

THE MYXOPHYCEÆ OF THE UNITED PROVINCES, INDIA.—I.

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ALTHOUGH the Myxophyceæ are mainly a vegetation of the tropics no serious and continued effort has yet been made to record all the forms that grow in this large country. In recent years Carter, Ghose, Brühl, Biswas and the writer have recorded a number of blue-green algæ from a few limited areas, but the number of species described is yet too small and most of the country still remains to be explored. A more vigorous and consolidated effort should therefore be made to record the myxophyceous flora of this land. The writer has been collecting these algæ for several years from various localities in the north, especially in the United Provinces, the Punjab and Kashmir, and has decided to determine them in lots. The present paper deals with twenty-one forms, representing ten genera, collected from Benares.* With the exception of *Glæocapsa atrata* (Turp.) Kütz., which was found growing on a damp wall, all the forms are aquatic. Out of twenty-one plants described below, seven are new species, three are new varieties and four are new forms.

SYSTEMATIC ENUMERATION OF THE SPECIES OBSERVED.

I. CHROOCOCCALES.

Chroococcaceæ.

Genus *Microcystis* Kützing.

1. *Microcystis æruginosa* Kütz. Geitler, in Rabenhorst's *Kryptogamenflora von Europa*, XIV Band, Cyanophyceæ, 1930-32, p. 136, Fig. 59d.

Colonies spherical when young, elongated and distinctly broken through when old. Sheath indistinct. Cells with pseudovacuoles.

Lat. cell., 3-4.5 μ .

Habitat:—Planktonic in a stagnant pond.

2. *Microcystis flos-aquæ* (Wittr.), Kirchn. Lemmermann, *Kryptogamenflora d. Mark Brandenburg*, iii, Algen I, p. 75, 1910; in *Engler-Prantl Nat. Pflanzenfam.* I, 1a, p. 56, 1900.

* Benares is situated in latitude 25° 19' N. and longitude 83° 03' E., at a height of 267 feet above mean sea-level. The hottest months, namely, April, May and June, have a mean maximum temperature of 113.2°F., the highest temperature recorded being 117°F. The coldest months are December and January and they record a mean minimum temperature of 39°F., the extreme minimum temperature being 36°F. June, July, August and September are the chief rainy months, and during this period the rainfall averages about 33", the average annual rainfall being about 40".

Colonies more or less rounded, unbroken, with indistinct sheath. Cells spherical, with pseudovacuoles.

Lat. cell., 3–6 μ .

Habitat:—Planktonic in a stagnant pond.

3. *Microcystis ramosa* Sp. Nov. (Fig. 1, A).

Colonies long, varying greatly in form and size, irregularly branched, constricted at intervals to form daughter-colonies which are ultimately broken off. Daughter-colonies at first almost compact and rounded, later elongated and irregularly branched like the parent. Sheath thick, unstratified, hyaline, and rather indistinct, stained violet with methylene blue. Cells spherical, with pseudovacuoles.

Lat. cell., 3–5 μ ; diam. colon., up to 80 μ ; long. colon., up to 1,600 μ .

Habitat:—Planktonic in a stagnant pond.

This species resembles *Microcystis pseudofilamentosa* Crow in its elongated form and being composed of small colonies which break off and grow again into compound colonies, but it differs from the Ceylon species in its much larger colonies and rather smaller size of the cells. The Benares species also differs in its branched habit and being never broken through or reticulate.

Genus *Aphanocapsa* Nægeli.

4. *Aphanocapsa benaresensis* Sp. Nov. (Fig. 1, B).

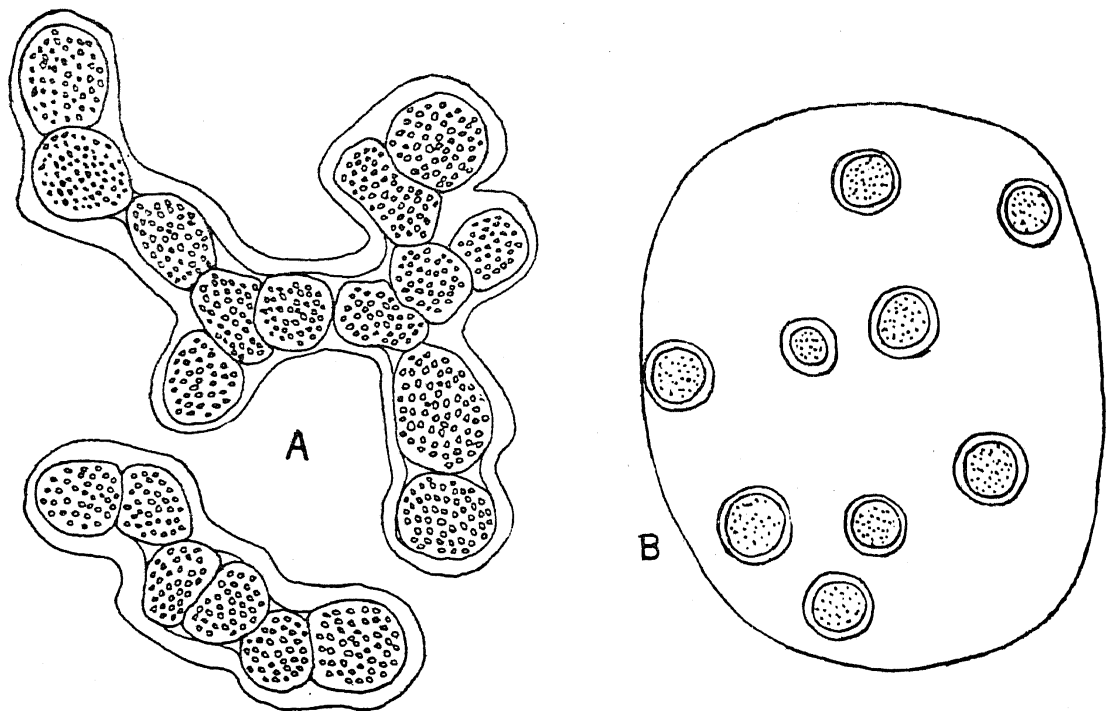


FIG. 1.

A—*Microcystis ramosa* Sp. Nov.; B—*Aphanocapsa benaresensis* Sp. Nov. A $\times 150$; B $\times 1,200$.

Plant-mass soft, spherical, hollow, irregularly broken, hyaline or cream-coloured. Cells oval or almost spherical. Sheath thick, unstratified, hyaline, closely adpressed to the cells.

Diam. plant-mass, up to 1.5 cm.; lat. cell., 4-6.2 μ ; lat. vag. up to 1 μ .

Habitat:—Planktonic in a stagnant pond.

This alga approaches *Aphanocapsa Roeseana* de Bary according to the key given by Geitler (*op. cit.*), but it differs in the size and colour of the plant-masses and also in the size of the cells.

Genus *Glæocapsa* Kützing, emend. Nægeli.

5. *Glæocapsa atrata* (Turp.) Kütz. Geitler, *op. cit.*, p. 186, Fig. 83c.

Plant-mass expanded, gelatinous, slightly hard, of indefinite shape, pale-yellow. Sheath thin, hyaline, unstratified.

Diam. colon., up to 50 μ ; lat. cell., 3.4-5 μ ; lat. cell., cum vag., 5.2-14.5 μ .

Habitat:—On a damp wall, near a small water reservoir in the writer's house.

II. HORMOGONIALES.

(a) *Oscillatoriaceæ*.

Genus *Lyngbya* C. Agardh.

6. *Lyngbya Martensiana* Menegh. Geitler, in Pascher's *Die Süßwasserflora Deutschlands, Österreichs und der Schweiz.*, Heft 12, *Cyanophyceæ*, 1925, p. 407, Fig. 521a.

Forma (Fig. 2, A).

Filaments single, long, straight, rarely slightly curved. Sheath thick, firm, hyaline, diffuent on the outside and exhibiting an uneven surface. Trichomes uniformly thick, without constrictions at the joints and with a row of coarse granules on either side of the indistinct cross-walls. Cells flattened; apical cell broadly rounded. Hormogones consisting of one to many cells; single-celled hormogone often getting turned over and presenting its flat surface in optical section.

Long. fil., up to 3 mm.; lat. vag., up to 3.1 μ ; lat. trich., 10.5 μ ; long. cell., 2.1-5.2 μ .

Habitat:—On dead leaves, among other algæ, floating in a stagnant pond.

This form agrees with the type in (1) the presence of granules by the side of the indistinct cross-walls, (2) the end-cell being broadly rounded, and (3) the colourless thick sheath; but it differs from the same in (a) the filaments being generally straight and not curved, and being single and never

in bundles, (b) the trichomes being a little broader, and (c) the sheath being diffuent on the outside.

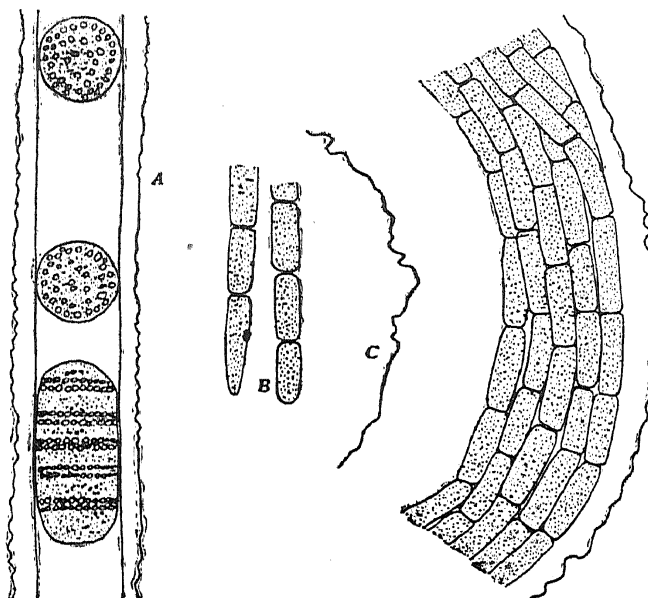


FIG. 2.

A—*Lyngbya Martensiana* Menegh. forma; B—terminal portions of two trichomes and C—portion of filament of *Microcoleus chthonoplastes* Thur. All $\times 910$.

Genus *Microcoleus* Desmazières.

7. *Microcoleus chthonoplastes* Thur. Gomont, *Monographie de Oscillariées*, 1893, Pl. XIV, Figs. 5–8. (Fig. 2, B and C).

Lat. cell., 3.1μ ; lat. vag., up to 16.8μ .

Habitat:—In a stagnant pond along with other algæ.

This alga differs from the type in the cells being up to four times as long as broad, and the apical cells being occasionally broadly rounded at the apex, although as a general rule they are conical.

(b) *Rivulariaceæ*.

Genus *Calothrix* Agardh.

8. *Calothrix scytonemicola** Tilden. *Minnesota Algæ*, 1910, I, p. 265, Pl. 17, Fig. 7. (Fig. 3, A and B).

Forma.

Long. fil., up to 350μ ; lat. cell., up to 6.3μ ; lat. heterocyst termin., $4.2-6.3 \mu$; long. heterocyst subtermin., $9.4-21 \mu$; lat. heterocyst subtermin., $4.2-7.3 \mu$.

Habitat:—On other algæ (e.g., *Aulosira*) growing on floating dead leaves in a stagnant pond.

* Geitler (*op. cit.*, 1930–32, p. 627) does not write well about this species and also about Borge's variety *brasiliensis*.

This form differs from the type in the sheath being generally distinct and the heterocysts being smaller, the terminal ones being also provided with finely granular contents. The distinctive feature in this form is the presence of basal heterocysts in pairs, one spherical or almost spherical and the other cylindrical. The other species of *Calothrix* possessing two basal heterocysts are *C. confervicola* Kg., *C. stagnalis* Gomont and *C. Castelli* Frémy with which there is no resemblance of the alga under discussion.

9. *Calothrix Ghosei* Sp. Nov. (Fig. 3, C—F).

Filaments in groups, straight or slightly bent. Sheath very distinct, thin, hyaline. Mature trichomes with slight constrictions at the distinct septa ; terminal portion not tapering into a hair and the terminal cell being

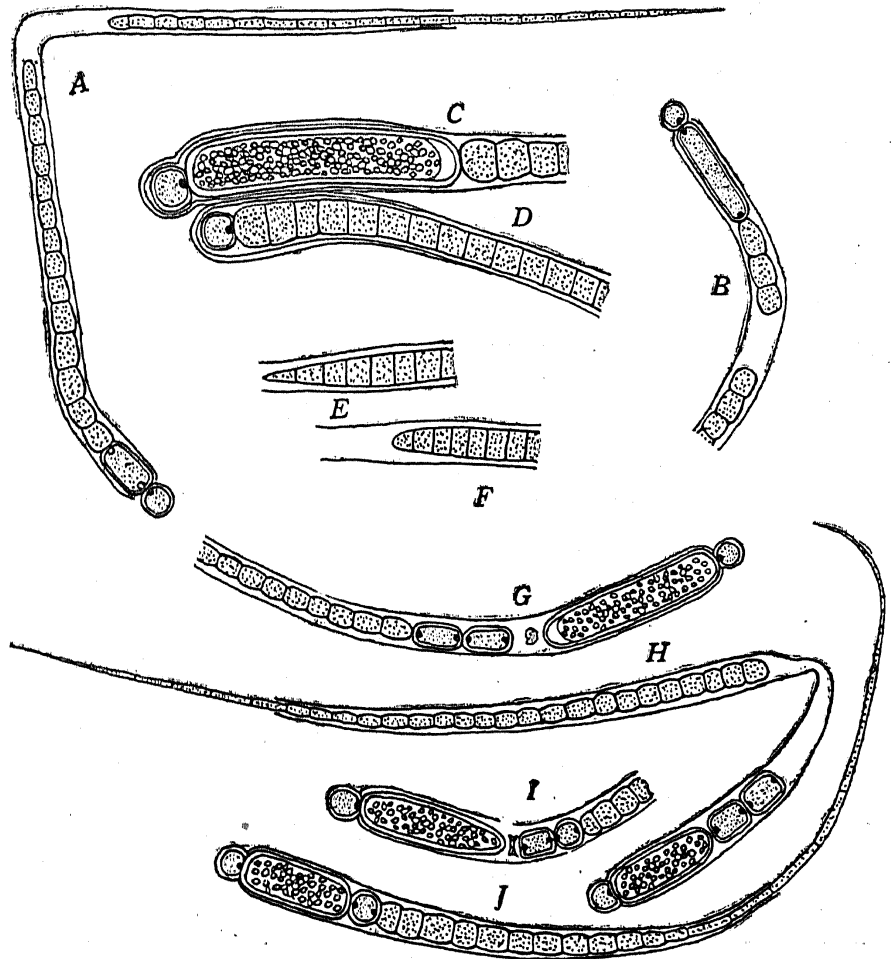


FIG. 3.

A and B—*Calothrix scytonemicola* Tilden ; C and D—basal portions and E and F—terminal portions of filaments of *Calothrix Ghosei* Sp. Nov. ; G—J—*Calothrix Fritschii* Sp. Nov.

A, B, G—J $\times 900$; C—F $\times 640$.

either sharply pointed or rounded at the apex. Cells quadratic or barrel-shaped, slightly longer or shorter than broad. Heterocysts single, basal, almost spherical or slightly broader than long, enclosed within the sheath. Spores single adjoining the basal heterocyst, cylindrical with rounded end-walls, the outer wall being smooth and hyaline.

Long. fil., up to 250 μ ; lat. fil., 7.3–13.7 μ ; lat. cell., 6.3–8.4 μ ; lat. heterocyst., 4.2–6.3 μ ; lat. spor., 10.5–12.5 μ ; long. spor., 31.5–52.5 μ .

Habitat:—Epiphytic on a species of *Chara* in a stagnant pond.

This alga resembles *Calothrix gracilis* Fritsch in (1) its epiphytic habit, (2) the absence of a hair-like termination of the trichome, (3) a distinct thin sheath enclosing the basal heterocyst, and (4) the cylindrical spores; but it differs from the same in (a) the filaments being shorter and broader, (b) the heterocysts being slightly narrower than the trichomes and being almost spherical or slightly broader than long, but never hemispherical, (c) the absence of intercalary heterocysts, and (d) the larger spores.

10. *Calothrix Fritschii* Sp. Nov. (Fig. 3, G—J).

Filaments generally in groups of 3 to 7, straight or slightly bent. Sheath very distinct, thin, hyaline, closely adpressed to the trichome. Trichomes with constrictions at the joints and tapering into a long hair, the terminal portion of which is generally unsheathed; septa distinct. Cells barrel-shaped, as long as broad or slightly longer (or sometimes slightly shorter) than broad; cells of the hair very much elongated and almost rectangular. Heterocysts basal and intercalary; basal heterocysts single, spherical or sub-spherical; intercalary heterocysts single or in pairs, spherical, quadratic or cylindrical, adjoining the basal spore or occasionally separated from it by a small dis-integrated cell. Spores single, adjoining the basal heterocyst, cylindrical or sometimes somewhat conical, with rounded end-walls; outer wall smooth and hyaline.

Long. fil., up to 420 μ ; lat. trich., up to 6.3 μ ; lat. heterocyst., 4.2–6.3 μ ; lat. spor., 6.3–8.4 μ ; long. spor., 21–42 μ .

Habitat:—On a species of *Aulosira* growing on floating dead leaves in a stagnant pond.

The distinctive feature of this species is that, besides a single spherical basal heterocyst, there are one or two intercalary ones also adjoining the sub-basal spore. Geitler (*op. cit.*, 1930–32) has recorded only seven species of *Calothrix* which produce spores, and of these only two, *C. stagnalis* Gomont and *C. wembærensis* Hieron. et Schmidle, produce intercalary heterocysts adjoining the spores. The present species bears a striking superficial resemblance with *C. stagnalis* Gomont in its epiphytic habit, in the trichomes ending in a long hair and in the presence of intercalary heterocysts adjoin-

ing the spores which are cylindrical or slightly conical. But it differs from Gomont's species in the much shorter filaments, the narrower and barrel-shaped cells, the presence of constrictions at the joints, the thinner spores, and in the basal heterocysts being never in pairs.

A comparison may also be made with *Calothrix wembærensis* Hieron. et Schmidle on account of the presence of barrel-shaped cells and the presence of intercalary heterocysts adjoining the cylindrical spores; but the Benares species differs from it in the shorter filaments, a thinner sheath and narrower cells, and also in the basal heterocysts being never in pairs and the spores being thinner and never in chains.

(c) *Scytonemataceæ.*

Genus *Microchæte* Thuret.

11. *Microchæte tenera* Thur. Bornet et Thuret, *Notes Alg.*, 2, Pl. XXX, Fig. 5, 1880.

Forma.

Lat. fil., 10–12 μ ; lat. trich., 8 μ ; lat. heterocyst., 8 μ ; long. heterocyst., 12–20 μ .

Habitat:—Along with species of *Stigeoclonium* and *Anabæna sphaerica* Born. et Flah. in a stagnant pond.

The form resembles the type except for the pale brownish-purple cell-contents, the occasional slight constrictions at the joints and much broader filaments.

Var. *tenuis*, Var. Nov. (Fig. 4, A—C).

Long. fil., up to 250 μ ; lat. fil., up to 4.2 μ ; lat. trich., 3.1–3.6 μ ; lat. heterocyst., 3.6–4.2 μ .

Habitat:—On floating dead leaves, among other algæ, in a stagnant pond.

This alga resembles the type in the thin hyaline unstratified sheath, in the cylindrical cells which are about twice as long as broad, and in the spherical heterocysts; but it differs in the narrow filaments and trichomes, and in the absence of cylindrical intercalary heterocysts. This variety possesses the narrowest filaments out of all the freshwater species of the genus so far recorded.

12. *Microchæte grisea* Thur. Bornet et Thuret, *op. cit.*, Pl. XXX.

Var. *brevis* Var. Nov. (Fig. 4, D).

Filaments straight, at the base often curved and swollen. Sheath thin and hyaline. Trichomes with distinct septa. Cells discoid, 2–3 times as broad as long. Heterocysts single, basal, hemispherical.

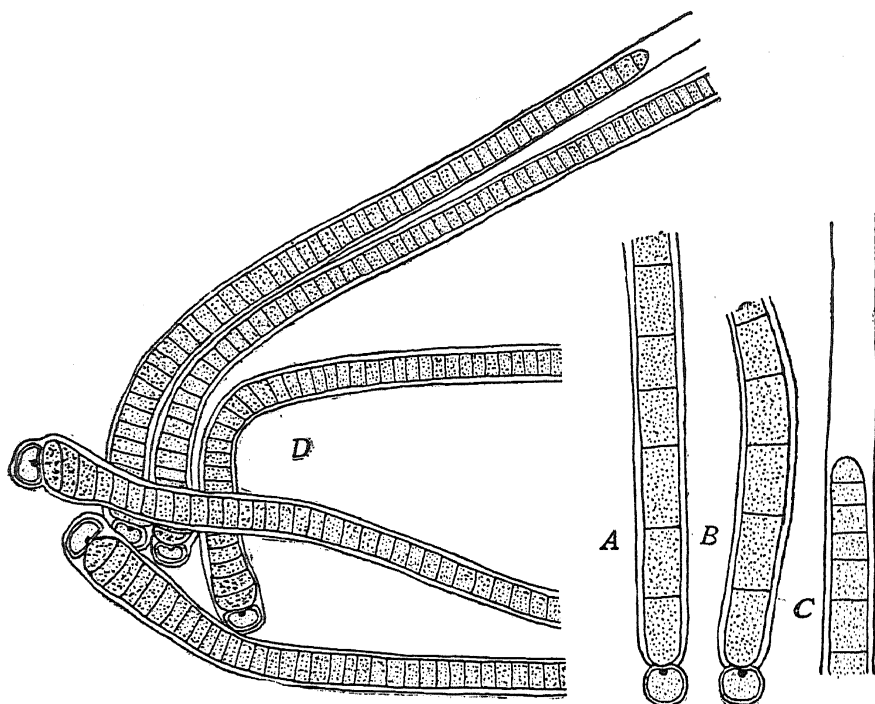


FIG. 4.

A and B—basal portions and C—terminal portion of filaments of *Microchate tenera* Thuret, var. *tenuis* Var. Nov.; D—*Microchate grisea* Thuret, var. *brevis* Var. Nov. A-C $\times 1370$; D $\times 640$.

Long. fil., up to 350μ ; lat. fil., $6.8-8.3 \mu$; lat. trich., $5.4-7.3 \mu$; lat. het., $6.3-10.5 \mu$.

Habitat:—Epiphytic on a species of *Chara* in a stagnant pond.

This form differs from the type in possessing much shorter filaments, in the apical portion of the trichome being not widened out, and in its growing in fresh water and not in sea.

(d) *Nostocaceæ*.

Genus *Nostoc* Vaucher.

13. *Nostoc carneum* Ag. Geitler, *op. cit.*, 1930-32, p. 839.

Forma minor. Form. Nov.

Lat. trich., $3.1-4.2 \mu$; lat. heterocyst., $4.2-5.7 \mu$; long. heterocyst., $4.2-6.3 \mu$; lat. spor., $4.2-6.3 \mu$; long. spor., $6.3-10.5 \mu$.

Habitat:—Among other algæ, in a stagnant pond.

The form resembles the type except for the smaller size of the heterocysts and spores.

Genus *Nodularia* Mertens.

14. *Nodularia spumigena* Mertens. Bornet et Thuret, *op. cit.*, Pl. XXIX, Figs. 10 and 11; Geitler, *op. cit.*, 1930-32, Fig. 554. (Fig. 5, A-C).

Lat. fil., 10–12 μ ; lat. cell., 8.4–9.4 μ ; long. cell., 2.1–3.6 μ ; lat. heterocyst., 9.4–11.5 μ ; long. spor., 5.2–7.3 μ .

Habitat:—Among other algæ in a stagnant pond.

The alga differs from the original type in the occasional development of terminal heterocysts and the smaller spores.

Genus *Anabæna* Bory.

15. *Anabæna oscillarioides* Bory. Geitler, *op. cit.*, 1930-32, Fig. 567e.

Var. *angustus* Var. Nov. (Fig. 5, D–F).

Trichomes single, irregularly bent or spirally coiled; end-cell rounded. Cells barrel-shaped, as long as or slightly shorter or longer than broad. Heterocysts intercalary, very rarely terminal, ellipsoidal. Spores long cylindrical, single or in short or long chains, on both sides of the heterocysts, with smooth yellow-brown outer wall.

Lat. cell., 4.2–5.2 μ ; lat. heterocyst., 5.2–6.3 μ ; long. heterocyst., 7.3–10.5 μ ; lat. spor., 6.5–8.4 μ ; long. spor., 14.7–41.0 μ .

Habitat:—Among other algæ in a stagnant pond.

This variety differs from the type in the narrower filaments, ellipsoidal heterocysts and narrower spores, which may be in long chains, with smooth yellow-brown outer wall and surrounded by a mucilaginous sheath.

16. *Anabæna sphaerica* Born. et Flah., *Rev. Nost. hét., Ann. Sci. Nat. Ser.*, IV, p. 228, 1888.

Var. *tenuis* G. S. West, in Geitler, *op. cit.*, 1930-32, Fig. 560b.

Lat. cell., 4–5 μ ; lat. heterocyst., 4.5–6.3 μ ; lat. spor., 10–13 μ ; long. spor., 11–14 μ .

Habitat:—In a stagnant pond.

Var. *attenuata* Var. Nov. (Fig. 5, G–H.)

Thallus floccose, gelatinous, thin, free-floating, pale blue-green. Trichomes blue-green, curved or straight, more or less entangled with each other, slightly attenuated at the ends, with rounded end-cells, without a mucilage-sheath. Cells spherical or slightly barrel-shaped. Heterocysts intercalary, spherical or slightly pressed from both sides. Spores single, on one or both sides of the heterocyst, spherical or oval, with smooth and yellow-brown outer wall.

Lat. cell., 3.2–5.2 μ ; lat. heterocyst., 5.2–6.2 μ ; lat. spor., 10.5–12.6 μ ; long. spor., 10.5–14.7 μ .

Habitat:—In a stagnant pond.

The alga resembles the type in the spherical or barrel-shaped cells, spherical or oval heterocysts, and single, spherical or oval spores on one or both sides of the heterocysts. It comes close to var. *tenuis* G. S. West on

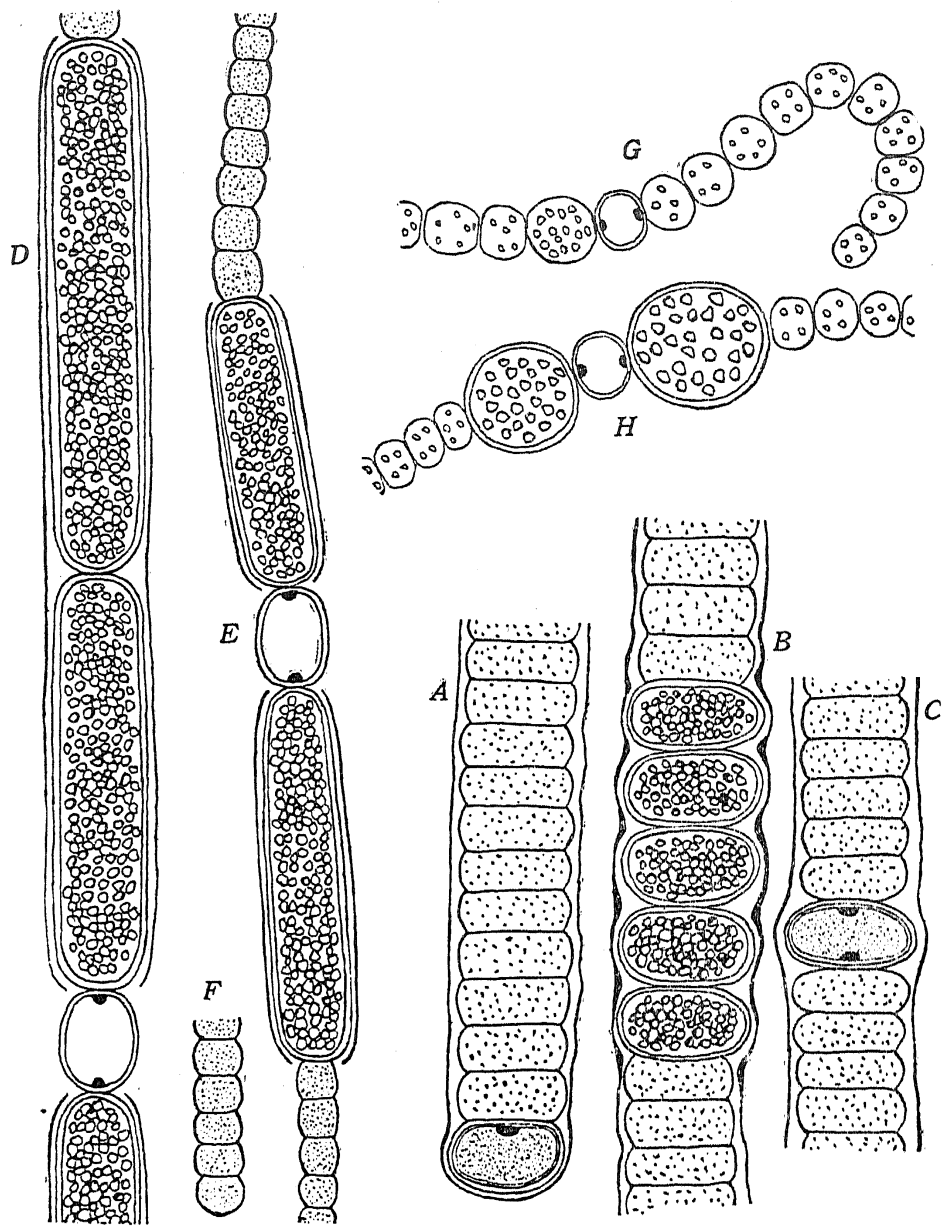


FIG. 5.

A-C—*Nodularia spumigena* Mertens.; D and E—sporogenous portions and F—terminal portion of filaments of *Anabaena oscillarioides* Bory, Var. *angustus* Var. Nov.; G and H—*Anabaena sphaerica* Born. et Flah., Var. *attenuata* Var. Nov. All $\times 1370$.

account of the narrow trichomes, and smaller heterocysts and spores, but it differs from this variety and the type in the thallus being pale blue-green, in the trichomes being curved in various ways and more or less entangled with each other and being slightly attenuated at the ends, in the spores being never in pairs, and in the slight variations in the dimensions of all parts.

From the variety *tenuis* G. S. West it further differs on account of the presence of spherical cells and the heterocysts being slightly pressed from both sides.

17. *Anabæna doliolum* Sp. Nov. (Fig. 6, A and B.)

Plant-mass mucilaginous, pale blue-green. Trichomes single; free swimming; straight, curved or slightly coiled; slightly tapering at the ends; with conical apical cell, possessing almost pointed apex. Cells barrel-shaped as long as broad or a little longer or shorter than broad. Heterocysts barrel-shaped. Spores ellipsoidal with almost pointed apices in short or long chains adjoining the heterocysts but developed centrifugally, with thick, smooth, and hyaline or yellow-brown outer wall.

Lat. cell, $3.6-4.2 \mu$; lat. heterocyst., $5.2-6.3 \mu$; long. heterocyst., $6.3-9.4 \mu$; lat. spor., $4.2-6.2 \mu$; long. spor., $6.3-11.5 \mu$.

Habitat:—Among other algæ in a stagnant pond.

This alga is quite unique and differs from all other species in the possession of barrel-shaped cells and heterocysts, and chains of ellipsoidal spores, with almost pointed ends, adjoining heterocysts but developed centrifugally.

18. *Anabæna kashiensis* Sp. Nov. (Fig. 6, C—G.)

Thallus dense, soft, mucilaginous, deep green. Trichomes blue-green; often irregularly curved and more or less entangled with each other, slightly constricted at the joints, attenuated at the ends; the terminal cell being often conical with a sharp or rounded apex; without mucilage-sheath. Cells cylindrical, up to twice as long as broad, rarely barrel-shaped and almost as long as broad. Heterocysts single, intercalary and distributed at regular intervals throughout the length of the trichome, cylindrical. Spores in short or long chains, ellipsoidal or barrel-shaped, remote from the heterocysts; with outer wall thick, smooth and colourless.

Lat. cell., $3.1-4.2 \mu$; lat. heterocyst., $4.2-5.2 \mu$; long. heterocyst., $8.4-12.6 \mu$; lat. spor., $4.2-6.3 \mu$; long. spor., $6.3-10.5 \mu$.

Habitat:—On floating dead leaves in a stagnant pond.

The alga approaches *Anabæna variabiles* Kütz. in the deep green mucilaginous thallus, the presence of slight constrictions at the joints of the trichome, the conical end-cells, and in the barrel-shaped spores formed in chains remote from the heterocysts. It, however, differs in the elongated cylindrical cells and heterocysts and in the smaller breadth of the trichome, heterocysts and spores.

19. *Anabæna Iyengari* Sp. Nov. (Fig. 6, H—K.)

Trichomes single, straight or irregularly curved; end-cell conical with rounded apex. Cells barrel-shaped, as long as broad or slightly shorter or longer than broad. Heterocysts barrel-shaped, rarely spherical. Spores

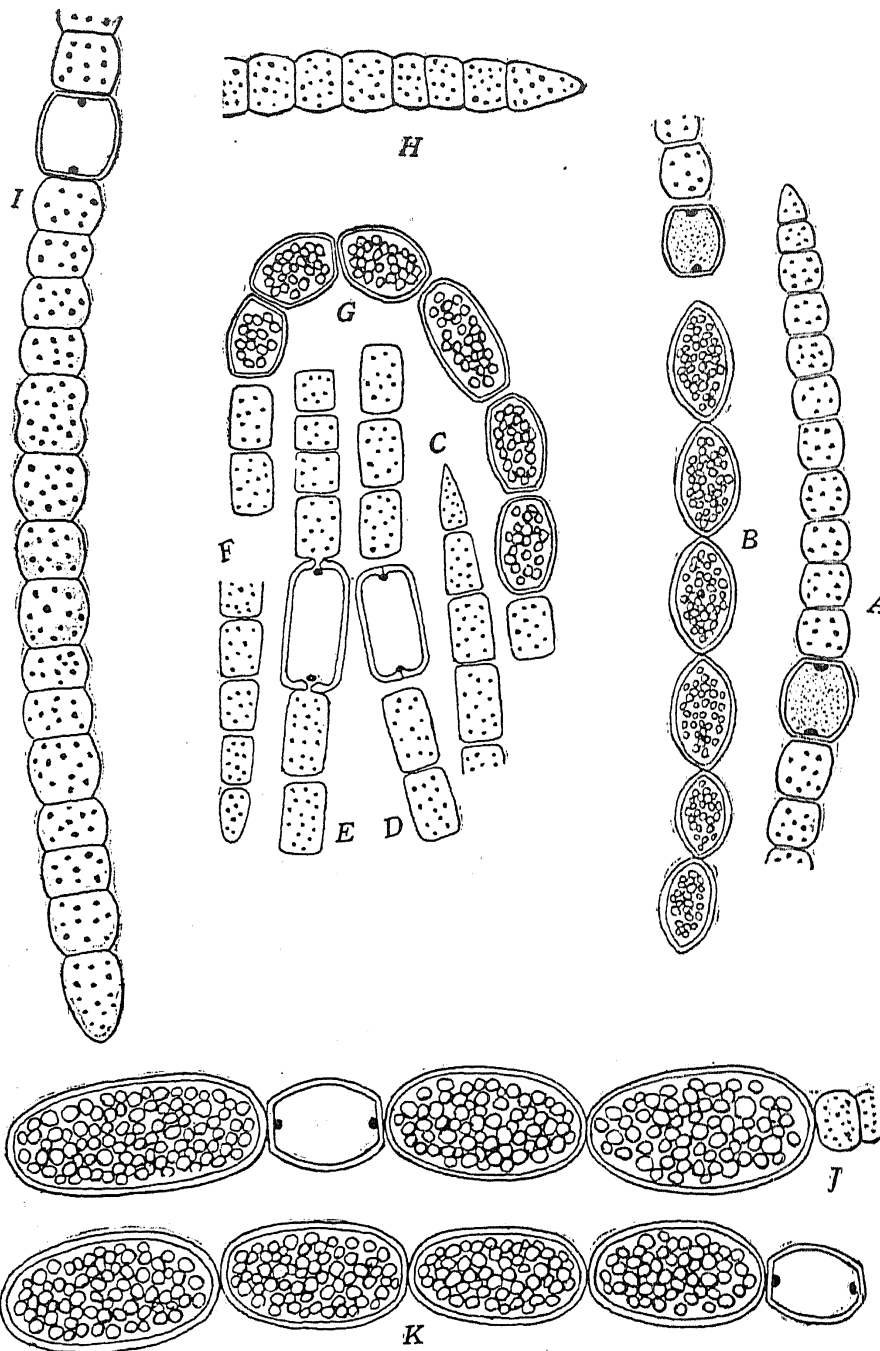


FIG. 6.

A and B—*Anabaena doliolum* Sp. Nov.; C-G—*Anabaena kashiensis* Sp. Nov.;
H-K—*Anabaena Iyengari* Sp. Nov. All $\times 1370$.

ellipsoidal, often in long or short chains, rarely single, on both sides of the heterocysts, with thick, smooth, yellow-brown outer wall.

Lat. cell, $5.2-6.3 \mu$; lat. heterocyst., $7.3-8.4 \mu$; long. heterocyst., $7.3-10.5 \mu$; lat. spor., $8.4-10.5 \mu$; long. spor., $10.5-21.0 \mu$.

Habitat:—Among other algæ in a stagnant pond.

This alga can only be compared with *Anabæna sphaerica* Born. et Flah.; both have barrel-shaped cells, and the spores are developed on both sides of the heterocysts. The present species, however, differs in the presence of conical end-cells of the trichomes, the larger barrel-shaped heterocysts, and the larger ellipsoidal spores formed often in long or short chains.

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