under 20 genera were identified and their number varied from 0.11×10^4/g to 2.8×10^4/g soil. *Anabaena oryzae, Calothrix* sp., *Cylindrospermum majus* and *Hapalosiphon hibernicus* and *Nostoc spongiaeforme* were selected for their nitrogen fixing potential. Maximum amount of total nitrogen was recorded in *Nostoc spongiaeforme* followed by *Hapalosiphon hibernicus*, *Cylindrospermum majus*, *Anabaena oryzae* and *Calothrix* sp. after 30 days growth in batch cultures.

Introduction

Members of the division Cyanophyta/Cyanobacteria are perhaps of greater ecological importance as pioneer forms than the members of any other class of algae. Some information are available on the distribution and nitrogen fixing capacity of cyanobacteria in the rice fields of Bangladesh (Aziz *et al*. 1992, Begum 1983, Begum and Mandal 1997, Begum *et al*. 1993, Bhuiya *et al*. 1981, Khan and Venkataraman 1991, Mandal *et al.* 1993). There is also a good number of systematic studies on the blue-green algae (BGA) from different habitats (Aziz and Yasmin 1997, Gafur and Uddin 1992, Islam 1973b, Islam and Aziz 1979, Islam and Uddin 1969, 1973, 1978a, b) but only a few information exists (Aziz *et al*. 1992, Begum *et al.* 1993) about the occurrence and their distribution of the soil BGA of Bangladesh.

It was estimated that in the Philippino rice fields BGA adds up to 40 kg nitrogen per hectare per year to the soil (Watanabe *et al*. 1977). Rother *et al*. (1988) estimated nitrogen fixation inside deepwater rice fields 16.7 and 8.2 kg nitrogen per hectare per flood season at Manikganj and Sonargaon, Bangladesh, respectively. De (1939) demonstrated that the fertility of tropical rice field soil is maintained by the blue-green algae through dinitrogen fixation. Thus it was important to examine the occurrence, distribution and quantitative enumeration and isolation of blue-green algae and to study nitrogen fixing potential of some isolates.

Materials and Methods

The Chittagong University Campus lies in the longitude of about 91°5′ east and latitude of 22°30′ north and covers a total area of 520 hectares which is mostly hilly (Gafur *et al*. 1979).

Thirty soil samples were collected at 0 to 15cm depth from plain land, pond side, hilly area, dry rice fields and each was composite of five sub-samples. Two grams of each of the air dried soil sample were transferred into the conical flask containing sterilized Chu-10D medium (Chu 1942) and incubated. After 21 days a mixed growth of BGA was observed. These were microscopically examined and identified. The quantitative enumeration of BGA in the samples was done by most probable number method with the help of MPN chart from the number of positive tubes inoculated with higher dilutions (Alexander 1965).

From the mixed algal growth BGA were isolated and cultured in nitrogen free liquid medium under natural light and room temperature. The algal mass for each isolate after growth for 30 days

was separated from the medium by filtration through Whatman No. 41 paper and nitrogen content was determined by microkjeldahl digestion and distillation method (Jackson 1958).

Results and Discussion

The number of BGA/g soil obtained after 21 days growth in conical flasks in shown is Table 1. Maximum number was obtained in soils of slopes of a pond, south of Botanical Gardens. This was followed by plain land in front of RCMPS, mid-hill regions low land rice fields, etc.

Cyanobacterial number varied from 0.11×10^4/g to 2.80×10^4/g soil (Table 1). The number of nitrogen fixers in soil samples of four places in the study areas was higher in the present study compared to that reported by Mandal *et al.* (1993).

Table 1. Number of blue-green algae in different soil samples of Chittagong University Campus.

Sample no.	Description of sites	No. of BGA/g soil ($\times10^4$)	95% confidence limit ($\times 10^4$)
1.	Lemon corner, Botanic Garden, plain land	1.40	0.42 - 4.62
2.	Jack fruit corner, Botanic Garden, plain land	0.70	0.21 - 2.31
3.	Near Orchid house, Botanic Garden, plain land	1.10	0.33 - 3.63
4.	Miscellaneous corner, Botanic Garden, plain land	0.17	0.05 - 0.56
5.	Slope of a pond, south of Botanic Garden	2.80	0.84 - 9.24
6.	Rice field, beside Botanic Garden	0.70	0.21 - 2.31
7.	Side of a stream, east of Botanic Garden	0.79	0.23 - 2.60
8.	Foot hill, east of Botanic Garden	0.33	0.10 - 1.08
9.	Low land rice field, south-east of Botanic Garden	0.11	0.03 - 0.36
10.	Plain land, infront of Research Centre for Mathematical and Physical Sciences (RCMPS)	2.20	0.66 - 7.26
11.	Bank of a pond near RCMPS	0.70	0.21 - 2.31
12.	Plain land, west of RCMPS	1.10	0.33 - 3.63
13.	Low land rice field, west of RCMPS	1.70	0.51 - 5.61
14.	Low land rice field, north of RCMPS	0.79	0.23 - 2.60
15.	Hill top, south of Pritilata Hall	0.49	0.14 - 1.61
16.	Mid-hill region, south of Pritilata Hall	2.20	0.66 - 7.26
17.	Low land rice field, east of V. C. hill	1.10	0.33 - 3.63
18.	Plain land, north of Shamsun Nahar Hall	0.22	0.06 - 0.73
19.	Low land rice field, north of Shamsun Nahar Hall	1.40	0.42 - 4.62
20.	Mid-hill region, east of Shamsun Nahar Hall	1.40	0.42 - 4.62
21.	Foot-hill, east of Shamsun Nahar Hall	0.79	0.23 - 2.60
22.	Foot-hill, west side of Shahid Minar	1.40	0.42 - 4.62
23.	Mid-hill region, west of Shahid Minar	0.17	0.05 - 0.56
24.	Foot-hill, west of Central library	0.49	0.14 - 1.61
25.	Low land rice field, west of Shahid Minar	0.49	0.14 - 1.61
26.	Low land rice field, south-east of Science Faculty	1.30	0.39 - 4.29
27.	Foot-hill, south of Science Faculty	0.17	0.05 - 0.56
28.	Mid-hill region, south of Science Faculty	0.14	0.04 - 0.46
29.	Low land rice field, south of Science work shop	0.70	0.21 - 2.31
30.	Low land rice field, north of IMS	1.10	0.33 - 3.63

Twenty four species under 20 genera of BGA were identified from different sites (Table 2). Among these species, six belong to family Chrococcaceae, five to Oscillatoriaceae, seven to Nostocaceae, one from Rivulariaceae, one from Scytonemataceae and four from Stigonemataceae.

A highest percentage of occurrence (76.67%) was observed by various species of *Nostoc* followed by *Anabaena oryzae* (66.67%) and the lowest was for *Aphanothece microscopica*, *Oscillatoria princeps* and *Stigonema* sp. (10%). *Aulosira* sp., *M. flos-aquae* and *Spirulina gigantea* were found rarely (Table 2). *Nostoc spongiaeforme* alone occupied 3rd position in terms of % occurrence.

Table 2. Percentage occurrence of blue-green algae in soils of Chittagong University Campus.

Name of the species	Percentage of occurrence*
Nostoc sp.	76.67
Anabaena oryzae	66.67
Nostoc spongiaeforme	60.00
Lyngbya sp.	46.67
Chroococcus sp.	40.00
Fischerella muscicola	40.00
Gloeocapsa sp.	40.00
Anabaena iyengarii	36.67
Pseudanabaena sp.	33.33
Phormidium sp.	33.33
Cylindrospermum majus	30.00
Hapalosiphon hibernicus	26.67
Calothrix sp.	26.67
Westiellopsis prolifica	23.33
Synecococcus sp.	23.33
Scytonema sp.	23.33
Spirulina gigantea	23.33
Aulosira sp.	20.00
Microcystis marginata	16.67
Oscillatoria sp.	13.33
Microcytis flos-aquae	13.33
Aphanothece microscopica	10.00
Oscillatoria princeps	10.00
Stigonema sp.	10.00

*Calculated from the presence of a species in number of samples out of total 30 samples.

It appears that spp. of *Nostoc*, *A. oryzae* and *N. spongiaeforme* are the most widely distributed algae in the sampling areas (Table 2). The result corroborates with the reports of Begum *et al*. (1993), Islam and Aziz (1979), Islam and Uddin (1978a, b), Bhuiya *et al.* (1981), Khan and Venkataraman (1991). *Hapalosiphon hibernicus* reported in the soils of Bangladesh (Begum *et al*. 1993, Islam and Uddin 1978b, Khan and Venkataraman 1991) was also present in the study area. *Fischerella* sp. is one of the most common soils nitrogen fixing blue-green algae (Begum *et al*. 1993) and was also present in the study areas.

The amount of nitrogen fixed increased with the age of culture in *N. spongiaeforme*, *A. oryzae*, *C. majus* and *H. hibernicus* but it decreased in case of *Calothrix* sp. (Table 3). The highest amount of nitrogen content was found in *N. spongiaeforme* (3.38 mg/g biomass/30 days) followed by *H. hibernicus* (2.90 mg/g biomass/30 days) and the lowest was found in *Calothrix* sp. (1.45 mg/g biomass/30 days). The amount of nitrogen content by *A. oryzae* was 1.86 mg/g biomass/30 days. In the present investigation *N. spongiaeforme* showed maximum N_2-fixation after 30 days incubation.

Table 3. Nitrogen fixation by some isolates of cyanobacteria.

Algal isolates	Nitrogen content (mg/g dry wt.) of different isolates in different incubation periods (days)				
	15	20	25	28	30
Nostoc spongiaeforme	1.20	2.25	3.09	3.28	3.38
Anabaena oryzae	1.13	1.50	1.50	1.61	1.86
Calothrix sp.	0.41	0.97	1.61	1.54	1.45
Cylindrospermum majus	0.16	0.69	0.81	1.52	2.45
Hapalosiphon hibernicus	0.97	1.29	1.35	1.79	2.90

Highest amount of total nitrogen content was observed in *Nostoc commune* (5.41 mg 50 ml^{-1} 30 days) from the soils of Jhenaidah, Bangladesh (Begum and Mandal 1997). Low amount of N_2 fixation by *Calothrix wembaerensis* was reported by Begum and Mandal (1997) which corroborates with the present findings. In the present study *H. hibernicus* showed much more N_2-fixation at 30 days incubation than that reported by Begum and Mandal (1997).

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