

CONTRIBUTION TO SOIL ALGAE (CYANOPHYCEAE) FROM KARACHI - PAKISTAN PART - I

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Abstract

An ecological survey of soil algae was carried out during 1990-93. Samples were collected from different localities around Karachi. Majority of the soil samples with alkaline pH, containing members of Cyanophyceae, while acedic pH with the Chlorophyceae. Present work deals with the class Cyanophyceae. Out of 44 samples members of the seven genera including fourteen species were isolated in pure culture. They include one species of *Anabaina*, two species of *Calothrix*, three species of *Lynqbya*, three species of *Nostoc*, three species of *Oscillatoria*, one species of *Phormidium* and one of *Tolypothrix*.

Introduction

Cyanphyceae or blue-green algae are the simplest among the algae, being photoautotrophic, lead a unique form of life. They have world wide distribution occuring predominantly on damp soil, particularly on the surface of neutral or alkaline areas, (Fog et al., 1973). In general the number of blue-green algal records are extermely varied from habitat to habitat. A marked seasonal fluctuation in this type of flora have been recorded from vicinity of Karachi (Zahid, et al., unpublished).

Earliest studies on soil algae were carriesd out by many workers such as Frank (1889), Schloesing and Laurent (1892), Beijarinick (1901), and others, that soil algae infact play a major role as primary colonizer which help in the establishment of other members of the soil flora, in the accumulation of humus, prevent erosion, which is helped by their gelatinous sheaths. They also help to maintain moisture in the soil (Booth 1941), in Oklahoma. He also investigated that soil with an algal covering had a moisture content of 8.9% as compared 1.3% in the absence of algae, and they are in many cases the dominant componant of the soil microflora. On account of their water holding capacity the maximum temperature of the surface of the soil being much higher, therefore, soil algae have a tremendous capacity to withstand desceation but after short period of

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rain, profuse growths may develop from these previously desiccated algae.

Besides this, blue-green algae play an important role in maintaining fertility of the soil organisms which utilize gaseous nitrogen. The nitrogen fixing agents or contribute combined nitrogen in variety of habitat they can also fix atmospheric carbondioxide in the presence of light as studied by like (Beijerinick 1901) and help higher plants by supplying growth substances. (Mishutin and Shil nikova 1971)

The purpose of present work was to select such varieties of blue-green algae which Could survive in the climatic conditions of Karachi all the year round and would be suitable for mass culture. For this purpose fourteen species were isolated, their uni-algal cultures were prepared in order to utilize them and to know the effects of these algae on different crop plants.

Materials and Methods

Soil samples were collected in polythene bags from the surface six inches depth from crop field like experimental fields of plant protection of Botany Department, Malir, Nazimabad, North Nazimabad, North Karachi, F.B. Area, Landhi, Korangi, etc. Two methods were adapted for the isolation of algae.

First Method: 10 grams of soil placed in petridishes and reweted with distilled water or mineral salt medium. After 3-5 days, 5 grams of soil shaken with 5 c.c. of water to a uniform suspension. From this suspension different suspensions were prepared with Bold's basal solution in the ratio of 4 drops of suspension with 10 ml. of nutrient solution and like this 8-10 drops added with 10 ml. of solution in different test tubes, then few drops of suspensions were transferred to the petridishes containing maineral salts agar medium and culture kept at room temperature (15-25°C in winter and 25-35°C in summer season).

The first sign of algal colonies were observed in the petridishes after fifteen days of inoculation. When colonies became larger were transferred by a wire loop in liquid medium as well as in agar media. Rapid growth of blue-green nitrogen fixing algae appeared in Allen's medium, no growth in Kratz's and Myer's medium was noted. The cultures obtained by this method was semipure, but by repeated dillution of suspension the unialgal culture of some species were obtained.

Second Method: The other method was carried out by the inoculation of a small quantity of soil into nutrient solution. The first sign of algal growth was observed after a week in the form of a green rim around the level of liquid medium in the test tubes and petridishes. After 3-4 days this algal material was teased slightly in a sterilized petridish with a drop of distilled water and transfered into test tubes containing Allen's and Kratz's and Myer's medium and

then it was shaken well for sometime. From these test tubes the suspension was diluted in such a manner that every drop contained less number of trichome and cells. Then 6-8 drops of the diluted suspension with the help of sprayer was transferred on to the fresh petridishes containing *Kratz's* and *Myer's* and *Allen's* media.

After fifteen days, colonies appeared, only unialgal colonics were transferred into fresh medium. The colonies which were not pure, their suspension was prepared again by the repeated method untill a unialgal or pure culture was obtained.

By these methods fourteen unialgal cultures of the species listed below were prepared and kept in the culture collection:

1. *Lyngbya polysiphonea*
2. *L. majascula*
3. *L. hieronymusii*
4. *Oscillatoria amoena*
5. *O. cortiana*
6. *O. acuminata*
7. *Phormidium trunicola*
8. *Nostoc linckia*
9. *N. carneum*
10. *N. ellipsosporum*
11. *Anabaina vaginicola*
12. *Tolypothrix tenuis*
13. *Calothrix braunii*
14. *C. marchica*

Description of Species

(i) *Lyngbya* Agardh

Agardh 1824; 25; Desikacharv, 1959; 278

Trichome single or free in a thin or very massive thick firm sheath, which is mostly colourless, seldom coloured, yellow to brown or red. Blue to purple

red. filaments either attached or free living forming free floating thallus.

Key to the species of the genus

1. Trichomes upto 20 μm . long. cells $\frac{1}{2}$ - $\frac{1}{3}$ as long as broad _____ *Lyngbya polysiphonaea*
Otherwise _____ 2.
2. Trichomes 16-60 μm broad, without calyptra _____ *L. majascula*.
Otherwise _____ 3.
3. Trichomes narrow 12-14 (-5-20) μm broad _____ *L. hieronymusii* (3)

1. *Lyngbya polysiphonaea* Fremy

Geitler 1932: 1040 Desikachary 1959: 187.

(Plate 1 Fig. 1)

Plant occur as epiphyte on higher plants or algae or stones. Filaments measuring more than 200 μm long. Mucilage sheath very thin, delicate, colourless. Trichome pale, blue-green or soemtimes violet, constricted at the cross walls, 2.5 μm broad. Apices rounded, $\frac{1}{2}$ - $\frac{1}{3}$ as long as broad, Hormogonia 2.5-3 μm broad not rounded.

Distribution: In the soil samples collected from a field in Malir City where *Medicago sativa* and other grasses were growing.

Note: Our description is in agreement with those of Desikachary, only differs in the habitate i.e. it was collected in the soil samples.

2. *Lyngbya majascula* Harve ex Gomont

Harvey in Hooker (1833) English Flora (Part 1); 370; Desikachary 1959: 313

(Plate I Fig. 2).

Filaments blue-green or yellow brown, upto 3 cm. long, sheath colourless, lamellated upto 10 μm thick. Trichomes not constricted at the cross walls, bluntly ended 15-70 μm broad $\frac{1}{4}$ - $\frac{1}{5}$ times as long as broad cells without calyptra.

Distribution: Collected from soil samples near nursery Karachi.

Note: Karachi material agrees in general features with the type description but differes in having narrower trichome.

3. *Lyngbya hieronymusii* Lemmerman

Geitler. 1932, 1047. Fig. 656 a; Desikachary 1959; 297.

(Plate I Fig. 3)

Filaments occurs single not in tufts, straight, 10.5-14 μm broad; sheath firm, homogenous, colourless. cells 9-12 μm broad 2-5 μm long, not constricted at the cross-walls. Cell granulated with gas vacuoles, end cells broadly rounded.

Distribution: Collected from the crop fields of plant protection and in the ponds of North Nazimabad area.

Note: Our material agrees with the type description of the species, but differs in having broad rounded end cells.

(ii) *Oscillatoria* Vaucher ex Bornet et Flahault

Gomont 1892; 198: Desikachary 1959: 198.

Trichome single, free floating; sheath lacking; motile by creeping movements on the longitudinal axis. Trichome ended in a narrow apical portion slightly bent or coiled; terminal cells rounded or having calyptra, cells contents homogenous.

Key to the species of the genus

1. Trichomes not constricted at the base, and cells capitate.....*Oscillatoria amoena*
End cells not capitate2.
2. Trichomes broader, cells quadrate or longer and cells slightly tapering.....
O. cortiana
Trichome cells without conical pointed cells..... 3.
3. Trichome cells with conical pointed cells..... *O. acuminata*.
4. *Oscillatoria amoena* (Kütz) Gomont.
Geitler 1932; 969. Desikachary 1959; 230.

(Plate I, Fig. 4)

Trichomes straight, single, not constricted at the cross-walls, ends subcapitate, broadly conical with calyptra. Cells 2-4 μm broad nearly as long as broad, 2.3-4.3 μm long, septa granulated.

Distribution: On the garden soil at North Karachi.

Note: Our material agrees with the original description but differs slightly in the measurements.

5. *Oscillatoria cortiana* Meneghini ex Gomont

Geitler 1932: 971; Desikachary 1959: 233.

(Plate I, Fig. 5)

Trichome straight, slightly constricted at joints, 5-7.0 μm broad, gradually tapering at the ends, bent, not capitate, Blue-green, cells as long as broad, sometimes longer or shorter than broad, 5-8 μm long, at the end upto 14 μm long. Septa not granulated. End cells obtuse without calyptra.

Distribution: On moist garden soils around New Karachi.

Note: Our material agrees with the original description, differs in the measurements of end cells.

6. *Oscillatoria acuminata* Gomont

Geitler 1932: 978; Desikachary 1959: 240

(Plate I, Fig. 6)

Thallus blue-green in culture medium. Trichome straight not constricted at cross walls sheath absent, 2.5-5 μm broad; sharply pointed at the apices; bent; cells subquadrate 6-8 μm long; granulated at cross walls, calyptra absent.

Distribution: In the soil samples collected from field Near Malir City.

Note: Our material agrees with the original description. It differs slightly in the size of the cells.

(iii) *Phormidium* Kutzing

Kutzing 1843: 190.

Filaments forming a gelatinous or leathery sheath. Thallus attached by the lower side or floating; Sheath present, firm, diffuent, thin, colourless trichomes. Trichomes cylindrical, constricted at the joints. Apices often attenuated, straight, capitate or non-capitate, Apical cells generally with calyptra.

7. *Phormidium tranicola* Ghosh

Ghosh 1924: 338, Desikachary, 1959: 258

(Plate I, Fig. 7)

Thallus expanded, sheath very thin, yellow, greenish, thread like trichome, 4-8 μm broad, not constricted at cross-walls, cells quadrate and slightly attenuated at the apices.

Distribution: Found in majority of the soil samples collected from Malir, F.B. Area and crop fields, of Plant Protection Department.

Note: The specie resembles with specie described by Desikachary differs in the constriction of cross walls.

(iv) *Nostoc* Vauchar ex Bornet et Flahault

Bornet et Flahault 1888: 181, Desikachary, 1959: 372

Thallus mucilaginous, rounded, expanded, free-floating or attached, filaments curved or straght, entangled; sheath present or absent, cells spherical, barrel-shaped or cylindrical; Heterocyst intercalary or terminal, spores spherical or oblong in between the Heterocyst.

Key to the species of the qenus

1. Trichomes, subaerial, densely arranged, coloured *Nostoc linckia*
Trichomes not densely arranged 2.
2. Heterocyst 6 μm broad, spores 6x8-10 μm *N. carneum*
Cells cylindrical *N. elliposporum*
8. *Nostoc linckia* (Roth) Bornet ex Flahault
Desikachary 1959: 377.

(Plate II, Fig. 1)

Thallus form an expanded surface in liquid medium, gelatinuous, filaments flexous, sheath very thin sometimes invisible, colourless. Trichomes blackish-green, cells short barrel-shaped, 4-6 μm , long,, 4-5 μm borad. Heterocyst spherical to oblong. 7.2-8 μm long 6-7 μm broad. Episore smooth hyaline. Spore in long chain, sub-spherical.

Distribution: In the soil samples collected from the experimental fields or Plant protectio, where rice, wheat, Jwar, sugarcane, cotton were growing.

Note: The specie resembles in all characters with the specie described by Desikachary but differs in breadth of trichome 3.5-4 μm . Trichomes pale-blue green in colour.

9. *Nostoc carneum* Aq ex Bornet et Flahault
Desikachary 1959: 381

(Plate II Fig. 2)

Thallus expanded, papery, gelatinous, reddish, violet in colour. Sometimes change to green filaments, bent alternately in opposite direction, sheath colourless, delicate, sometimes indistinct. Trichomes 3.2-4 μm broad. Cells 4.4-5 μm broad, 6-8 μm long, cylindrical nearly twice of breadth with thin membrane, 4-5 μm long. Heterocyst spherical, twice as long as broad, 4.5-9 μm long. Spore smooth and haline.

Distribution: In the soil samples collected from fields of plant Protection Deptt and experimental fields of Botany Department, Karachi University.

Note: Our specimen differ from specie described by Desikachary in the measurements of Heterocyst. Our species contain spherical heterocyst while in the species described by Desikachary only oblong heterocysts and spores were recorded.

10. *Nostoc ellipsosporum* (Desm) Rabenh ex Bornet et Flahault Desikachary 1959: 383.

(Plate II, Fig. 3)

Thallus gelatinous, expanded, brownish, turns to orange when dried. Filaments not straight, curved, loosely entangled, trichome broad, cells cylindrical, 6-12 μm long. Heterocyst subspherical to oblong, 7-8 μm long, 7-12 μm broad, spores ellipsoidal to oblong 6.4-8 μm broad and 8-12 μm long.

Distribution: In the soil samples collected from plant protection Deptt. and from the crop fields of Malir City.

Note: Our species is in agreement of the original description, differs only in the measurements of the cells and the heterocyst.

(v) *Anabaina* Bory ex Bornet et Flahault

Bornet et Flahault, 1988: 224

Trichomes uniform, slightly attenuated, sheath present or sometimes lacking or diffluent, forming free or mucilagenous thallus. Heterocyst intercalary, spores either single or in chains, close or in between the heterocyst.

11. *Anabaina vaginicola* Fritsch and Rich
Desikachary 1959: 401

(Plate II Fig. 4)

Many trichomes are enclosed in a common mucilage sheath, filaments more or less parallel, measuring 3-4.5 μm broad. Cells sub-quadrated, cylindrical. Apical cell acuminate conical heterocyst, cylindrical 3-4 μm broad, 5-11 μm long, spores small, cylindrical or oblong, close

to the heterocyst often in 4-5 series, spore-wall hyaline, 6.8-9 µm broad and 10-8 µm long.

Distribution: Nursery and Malir crop fields Karachi.

Note: Our material agrees with those of Desikachary, differs in having generally terminal heterocyst.

(vi) *Tolypothrix* kutzing

Kutzing 1943; 227; Desikachary 1959; 493.

Filaments with a firm, thin or thick sheath, with a single trichome in each sheath. False-branches mostly subtending a heterocyst. Hormogonia formed from the tips. Apices of the trichome are often broad with short cells.

12. *Tolypothrix tenuis* (Kutz) Johns. Schmidt

Desikachary 1959; 494.

(Plate II, Fig. 5)

Thallus expanded, filaments entangled, blue-green, 8-14 µm broad, sheath thin, colourless or yellowish, not lamellated, cells 6-12 µm broad, quadratic, constricted at cross walls. Heterocyst rounded or oval, 10-12 µm long, 3-6 µm broad, colourless, single or in chains.

Distribution: On moist soils near Haleji lake and other ponds around Karachi.

Note: This species differs from Desikachary in the measurements of heterocyst.

(vii) *Calothrix* Agardh

Desikachary 1959; 522

Filaments single, or in small bundles, caespitose, tomentose, pulvinate or penicillate. Filaments arranged more or less parallel, mostly erect, unbranched or seldoms flase branched. Sheath mostly firm. Heterocyst mostly basal, Seldom intercalary. Spores when formed single or in series, next to the basal heterocyst.

Key to the species of the genus

- Filaments shorter, distinctly attenuated,
trichomes 5.5 - 7.5 µm broad *Calothrix braunii*
- Trichomes 4.4.5 µm broad *C. marchica*.

13. *Calothrix branunii* (A. Br) Bornet et

Flahault Detoni 1907, 15: 624; Desikachary, 1959: 535.

(Plate II, Fig. 6)

Filaments aggregated in tufts, blue-green, straight, swollen at the base, 9-12, μm broad, sheath thin, close to trichomes, colourless to yellowish. Trichome 7-8 μm broad and 5-4 μm at the base at middle, ending in a minute pointed cells which is sometimes seem to be with a long hair cells constricted at the cross-walls, spherical, 6-8 μm broad, 4-5 μm long. Heterocyst 5-10 μm . rounded to oblong,

Distribution: Collected from the fields of Plant Protection Deptt. Karach University where Jwar, cotton and soya beans were growing.

Note: Our material differs from the type material only in the measurements of heterocyst cells.

14. *Calothrix marchica* (Lemm) Cressa Rao C.B.

Rao, 1937; 349

(Plate II, Fig. 7)

Thallus brown, gelatinous, filaments bend entangled short to very long, sheath thin, yellowish 9-14.5 μm broad. Trichomes 8-12.5 μm broad, constricted at septa, cells concial with rounded or pointed ends, 2.5 μm long quadratic to sub-spherical, 3.4 μm long, trichomes somewhat tapering at the end of the filaments. Heterocyst spherical to sub-spherical, basal, sometimes intercalary, 8-12.5 μm broad, 4 μm ong. False branching sometimes present. Sometimes whole trichome not covered with Sheath.

Distribution: Collected in the soil samples of Plant Protection Department Karach University.

Note: Our material fully agrees with original description but differs sometime in the measurements.

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Description of Plates and Figures

Plate I

- Fig. 1. *Lyngbya polysiphonea* Sremy.
Fig. 2. *L. majascula* Harvey ex gomont.
Fig. 3. *L. hicronymusii* Lemmerman.
Fig. 4. *Oscillatoria amoena* (kutz) Gomont.
Fig. 5. *O. cortiana* Meneghint ex Gomont.
Fig. 6. *O. Acuminate* Gomont.
Fig. 7. *Phormidium trunicola* Ghose.
(Drawings are made according to measurement
1 um. = 1.5 cm.)

PLATE I

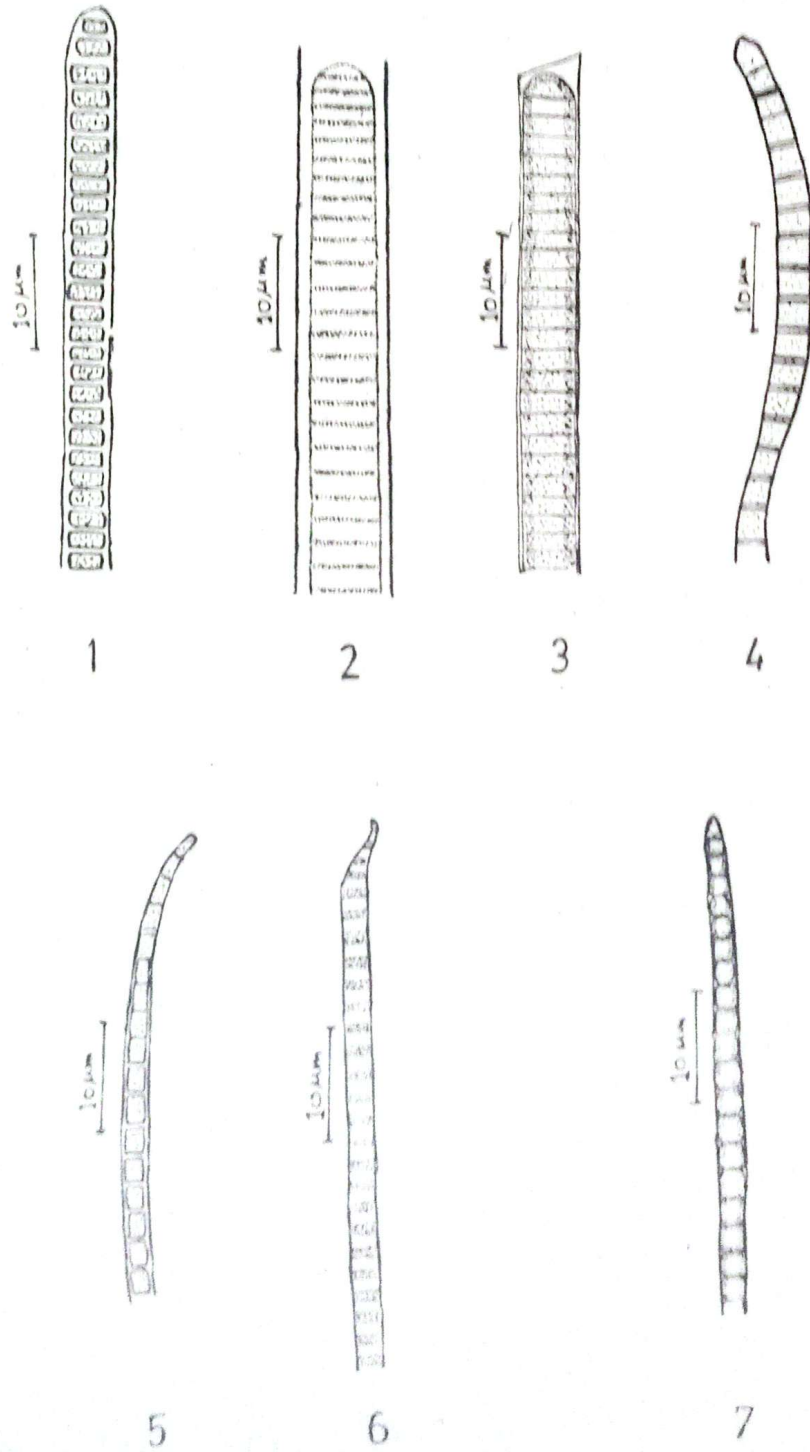


Plate II

- Fig. 1. *Nostoc linckia* (roth) Bornet ex Flahault.
Fig. 2. *N. Carneum* ag. ex. Bornet ex Flahault.
Fig. 3. *N. elliposporum* (deshm.) Rabenii ex Bornet et Flahault..
Fig. 4. *Anabaina vaginicola* Fritsch and Rch.
Fig. 5. *Tolypothrix tenuis* (kutz) Jhons Schmidth. emk.
Fig. 6. *Calothrix braunii* (a.br.) Bornet et Flahault.
Fig. 7. *C. marchica* (lemm.) Cressa Rao, c.b.

(Drawings are mae according to measurement
1 um. = 1.5 cm.)

PLATE II

