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Cyanobacterial Strains Recorded from Rice Field Soils of Five Tahsil of Gariyabandh District of Chhattisgarh in Relation to Soil pH, Soil Type and EC Value

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Abstract: ***Rice field ecosystem provides a favourable environment i.e. light, water, temperature and nutrient availability for the luxurious growth of cyanobacteria; hence they are the most important natural biofertilizer of this ecosystem. Due to the capability of several cyanobacteria to fix the atmospheric nitrogen, they play an important role in maintenance and build-up of soil fertility; consequently increase growth and yield of rice. "Algalization" helps to provide an environmentally safe agro-ecosystem in rice cultivation in respect to reducing cost and energy inputs. Chhattisgarh which is known as rice bowl of India, so the biodiversity of unexplored cyanobacteria of Chhattisgarh has been a subject of attention for local algalization programme. The present study is an attempt to isolate, identify and characterise the biodiversity of cyanobacterial strains from present unexplored study sites for better algalization.***

Keyword: Rice field, Unexplored cyanobacteria, Biofertilizer, algalization

I. INTRODUCTION

Cyanobacteria occupy a unique position because it carries out oxygenic photosynthesis like eukaryotic plant cells and possess metabolic system like bacteria. The abundance of cyanobacteria in rice field was first observed by Fritsch (1907). The rice field ecosystem consists of diverse habitats in respect to soil pH, conductivity, soil type etc. and could exhibits biologically distinct properties. Such heterogeneity should influence the biodiversity of cyanobacterial communities (Kimura, 2000 and Kirk, 2004). The ability of cyanobacteria to fix atmospheric nitrogen is increasing concern worldwide to exploit this tiny living system for nitrogenous fertilizers for sustainable agricultural practices.

Chhattisgarh is known for the presence of five types of soil, locally known as Dorsa, Kacchar, Kanhar and Bhata (Sharma and Jain, 2016). Some reports are available about cyanobacterial biodiversity in the rice fields of Chhattisgarh (Sharma and Naik 1996 and 1998, Shrivastava et al. 2009, Bajpai, 2013, Sharma et al. 2017 and Sharma 2018). However, these reports are confined to identification of cyanobacteria in the paddy fields.

There is few comprehensive research or data are available to establish the role of soil type, pH and EC values on distribution pattern of cyanobacterial spp. in rice fields of Chhattisgarh. Because soil type and pH is essential parameters which influence the relations and possibly affecting the biodiversity of cyanobacterial species in rice fields (Bajpai, 2013; Sharma and Jain, 2016 and Sharma, 2018). The present investigation deal with the collection of rice field's soil samples from 16 rice fields of Gariyabandh district of Chhattisgarh and analysis of physico-chemical properties of soil along with their impact on the biodiversity of the cyanobacterial spp.

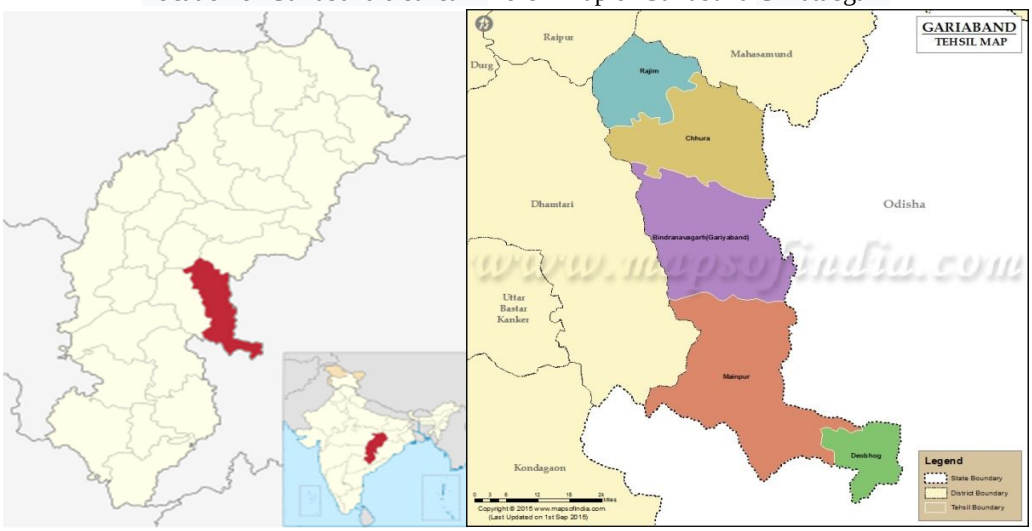
II. MATERIAL AND METHODS

1) *Study Site:* 1951.861 sq. km (50.41%) area of the "Gariaband district is covered with forest. The major types of forests present in this district are Teak Forest (Sagon Van) - 0.37%, Saal Forest (Saal Van) - 22.66%, mixed forest - 54.51% other forest - 22.46%. The district is divided into geographical area of the five talukas Gariaband (726.12 sqkm), Chhura (714.62 sqkm), Mainpur (670.52 sqkm), Devbhog (301.53 sqkm) and Rajim (474.27 sqkm) respectively. Farming is wide across the district. Near about 49.56% area of the district is irrigated. The Gariaband, Chhura and Mainpur blocks are multiplicity of Tribal's. There is four urban bodies in the district in which one municipality (Gariaband) and three Nagar Panchayat (Rajim, Chhura and Fingeshwar).

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Location of Gariaband district in Tehsil Map of Gariaband Chhattisgarh



2) *Physico-chemical analysis of soil:* A number of physic-chemical properties such as pH and electrical conductivity were analyzed from different study sites.

a) *Determination of pH:* For measuring soil pH 10 gram of rice field soil was dissolved in 25 ml of distilled water. Suspension was shaken for 30 minutes, pH meter was calibrated by using buffer solutions of pH 4.0 and 7.0.The electrode was dipped in soil-water suspension. The reading was measured in triplicate.

b) *Determination of Electrical Conductivity:* The electrical conductivity have been calculate by using the procedure 1:2 soil water soil water- suspension was prepared by dissolving 10 gram of soil in 20 ml distilled water. Suspension was shaken for 30 minutes. The conductivity cell was dipped in soil water suspension. The galvanometer of conductivity meter was balanced and the conductance of soil solution was measured

c) *Determination of Soil Type:* On the basis of texture of soil, the soils of the study site were categorised in to five type, via. Bhata, Sirsa, Macchar, Kabhar and Matasi.

d) *Collection of Soil Samples and Isolation and Enumeration of Cyanobacteria:* Soil samples were collected from different agro-ecological regions and soil types (Fig. 1 and Table 1) were measured for their EC and pH range and utilized for enrichment studies in Chu-10 medium.

e) *Culture Preparation/ Isolation:* Moist cultures of cyanobacteria were prepared by taken 1gram rice field's soil and moistened with Chu-10 media {(Gerloff et al, 1950 amended with 1ml Fogg's micronutrients a solution (Fogg, 1949)} in previously sterilized conical flask. In about a fortnight after incubation, the visible growth of cyanobacterial stains appears in the culture. The enrichment flasks were regularly monitored for growth and observed microscopically. One of the replicates was disturbed for microscopic examination while others were left undisturbed for further observation. Standard plating / streaking techniques were used for isolation and purification of cyanobacterial strains [Stanier et al. 1971].

f) *Identification of Cyanobacteria:* The growth pattern and morphological examination of the cyanobacterial strains was carried out at different stages of growth in nitrogen-free liquid and solid (agar) Chu-10 medium. Morphological observation of cyanobacteria:[shape and size of the vegetative cells, heterocyst's and akinites] in the axenic cultures were studied by using an Olympus microscope as described by Prescott (1950), Desikachary (1959), Anand (1989). Cyanobacterial images were study at 100X magnification.

III. RESULTS and DISCUSSION:

1) *Physico-Chemical Analysis of rice fields Soils of Study Sites:* The result showed that there are 5 types of soils recorded from study site. Heterocystous forms(19 forms) were mainly prefer Kanhar and Matasi soil which are the most important rice field soil of Chhattisgarh(Table-1). The pH values of the soils are 4.8-8.5 (Table-1). There are very few reports on the existence of cyanobacteria at low pH (acidic range) as they are in general, intolerant to low pH conditions (Hunt *et al.*, 1979; Dominic and .Madhusoodanan, 1999). The result also clearly showed that hetrocystous cyanobacteria, which are one of the most significant N_2 fixing organisms in rice field soils, are preferring neutral to alkaline soil (pH 6.9-8.5), where 19 forms were recorded (Table-1). Similar results are showed in many studies of Chhattisgarh region (Sharma and Naik, 1996, 1998; Bajpai 2013; Singh et al.

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2014; Sharma and Jain 2016; Sharma et al. 2017, and Sharma 2018). The conductivity values for different study sites were in the range of 0.o36 to 1.784 m mho/cm.which showed that this value is good for cyanobacterial growth. Where electrical conductivity grows above 2 m mhos/cm than soil became salty in nature and not good for the growh of cyanobacteria (Bajpai, 2013)19 heterocystous forms were recorded in EC value between 0.450-1.784 m mho/cm and 12 forms were recorded between 0.410-0.696m mho/cm (Table-1).

2) *Biodiversity of Rice Field Cyanobacterial Strains:* The rice field cyanobacterial flora was isolated from different sites of Gariabandh district are listed in Table 2-6. The result showed that in the present study site cyanobacteria exhibit a great morphological diversity and their broad spectrum of physiological properties reflects their widespread distribution and tolerance to environmental stress (Dominic and Madhusoodanan 1999). Several reports have indicated a widespread distribution of forms like *Oscillatoria, Nostoc, Anabaena, Phormidium* and *Aphanothece* (Gupta, 1975; Venkataraman, (1981); Whitton, 2000 and Singh et al. 2014. The dominating heterocystous nitrogen fixing cyanobcaterial species of *Aluosira, Cylindrospermum, Nostoc, Anabaena, Tolypothrix* and *Calothrix* were also reported from soils of Cuttack and Orissa (Singh, 1961). Besides their well established role as nitrogen supplements and tolerance to desiccation, cyanobacteria can be key players in carbon sequestration and improving nutrient use efficiency and crop yields (Watanabe and Yamamoto 1971; Rao and Burns 1990).

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Table-1: Physico-chemical analysis of rice field soils of five tahsil of Gariyabandh district

S. No.	Name of Tahsil	Soil type	Soil pH	EC value m mho/cm	Unicellular	Non-heterocystous form	heterocystous form	Total forms
1	Chhura	Dorsa Kacchar Kanhar	4.8-6.5	0.036-0.294	03	22	02	27
2.	Deobhog	Kanhar Matasi	6.9-8.5	0.450-1.784	04	23	19	46
3.	Gariyabandh	Dorsa Kacchar Matasi	5.0-7.3	0.050-0.612	02	31	01	34
4.	Mainpur	Dorsa Kacchar Kanhar Matasi	5.0-6.7	0.052-0.360	03	41	03	47
5.	Rajim	Dorsa Kacchar Kanhar Matasi	6.8-7.5	0.410-0.696	09	41	12	62

Table-2: Cyanobacteria species recorded from rice fields of Chhura tahsil of Gariaband district of Chhattisgarh (pH of the soil 4.8-6.5)

Unicellular colonial form	Non- heterocystous filamentous form	Heterocystous filamentous form
Genus- Chroococcus C. minus	Genus- Oscillatoria O. acuminate O. amoena O. amoena var. non-granulata O. amphibia O. anguina O. jasorvensis O. laete-virens O. minnesotensis O. rubescens O. terebri-formis	Genus- Aulosira A. fertilissima
Genus- Aphanocapsa 1. A. koordersi 2. A. roeseana	Genus- Phormidium P. ambiguum P. favosum P. fragile P. inundatum P. rotheanum P. stagnina P. valderianum Genus- Lyngbya L. corbierei L. scotti	Genus- Hapalosiphon H. hibernicus

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	L. Taylorii	
	Genus- Symploca S. elegans	
	Genus- Microcoleus M. chthonopladtes	

Table-:3 Cyanobacteria species recorded from rice fields of Devbhog tahsil of Gariaband district of Chhattisgarh (pH of the soil 6.9-8.5)

Unicellular colonial form	Non- heterocystous filamentous form	Heterocystous filamentous form
Genus- Aphanocapsa A. montana A. roeseana	Genus- Oscillatoria O. angusta O. cruenta O. fremyii O. minneso-tensis O. salina f.major	Genus- Richelia R. interce-llularis
Genus- Aphanothece A. castagnei	Genus- Phormidium P. autumnale P. foveolarum P. jenkelianum P. papyraceum P. uncinatum	Genus- Cylindrospermum C. doryphorum
Genus- Myxosarcina M. spectabilis	Genus- Lyngbya L. allorgei L. ceylanica L. digueti L. erebi L. lagerheimii L. semiplena L.spiralis	Genus- Wollea W. bhara-dwajae
	Genus – Schizothrix S. pulvinata S. tenuis	Genus- Nostoc N. calcicola N. ellipsosporum var. violacea N. Punctiforme N. spongifo-rmae N. spongifo-rmae var. tenuis N. spongifo-rmae ar. varians
	Genus- Symploca S. elegans S. laete-viridis S. muralis	Genus- Anabaena A. ambigua A.fertilissima A. oryzae
	Genus- Microcoleus M. lacustris	Genus- Plectonema P. gracillimum
		Genus- Calothrix C. brevissima var. moniliformae C. marchica C. marchica var. intermedia
		Genus- Mastigocladus M. laminosus

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		Genus- Westiellopsis W. prolifica
		Genus- Stigonema S. hormoides

Table-4: Cyanobacteria species recorded from rice fields of Gariyabandh tahsil of Gariaband district of Chhattisgarh (pH of the soil 5.0-7.3)

Unicellular colonial form	Non- heterocystous filamentous form	Heterocystous filamentous form
Genus- Chroococcus C. minor	Genus- Oscillatoria O. amoena O. animalis O. chalybea O. cortiana O. foreaui O. Formosa O. limosa O. minnesotensis O. schultzii O. subbrevis	Genus – Nostoc N. piscinale
Genus- Aphanocapsa A.montana A. roseana	Genus- Phormidium P. ambiguum P. autumnale P. foveolarum P. fragile P. inundatum P. papyraceum P. uncinatum	Genus- Anabaena A. ambigua A. Iyengarii A. laxa A. spherical var. tenuis
Genus- Synecosystis S. pevalekii	Genus- Lyngbya L.aestuaii L. ceylanica L. circumcreta L. erebi L. porphyrosiphonis L.spiralis L. Taylorii	Genus – Plectonema P. gracillimum
Genus – Chlorogloea C. fritschii	Genus – Schizothrix S. aerinaria S. friesii S. friesii f. repens S .tenuis	
	Genus- Symploca S. cartilaginea S. elegans S. muralis	
	Genus- Microcoleus M. sociatus	

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Table-5: Cyanobacteria species recorded from rice fields of Mainpur tahsil of Gariaband district of Chhattisgarh (pH of the soil 6.9-8.5)

Unicellular colonial form	Non- heterocystous filamentous form	Heterocystous filamentous form
Genus- Aphanocapsa A.1grevillei A.littoralis A. roseana	Genus- Oscillatoria O. annae O. chalybea var. insularis O.foreaui O. fremyii O. limnetica O. okeni O. raoi O. rubescens O. simplissima O. splendid O. terebriformis	Genus- Anabaena A. oryzae
	Genus- Phomidium P. ambiguum P. fragile P. inudatum P. microtomum P. papyraceum P. stagnina P. subfscum P. uncinatum	Genus- Tolypothrix T. bouteillei
	Genus –Lyngbya L. aestuarii L. arboricola L. ceylanica L. connectens L. digueti L. erebi L. martensiana L. nigra L. polysiphoniae L. putealis L. Taylorii	Genus- Calothrix C. clavata
	Genus – Schizothrix S. aerinaria S. fragilis S. friesii f. Repens S. penicillata S. pulvinata	
	Genus- Symploca S. elegans S. hydronoides	
	Genus- Microcoleus	

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	M. lacustris M. sociatus M.vaginatus	

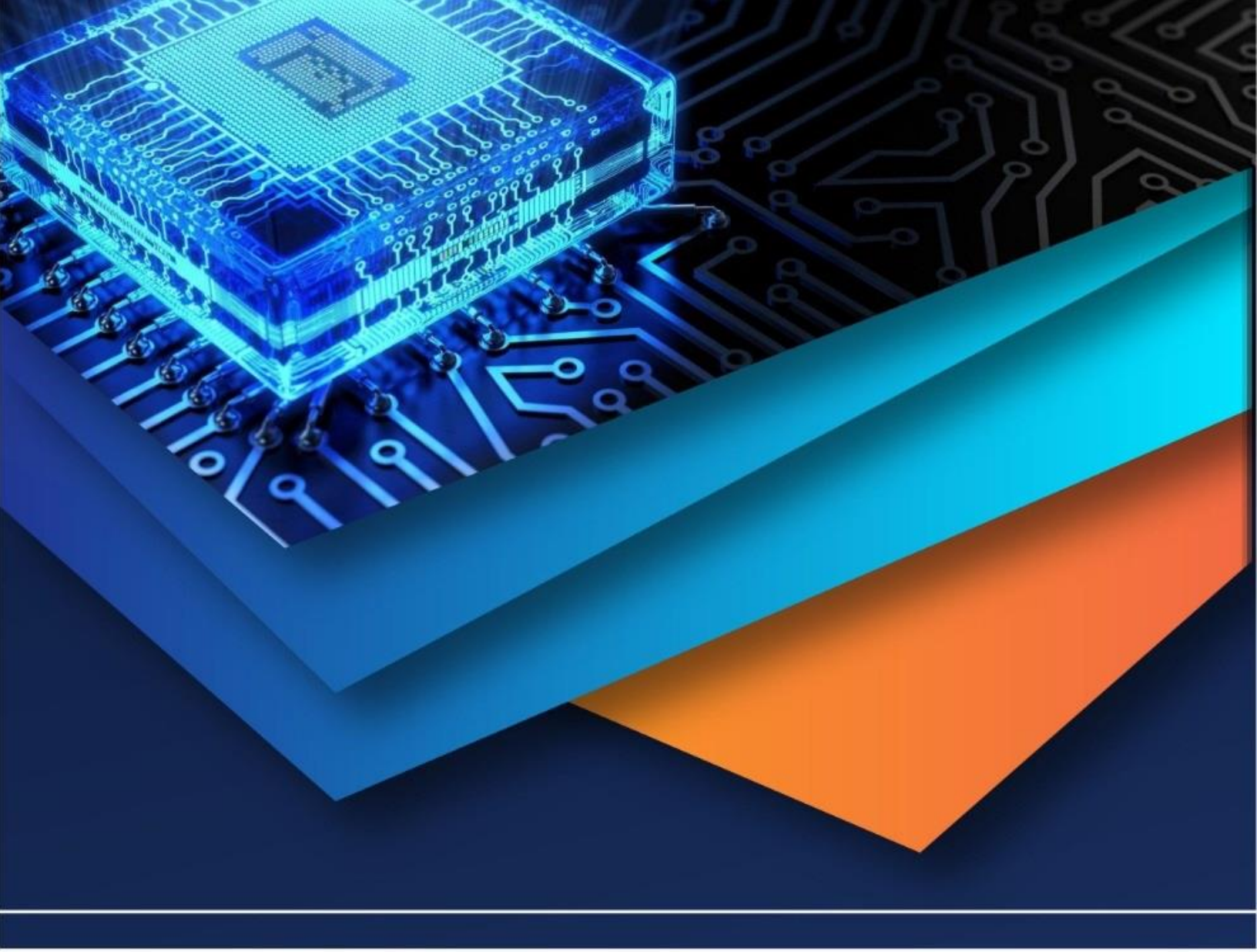
Table-6: Cyanobacteria species recorded from rice fields of Rajim/Fingeshwar tahsil of Gariaband district of Chhattisgarh (pH of the soil 6.8-7.5)

Unicellular colonial form	Non- heterocystous filamentous form	Heterocystous filamentous form
Genus- Chroococcus C. minimus C. pallidus	Genus- Oscillatoria O. acuminate O. acuta O. chalybea var. insularis O. chlorine O. foreaui O. jasorvensis O. laete-virens O. okeni O. proboscidea O. subbrevis O. terebriformis	Genus- Nostoc N. punctiforme
Genus- Aphanocapsa 1. A. koordersi 2. A. montana 3. A. roeseana	Genus- Phormidium P. ambiguum P. foveolarum P. jadinianum P. papyraceum P. uncinatum	Genus- Anabaena A. Iyengarii A. oryzae A. torulosa
Genus- Aphanothece A. naegelii	Genus- Lyngbya L. aestuarii L. allorgei L. ceylanica L. cinerescens L. connectens L. contorta L. corbierei L. digueti L. erebi L. hieronymusii L. limnetica L. majuscule var. chakiaense L. nigra L. porphyrosiphonis L. putealis L. spiralis L. Taylorii L. versicolor	Genus- Scytonema S.multiramosum
Genus- Synechocystis S. pevalekii	Genus – Schizothrix S. aerinaria S. friesii	Genus- Tolypothrix T. bouteillei T. byssoidea
Genus- Myxosarcina M. burmensis	Genus- Symploca S. elegans	Genus- Microchaete M. aequalis

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M. spectabilis	S. laete-viridis	M. uberrima
	Genus- Microcoleus M. acutissimus M. lacustris M. sociatus	Genus- Calothrix C. elenkinii C. Marchica var. intermedia C. membranacea

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