

SOIL ALGAE FROM SEMI-ARID REGIONS

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ABSTRACT

The soil algal flora of the semi-arid regions has attracted very little attention so far. The present paper deals with the study of the blue-green algae from the semi-arid north western Rajasthan. Very few earlier reports are available and still few are directly concerned with the soil algae. Cyanophyceae members are the dominant constituent and forty one species belonging to seventeen genera are being described.

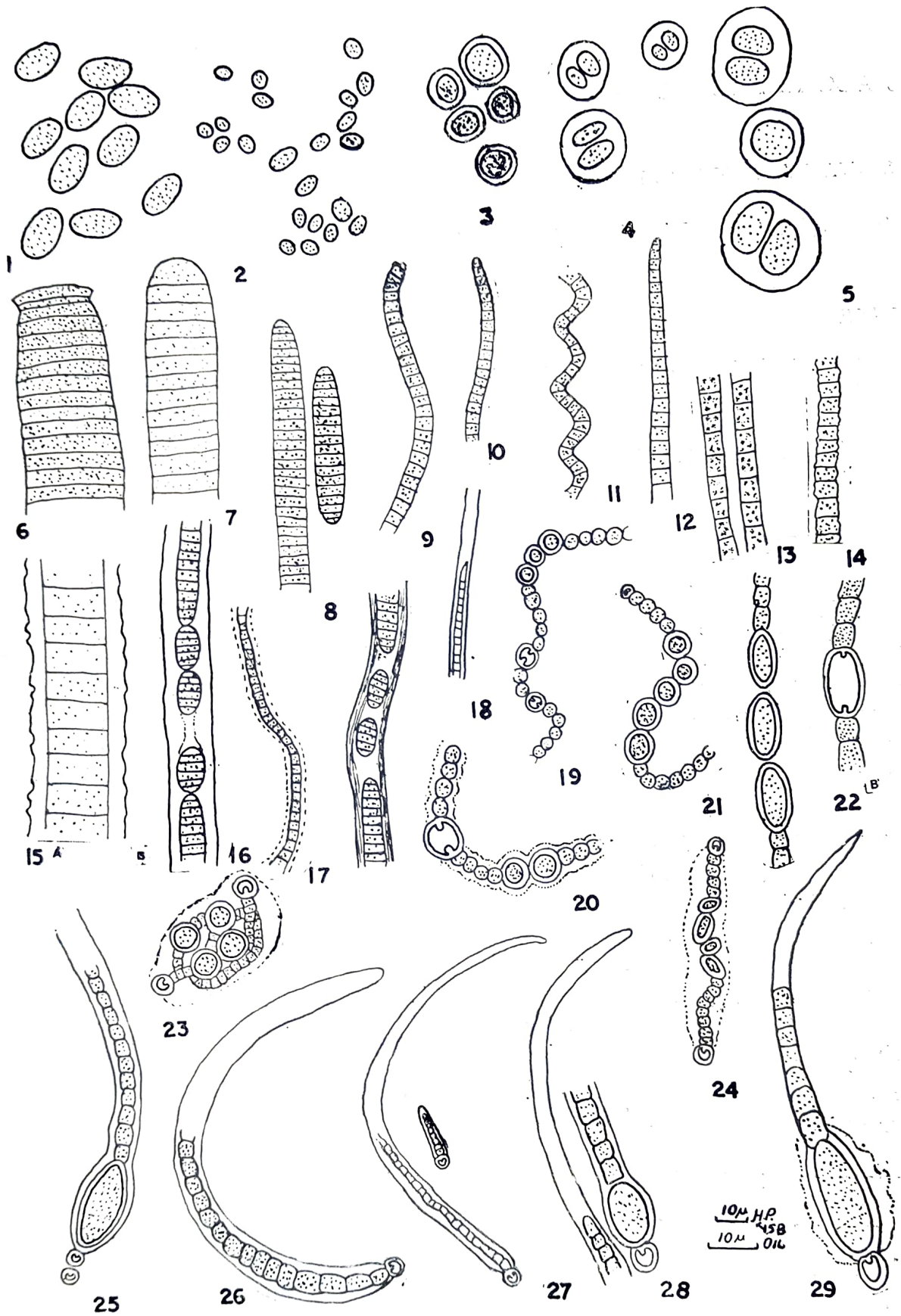
INTRODUCTION

The study of soil algae from the semi-arid regions of the north western Rajasthan has received very little attention so far. BHANDARI (1952) described algal flora of Jodhpur in which only 18 genera of blue green algae were described without assigning the species. GODBOLE (1952) described 5 species of algae while tracing the origin of salt in Sambhar lake. KAMAT (1968) gave an account of the algal flora of Mount Abu. VAIDYA AND PATEL (1968) also gave a preliminary survey of algal flora of Mount Abu. GUPTA AND KUMAR (1968) described the blue-green algal flora of Udaipur. VYAS (1968) discussed the ecology of phytoplanktons of Pichhola lake, Udaipur. SUBBARAMAIAH (1970), while dealing with the biology of the blue-green algae of the Sambhar lake reported 15 species of blue-green algae. GUPTA (1972) has reported 16 species of blue-green algae from different parts of Rajasthan. The present study deals with the survey of blue-green soil algae of the semi-arid regions. We report in this paper the description of algae from the soils and soil cultures of these regions.

Jodhpur lies between 26.18 North lat. and 73.1 East long. It has arid conditions characterised by high temperatures and an annual precipitation of 25 to 30 cms. During the rains, the soils support good algal flora which survives for a long time in the moist sheltered places along the water reservoirs and their channels. Members of Cyanophyceae are the dominant constituents of this soil algal flora.

MATERIAL AND METHOD

The algae have been collected from sub-aerial terrestrial habitats. The soil samples were collected under aseptic conditions in polythene bags and brought to the laboratory. The cultures were obtained by using the dilution method. Allen and Arnon medium was used for the cultures. The soil water biphasic medium and Chu 10 and the Godward media were also used with good success. The cultures were maintained at room temperatures and light was provided by a band of fluorescent tube lights. The following taxa have been collected, identified and in most of the cases obtained in the laboratory cultures also. All the identifications are based on DESIKACHARY (1959) except *Gloeotrichia raciborskii* var. *kailaensis* which is based on GOYAL (1964).



1. *Synechococcus aeruginosus*, part of colony, 2. *Aphanothece nagelli*, part of a colony, 3. *Gloeocapsa pleurocapsoides*, few cells of a colony, 4. *Chroococcus minutus*, few cells, 5. *Chroococcus turgidus*, few cells, 6. *Oscillatoria princeps*, portion of a filament, 7. *Oscillatoria curviceps*, habit of a filament, 8. *Oscillatoria subbrevis*, part of a filament, 9. *Oscillatoria okenii*, part of a filament, 10. *Oscillatoria chlorina*, portion of a filament, 11. *Arthrospira platensis*, Part of a filament showing the habit, 12. *Oscillatoria jatorvensis*, part of a filament, 13. *Oscillatoria raouii*, part of a filament, 14. *Oscillatoria ornata*, part of a filament, 15. *Lyngbya major*, A & B. Show-

SYSTEMATIC ENUMERATION

1. *Microcystis aeruginosa* Kuetz.

Colonies when young round and solid with hyaline mucilage. Cells slightly longer than broad, 3.0-6.5 μm in diameter. Obtained from the Chattar tank soil cultures but forms almost perennial bloom in many tanks.

2. *Chroococcus turgidus* (Kuetz.) Naeg., Text-fig. 5.

Cells spherical or ellipsoidal, single or in groups of 2-4, without sheath 8-32 μm broad, with sheath 13-25 μm broad, sheath colourless. Cells light blue-green. Collected from the Chattar tank soils and from soil cultures therefrom, August, 1977.

3. *Chroococcus minutus* (Kuetz.) Naeg., Text-fig. 4.

Thallus microscopic, colonies with few cells only, cells spherical to oblong, single or in groups of 2-4, blue-green, without sheath 4-10 μm broad with sheath 6-15 μm broad, sheath, thin hyaline and non-lamellated. Obtained from the soils and soil cultures from Chattar tank, February 1977.

4. *Gloeocapsa pleurocapsoides* Novacek., Text-fig. 3.

Thallus crustaceous, thin, blackish brown, cells spherical, without sheath, 5-10 μm in diameter, sheath thin, non-lamellated. Obtained from soil collections, Chattar tank, March 1977.

5. *Gloeothece membranacea* (Raben.) Bornet

Thallus expanded and leathery, cells olive-green. Without sheath 4.5-5.6 μm broad, 8.0-9.0 μm long, sheath colourless and diffluent. Obtained in the soil collections of Mandore soils and Chattar tank.

6. *Aphanothece naegelli* Wartm., Text-fig. 2.

Thallus shiny, gelatinous and yellowish-brown. Cells oval but become spherical before dividing. 3.5-4.5 μm broad and 6.5-8.0 μm long. Sheath diffluent. Collected from the campus soils, January-February 1977.

7. *Synechococcus aeruginosus* Naeg., Text-fig. 1.

Cells single or in groups of 2 to 4, cylindrical in shape. Colonies blue-green, microscopic patches on soil. Cells 6.0-14.5 μm broad and upto 28.5 μm long. Mucilage not very distinct and the cells show very clear transverse divisions. This alga has not been reported so far from north India.

8. *Coelosphaerium kuetzingianum* Naeg.

Colonies microscopic, more or less spherical and have a thin mucilage cover, cells loosely arranged, subspherical, 2.0-3.5 μm broad. Obtained from the Chattar tank soil cultures, February-March 1977. This is a new report for this alga from north India.

ing parts of filaments, 16. *Lyngbya rubida*, a part of a filament, 17. *Lyngbya truncicola*, a part of a filament, 18. *Phormidium rubroterricola*, filament showing habit, 19. *Nostoc linckia*, a part of colony showing heterocyst and akinete, 20. *Nostoc linckia* var. *arvense*, a colony showing habit, 21. *Nostoc calcicota*, a part of a filament, 22. *Nostoc ellipsesporum*, A & B, showing habit with akinete and heterocyst, 23. *Nostoc punctiforme*, a part of a filament, 24. *Nostoc paludosum*, a part of a filament, 25. *Calothrix membaerensis*, a filament with akinete and heterocyst, 26. *Calothrix marchica* var. *crassa*, a filament showing habit, 27. *Calothrix membranacea*, a filament with akinete and heterocyst, 28. *Calothrix bharaadwajae*, a filament showing habit, 29. *Gloeoetrichia raciborskii*, a filament with basal akinete and heterocyst.

9. *Merismopedia tenuissima* Lemm.

Microscopic pale blue green colonies of mostly 16 cells each. Cells subspherical, 1.3-2.0 μm broad. Obtained from Balsamand and Chattar tank soil cultures, March, 1977.

10. *Arthrospira platensis* (Nordst.) Gomont., Text-fig. 11.

Thallus blue-green, trichomes slightly constricted at the cross walls. Cells 6.0-8.0 μm broad, not attenuated, more or less spirally coiled, spirals 26.0-36.0 μm broad. Only few filaments obtained in the cultures of the soil collections from Balsamand and Mandore, February-March, 1977.

11. *Spirulina major* Kuetz. ex. Gomont.

Trichomes 1.5-2.0 μm broad, regularly spirally coiled, spirals 2.0-4.0 μm broad, spirals about 2.0 μm distant. Obtained rarely in fresh soil collections from Kailana and Mandore, August and September, 1977.

12. *Oscillatoria okeni* Ag. ex. Gomont., Text-fig. 9.

Thallus blue-green, trichomes straight, 5.0-9.5 μm broad, not constricted at cross walls, and cells slightly bent, sub-conical, not capitate. From cultures only. Mandore soil samples, November, 1976.

13. *Oscillatoria subbrevis* Schmidle forma *crassa* Dixit, Text. fig. 8.

Thallus blue-green, trichomes nearly straight, not attenuated, cells 5.0-6.5 μm broad, 1.5-2.0 μm long, not granulated, end cells round, hormogonia present. Very common on the moist soils and the cultures, both, July to October, 1976.

14. *Oscillatoria princeps* Vaucher ex. Gomont., Text-fig. 6.

Trichomes straight, unconstricted at the crosswalls, cells 35.0-40.5 μm broad, non-granulated, apical cells slightly convex. Thallus bright and the alga is common in late winters, beginning from October to March, 1977.

15. *Oscillatoria curviceps* Ag. ex. Gomont., Text-fig. 7.

Trichomes slightly bent at the spices otherwise straight, not attenuated. Cells 10.0-17.5 μm broad. 2.5-4.5 μm long, end cells rounded. Obtained from the soils and the soil cultures from Balsamand and Chattar tank collections, August, 1977.

16. *Oscillatoria chlorina* Kuetz. ex Gomont, Text-fig. 10.

Thallus bright yellowish green, trichomes straight, cells 3.5-4.0 μm broad, 4.0-5.0 μm long, cross walls nongranulated and the end cells rounded. Very common throughout the year in soils everywhere and easily obtainable in cultures.

17. *Oscillatoria jasorvensis* Vouk., Text-fig. 12.

Thallus bright blue-green, trichomes 3.5-5.0 μm broad and 4.0-6.5 μm long, slightly bent at the end and a little attenuated without calyptra.

18. *Oscillatoria raoi* De Toni J., Text-fig. 13.

Thallus pale blue-green. Trichomes straight, not constricted at cross walls, septa indistinct, many granules present at both the sides of septa, cells 5.2-6.0 μm broad, end cells slightly conical, not capitate. Planktonic with other algae in Chattar tank and Kailana lake, July to October 1977.

19. *Oscillatoria ornata* Ag. ex. Gomont., Text-fig. 9.

Thallus blue-green, trichomes straight, 5.0-6.5 μm broad, not constricted at the cross walls, gradually attenuated, end cells sub-conical and slightly bent, not capitate. Obtained in the soil cultures only. Mandore soils, November, 1976.

20. *Oscillatoria subuliformis* Kuetz. ex. Gomont.

Dull green thallus, trichomes very long and slightly bent, 5.0-6.0 μm broad, end cells attenuated and bent. Obtained only in soil cultures from Chattar tank soil samples, October, 1976.

21. *Oscillatoria acuta* Bruhl et Biswas, orth. mut. Geitler.

Thallus consists of parallel trichomes, cross walls smooth, trichomes slightly attenuated, cells 4-6 μm , ends acute, collected from moist soils, Chattar tank, October, 1976 and March, 1978.

22. *Phormidium tenue* (Menegh.) Gomont.

Thallus expanded, pale blue-green, filaments straight, sheath thin and hyaline. Filaments 1.4-2.0 μm broad, trichomes 1.0-1.5 μm broad. Obtained from almost all soils and soil cultures.

23. *Phormidium rubroterraicola* Gardner, Text-fig. 18.

Thallus thin, pale blue-green. Trichomes 2.0-2.5 μm broad, cells quadrate, sheath hyaline, thin and distinct in association with *Riccia* spp. rhizoids in nature, in soil cultures of Kailana and Chattar tank samples, January-March, 1977.

24. *Lyngbya rubida* Frémy, Text-fig. 16.

Filaments straight, purple-brown, sheath thick not lamellated, trichomes 4.0-4.5 μm broad, not constricted at the cross walls, sheath upto 1.0 μm thick, end cells rounded. Obtained in the Chattar tank soil cultures, August, 1977.

25. *Lyngbya truncicola* Ghose, Text-fig. 17.

Filaments straight, blue-green, sheath firm and shows few fine lamellae, filaments, 14.5-16.0 μm broad, unconstricted at the cross walls. Soils and soil cultures from Chattar tank, December-March, 1977.

26. *Lyngbya versicolor* (Wartm.) Gomont., Text-fig. 16.

Filaments blue-green, many entangled, trichome 2.5-3.0 μm broad, 2.5-6.0 μm long, end cells rounded. Soil cultures from Chattar tank.

27. *Lyngbya major* Menegh. ex. Gomont, Text-fig. 15.

Filaments long, dark-blue-green, straight, 10.0-14.5 μm broad, 2.5-4.0 μm long, end cells rounded and thickened. From the soil cultures and soil samples of Akhey Raj tank.

28. *Nostoc paludosum* Kuetz. ex. Born. et Flah., Text-fig. 24.

Thallus microscopic, gelatinous, sheath hyaline. Cells 3.0-3.5 μm broad and 3.0-3.5 μm long, barrel shaped. Heterocysts 5.6-6.0 μm broad, 6.0-7.0 μm long, spores oval, 4.0-4.5 μm broad, 6.5-7.0 μm long. From soils and soil cultures of Chattar tank samples.

29. *Nostoc punctiforme* (Kuetz.) Harriot, Text-fig. 23.

Thallus attached, subspherical. Filaments entangled, mucilage colourless, shining blue-green. Cells barrel shaped, 3.0-4.5 μm broad. Heterocysts ellipsoidal, 4.0-6.5 μm broad, spores thick walled, spherical to oblong, 5.0-6.0 μm broad and 5.0-7.5 μm long. Obtained from Mandore soil samples and soil cultures, August to November, 1977.

30. *Nostoc linckia* (Roth.) Born. et Flah., Text-fig. 19.

Thallus very small spherical to subspherical, blue-green to blackish in colour. Filaments entangled with hyaline mucilage. Trichomes 3.0-4.0 μm broad, cells barrel shaped and short, heterocysts subspherical 3.0-4.0 μm broad, spores also subspherical, 6.0-7.0 μm broad and 6.0-7.0 μm long. From the soils and soil cultures of all localities, August to November 1976 to 1977.

31. *Nostoc linckia* var. *arvense* Rao, C. B., Text-fig. 20.

Thallus yellowish brown to blue-green in colour, filaments many and contorted. Cells 4.5-5.5 μm broad, 4.8-6.5 μm long, distinct individual sheaths present with the trichomes in moist conditions. Heterocysts spherical but not covered with mucilage, 4.5-7.5 μm broad. Spores in long chains, spherical to subspherical, 7.0-8.0 μm broad. Obtained from Balsamand soil samples and soil cultures, August to November, 1977.

32. *Nostoc muscorum* Ag. ex. Born. et Flah.

Thallus expanded, attached, 2.5-4.5 μm in diameter, dirty green in colour, filaments contorted, sheath distinct at places. Trichomes 3.5-4.0 μm broad, cells bead shaped, 3.5-4.0 μm broad and 6.5-7.5 μm long. Heterocysts subspherical, 6.0-6.5 μm broad, spores 4.5-8.0 μm broad and 7.5-10.0 μm long, many in series. Obtained from Chattar tank soil and soil cultures, November, 1977.

33. *Nostoc calcicola* Brebisson ex. Born. et Flah., Text-fig. 21.

Thallus expanded, dirty blue-green in colour, sheath hyaline, cells barrel shaped, 2.5-4.0 μm broad. Heterocysts sub-spherical, 4.0-5.0 μm broad, spores spherical 4.0-5.0 μm broad. Trichomes in the present material are slightly bigger than recorded for the alga. Obtained from Chattar tank soil samples and soil cultures, February and March, 1977.

34. *Scytonema pascheri* Bharadwaja

Thick wooly growth forming dark-green stratum, filaments densely packed, 18.5-22.0 μm broad, sheath firm and thick, about 4.0 μm thick, cells 9.5-11.0 μm broad and 3.5-5.5 μm long, longer and narrower in the older parts, heterocysts intercalary, 9.5-12.5 μm broad and 10.5-19.0 μm long. Obtained from the soils and soil cultures of Balsamand and Mandore soil cultures, July and August 1977.

35. *Scytonema hofmannii* Ag. ex. Born. et Flah.

Thallus cushion like, filaments heterotrichous, 7.5-12.5 μm broad, false branches common, sheath firm, hyaline, trichome 5.6-10.0 μm broad, heterocysts intercalary, oval to oblong. From Chattar tank soils and soil cultures, August to September, 1976.

36. *Calothrix wembaerensis* Hieron. et Schmidle, Text-fig. 25.

Thallus dirty green. Filaments branched, long, sheath distinct and hyaline, cells at the base 7.5-8.5 μm broad, 3.5-10.5 μm long, heterocysts basal. Spores cylindrical to

subcylindrical, 10.5-12.5 μm broad. Filaments 10.5-14.0 μm broad at the base. From the campus soils and soil cultures, November, 1977.

37. *Calothrix bharadwajae* De Toni, J., Text-fig. 28.

Thallus brownish in colour and makes depressions in the agar medium. Filaments in groups, slightly bent with frequent false branching, sheath very distinct, hyaline and closely attached with the trichome. Trichome shows definite constrictions at the joints and slowly tapers but does not form narrow hair like structure. Cells barrel shaped. Heterocysts basal, spherical to sub-spherical, 4.0-5.5 μm broad, intercalary heterocysts also present. Trichome 6.5-7.0 μm broad at the base and about 4.0 μm broad at the apex. Spores 6.5-8.0 μm broad and 8.0-11.5 μm long. The length of the spores in this case is less than that recorded earlier. Chattar tank soil cultures, January 1977, 1978.

38. *Calothrix membranacea* Schmidle, Text-fig. 27.

Thallus blue-green to brown, filaments long blue-green showing few false branches only. Sheath thin, hyaline and clear. Trichomes 4.5-6.5 μm broad at the base and taper towards the anterior end. Cells 4.5-6.5 μm broad and as long. Hormogonia with few cells formed in series. Heterocysts basal, 4.0-5.0 μm , broad. Balsamand soil cultures only, January and February, 1977.

39. *Calothrix marchica* Lemmermann var. *crassa* Rao, C. B., Text-fig. 26.

Thallus blue-green to dull brown made up of filaments in groups, filaments entangled, 9.5-14.5 μm broad with thin, hyaline and firm sheath, trichomes constricted at the joints, 8.4-12.8 μm broad at the base, cells smaller in length than the breadth, heterocysts basal, spherical to sub-spherical. Dimensions of heterocyst, 8.0-10.0 μm .

40. *Gloetrichia raciborskii* Woloszynska, Text-fig. 29.

Thallus soft ; many radiating filaments, free floating in Kailana, Chattar tank and also at the banks of the water reservoirs. Trichomes at the base 8.0-10.0 μm broad, at the apex 5.0-7.5 μm broad, spores ellipsoidal, 11.0-15.5 μm broad. Heterocysts basal, spherical, sometimes two, 8.0-10 μm broad. Trichome tapers into a long thin hair. August-March 1976, 1977.

41. *Gloetrichia raciborskii* var. *kailaensis* Goyal.

Filaments dirty green to blue-green. Trichome at the base 8.0 to 10.5 μm broad, at the apex 5.5-7.0 μm broad. Spores ellipsoidal, 11.5-15.0 μm broad. Heterocysts basal and spherical, 8.5-10.0 μm broad. Sheath thin, hyaline. The apical portion ends in hair.

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