THE MYXOPHYCEAE OF THE UNITED PROVINCES, INDIA.—III.*

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The present communication is the third\(^1\) of the series, 'The Myxophyceae of the United Provinces, India'. It deals with algae (hitherto unrecorded with the exception of Anabaena ambiguа Rao) collected mainly from Benares and its environs from 1934 onwards. A few forms collected from Chakia, Chunar, Saranath, Ramnagar and Mussoorie have also been included. In all there are one hundred and five forms, representing twenty-five genera, and out of these, two species, sixteen varieties and twenty-seven forms are new. The habitat of these plants is varied; thirty-five have been collected on soil, seven from moist bricks, stones and rocks, eleven on walls and other elevated places, four on the bark of trees, five from the stagnant water of crop-fields and the rest from tanks, ponds, puddles and other aquatic situations.

The major part of the Benares Myxophyceae are sub-aerial in habitat. After the rains, one comes across very frequently on semi-clayey soil, during July and August, a very thick, semi-transparent and ash-brown mucilaginous scum extending over large areas and making the ground slimy. This is mostly comprised of Aphanothece pallida. It may be intermingled with Chroococcus montanus forma and var. hyalina, Aphanotheca Grévillei, Microcoleus chthonoplastes and others. On clayey soil, however, the stratum formed is deep blue-green and slimy, but closely adhering to the surface. This is commonly comprised of Gloeocapsa stegophila var. crassa, Cylindrospermum muscicola, Microcoleus chthonoplastes and M. socialus. During July and August, Cylindrospermum muscicola is noticed very frequently to form by itself blue-green strata on moist soil, and as its spores ripen the strata turn blackish-brown. In the month of September, conspicuous blue-green erect tufts of a form of Symploca muralis appear on shady soil. Frequently

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during August and September, circular, woolly, slimy and brown patches are seen scattered on the surface of lawns. These expand and finally coalesce to produce a brownish green stratum which for the most part consists of Microcystis tenera, Scytonema javanicum, with which, however, Microcystis chthonoplastes and a form of Anabaena variabilis may be intermingled. Oscillatoria terebriformis is the most common species of Oscillatoria in Benares and it occurs not only on all exposed muddy places, but also in stagnant ponds, puddles and dirty drains. Oscillatoria formosa is another form commonly met with in Benares, especially during rains, forming a crimson-green layer on the soil of shallow puddles and ditches. Among the other common blue-green algae, occurring on moist soil, mention may be made of Oscillatoria sancta, Phormidium Retzi and Lyngbya ceylanica. On places which are constantly wet, because of their being near drains or other water sources, Phormidium subiruncatum is very common. This alga has also been found growing in very delicate blue-green films spread on the sides of the aspirator bottles kept out of use in the Laboratory. Scytonema ocellatum, Lyngbya trunicola, L. astuarii var. arbustiva and L. arboricola are seen after rains in the form of expanded bluish-green woolly layers on the bark of Mangifera indica, Euphoria Jambolana, Bassia latifolia and Tamarindus indica. As the season becomes drier, the strata formed by these algae become thin and papery, and may ultimately peel off the trunk of the tree.

In Benares, there is a comparative paucity of the real aquatic forms. This is due to the fact that there are no large and permanent sheets of stagnant water. The characteristic aquatic habitats of these algae are a large number of pools, puddles and ditches formed by the stagnant rain-water in low-lying areas either in waste-places or amidst crop-fields or on the sides of the River Ganges, which flows by the side of the town. Some of the common planktonic forms are Microcystis flos-aquae, Chroococcus turidus, C. minutus, Merismopedia tenuissima and Spirulina platensis var. crassa. Oscillatoria princeps is rather frequent near the edges of pools, puddles and ditches as black masses of densely crowded hair-like filaments. Species of Anabaena, such as A. aphanizomenoides var. ellipsospora, A. Iyengarii var. tenuis, and A. unispora var. crassa, occur in a large number of rain-water pools. They are sterile during July and August, but form spores in September and October. Gloeotrichia natans occurs as large blue-green globules attached to aquatic angiosperms. Gloeotrichia intermedia var. hawaeense is abundant in several rain-water pools, either in a free state or adhering to Chara, and other aquatic plants. Aulosira fertilissima var. tenuis and Phormidium mucosum var. arvense are found in abundance during rains in stagnant water of crop-fields. Lyngbya confervoides grows in thick
fibrous and deep blue-green masses in the shade of closely spreading leaves of *Nelumbium* in the ornamental water reservoirs.

The Benares Myxophyceae grow luxuriantly during the rainy months of July, August and September and to some extent in October and November. But they are quite scarce during May and June, when it is very hot and dry. Some of the forms available during these hot months are *Microcystis flos-aquae*, *Merismopedia tenuissima* and *Spirulina major*, occurring in tanks with constant water supply, and also *Oscillatoria terebriformis* and *Phormidium subtruncatum* inhabiting places near water.

**SYSTEMATIC ENUMERATION OF THE SPECIES OBSERVED.**

I. **CHROOCOCALES.**

*Chroococcaceae.*

Genus *Microcystis* Kützing.


Var. *elongata.* var. nov. (Fig. 1, A–C).

Colonies spherical or elongated, solid or broken through to form a net; broken parts of the colony looking like filaments; sheath indistinct, stained violet with methylene blue; cells pale blue-green, more or less spherical, with gas-vacuoles.

Lat. cell., 2–2.8 μ.

Habitat:—In an ornamental water reservoir of a private garden, along with *Oscillatoria Annae*, *Lyngbya limnetica* and *Oedogonium* sp.

The form agrees with the type in having spherical or elongated colonies, which are solid or broken through with an indistinct sheath, and spherical cells with gas-vacuoles, but differs in the cells being smaller and the broken portions of the colonies looking like filaments.

Genus *Aphanocapsa* Nägeli.

2. *Aphanocapsa Koordersi* Ström. Geitler, *op. cit.*, 1930–32, p. 155, Fig. 68.

Colonies without definite shape. Cells laxly crowded; circular to sub-globose with pale blue-green homogeneous contents.
Lat. cell., 2.2–3.2 μ.

Habitat:—In the fountain tank, Women's Hostel, Benares Hindu University, along with Synechocystis aquatilis and Oedogonium sp. (Miss P. R. Parukutty Amma).

3. Aphanocapsa Grevillei (Hass.) Rabenh. Geitler, op. cit., 1930–32, p. 158, Fig. 71; Frémy, "Les Myxophycées de l'Affrique équatoriale française," Arch. d. Bot., iii (1929), Mem. 2, 1930, p. 23, Fig. 25; Tilden, op. cit., 1910, Pl. II, Fig. 7; West, Algae, I, 1916, p. 3, Fig. 2, A.

Lat. cell., 3.2–4.8 μ.

Habitat:—On the sides of the steps of a tank along with other algae. The plant-mass occurs as small yellowish patches distributed irregularly.

4. Aphanocapsa pulchra (Kütz.) Rabenh. Geitler, op. cit., 1930–32, p. 156, Fig. 69 g; Frémy, op. cit., 1930, p. 23, Fig. 22.

Fig. 1. A–C—Microcystis aeruginosa Kütz. var. elongata var. nov.;
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Fig. 1. D—Glaeocapsa stegophila (Itzigs.) Rabenh. var. crassa var. nov.; E—Chroococcus minimus (Keissl.) Lemm.; F & G—Chroococcus montanus Hansg. forma and var. hyalina var. nov. respectively.

A-C & G × 425; D & F × 875; E × 1,475.

Lat. cell., 3·2–4·5 μ.

Habitat:—Planktonic in a tank, Cantonment area.

Genus Aphanthece Nägeli.

5. Aphanthece bullosa (Menegh.) Rabenh. Frémy, op. cit., 1930, p. 33, Fig. 33.

Lat. cell., 4·9–5·4 μ; long. cell., 6·6–13·2 μ.

Habitat:—Free-floating in a rain-water pool along with Lyngbya spiralis Geitler.

The stratum is a deep blue-green fragile mass.

Genus Glaeocapsa Kützing.

Lat. cell., 1.6–3 μ; long. cell., 3.2 μ; lat. cell. cum vag., 3.5–4 μ; long. cell. cum vag., 4.2–6 μ.

Habitat:—In a cemented water-reservoir of a private garden, along with *Nostoc spongiforme* var. *tenuis*, *Tolyphrix lanata* forma, *T. distorta* var. *samoënsis* and *Oedogonium* sp.

7. *Glaucapsa stegophila* (Itzigs.) Rabenh. Geitler, *op. cit.*, 1930–32, p. 197, Fig. 91 b; Tilden, *op. cit.*, 1910, Pl. I, Fig. 24.

Var. *crassa*. var. nov. (Fig. 1, D).

Thallus soft, yellowish-brown; cells spherical, sub-spherical or elongated, commonly single or in colonies of 2–4; sheath golden yellow, sometimes striated.

Lat. cell., 4.6–4.4 μ; long. cell., 6.1–9.6 μ; lat. colon. cum vag., 8–15 μ; long. colon. cum vag., 9.6–19.2 μ; crass. vag., upto 3.2 μ.

Habitat:—On moist soil, singly or along with *Microcoleus chthonoplastes*, *M. sociatus*, *Cylindrospermum musicola* and others.

The variety differs from the type in having bigger cells and colonies.

Genus *Chroococcus* Naegeli.

8. *Chroococcus turgidus* (Kütz.) Näg. Geitler, *op. cit.*, 1930–32, p. 228, Fig. 109 b; Frémy, *op. cit.*, 1930, p. 41, Fig. 40; Tilden, *op. cit.*, 1910, Pl. I, Fig. 3; West, *op. cit.*, 1916, p. 41, Fig. 25 b.

Lat. cell., 11.5–16.5 μ; long. cell., 16.5 μ; lat. cell. cum vag., 14–19.2 μ; long. cell. cum vag., 19.5 μ; lat. colon. cum vag., 16.5–21.2 μ; long. colon. cum vag., 21.4–23.1 μ.

Habitat:—Planktonic in the tank of the Benares Electric Light and Power Supply Co., Ltd., along with *Chroococcus minutus*, *Merismopedia tenuissima* and *Spirulina major*.

The cells are yellowish-green, mostly 2–4 in each colony.

9. *Chroococcus minutus* (Kütz.) Näg. Geitler, *op. cit.*, 1930–32, p. 234, Fig. 113 c; Frémy, *op. cit.*, 1930, p. 41, Fig. 42.

Lat. cell., 5–6.6 μ; long. cell., 3.3–6 μ; lat. cell. cum vag., 6.6–10 μ; long. cell. cum vag., 6.3–13 μ; lat. colon. cum vag., 6.6–10 μ; long. colon. cum vag., 6.6–15.5 μ.

Habitat:—Planktonic in the tank of the Benares Electric Light and Power Supply Co., Ltd., along with *Chroococcus turgidus*, *Merismopedia tenuissima* and *Spirulina major*.

Cells are mostly in colonies of two and rarely four.

Lat. cell., 1.6-2.5(-3) μ; long. cell., 2-3.2 μ; lat. cell. cum vag., 3-4.5 μ; long. cell. cum vag., 3.2-5 μ; lat. colon. cum vag., 4.8-6.4 μ. long. colon. cum vag., 4.8-8.4 (-9.6) μ.

Habitat:—In an ornamental tank of a private garden; on the sides of a cemented water reservoir, by the side of the road leading to Allahabad.

The sheath in the form collected from the ornamental tank is sometimes dissolved or very indistinct.


Lat. cell., 2-4 μ; long. cell., 2.5-4 μ; lat. cell. cum vag., 3-5 μ; long. cell. cum vag., 3.5-5 μ; lat. colon. cum vag., 4.2-8.4 μ; long. colon. cum vag., 4.5-11.6 μ.

Habitat:—On the cemented platform of the Physical Laboratory, College of Science, Benares Hindu University.

12. *Chroococcus montanus* Hansg. Geitler, *op. cit.*, 1930-32, p. 236. *Forma* (Fig. 1, F).

Lat. cell., 5-6.4 μ; long. cell., 4.8-8 μ; lat. cell. cum vag., 6.4-9.6 (-12.8) μ; long. cell. cum vag., 8-11.2 μ; lat. colon. cum vag., 8-8-16 μ; long. colon. cum vag., 11.2-14.4 μ.

Habitat:—On moist soil, along with *Microcoleus chthonoplastes* and others.

The form differs from the type in the sheath being hyaline.

Var. *hyalina*. var. nov. (Fig. 1, G).

Stratum thick, mucilaginous and blue-green. Cells spherical or subspherical or elongated, single or 2-4 or occasionally up to 8 in spherical or ellipsoidal colonies. Colonies separate. Sheath thick, hyaline and lamellated.

Lat. cell., 4.8-7.5 μ; long. cell., 8-16.5 μ; lat. cell. cum vag., 13.2-23.1 μ; long. cell. cum vag., 13.2-30 μ; lat. colon. cum vag., 19.8-26 μ; long. colon. cum vag., 19-36 μ.

Habitat:—On moist soil along with other algae.

The variety agrees with the type in the mucilaginous stratum, the presence of 2-4 or occasionally more cells in each colony, and the sheath enveloping the colonies being stratified, but it differs from the same in the stratum being blue-green and the colonies, which are on the average bigger, possessing a hyaline and thick sheath.
13. *Chroococcus pallidus* Näg. Geitler, *op. cit.*, 1930–32, p. 238, Fig. 116 b; Frémy, *op. cit.*, 1930, p. 41, Fig. 48.

Lat. cell., 4·8–6·6 μ; long. cell., 4·8–7 μ; lat. cell. cum vag., 6·6–10 μ; long. cell. cum vag., 6·6–11·6 μ; lat. colon. cum vag., 8·4–10·5 μ; long. colon. cum vag., 10·5–13·2 μ.

Habitat:—On wet soil along with *Cylindrospermum muscicola*, *Microcoleus chthonoplastes* and others.

The cell-contents are deep blue-green.

Genus *Merismopedia* Meyen.


*Forma.*

Lat. cell., 0·2–0·4 μ.

Habitat:—Planktonic in the fountain tank, College of Science, Benares Hindu University.

The form differs from the type in possessing smaller cells and colonies consisting of up to 320 cells.

15. *Merismopedia tenuissima* Lemm. Geitler, *op. cit.*, 1930–32, p. 264, Fig. 129 b; Frémy, "Les Cyanophycées des Côtes d'Europe," *Mémoires de la Société Nationale des Sciences Naturelles et Mathématiques de Cherbourg*, tome XI, 1934, Pl. I, Fig. 1; Geitler, in Pascher's *Süsswasserflora Deutschlands, Österreichs und der Schweiz.*, Heft 12, Cyanophyceae, 1925, p. 107, Fig. 123 a.

Lat. cell., 1·6–2 μ.

Habitat:—Planktonic in the tank of the Benares Electric Light and Power Supply Co., Ltd., along with *Chroococcus turgidus*, *C. minutus* and *Spirulina major*.

The colonies are generally of 16–48 cells.

Genus *Synechocystis* Sauvageau.

16. *Synechocystis aquatilis* Sauvageau. Tilden, *op. cit.*, 1910, Pl. I, Fig. 10 (Fig. 2, A).

Lat. cell., 5·6–6·5 μ.

Habitat:—In the fountain tank, Women's Hostel, Benares Hindu University, along with *Aphanocapsa Koordersii* and *Oedogonium* sp. (Miss P. R. Parukutty Amma); in a temple tank, Benares City.
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Genus *Dactylococcopsis* Hansg.


*Forma.*

Lat. cell., 1.6–2 μ; long. cell., 20–35 (– 40) μ.

Habitat:—In a pond on the University grounds, along with *Calothrix marchica* var. *intermedia*, *Anabaena fertilissima* sp. nov., *A. Lyngari* var. *tenuis*, *Oscillatoria animalis*, *Lynghya Digesti* forma and sterile filaments of *Spirogyra* and *Oedogonium*.

The form differs from the type in the cells being longer and usually falciformed. It also differs from *forma falciformis* Printz in having much longer cells.

II. *Chæmosiphonales.*

*Chæmosiphonaceæ.*

Genus *Chæmosiphon* A. Braun et Grunow.

18. *Chæmosiphon sideriphilus* Starmach. Geitler, *op. cit.*, 1930–32, p. 431, Fig. 251.

*Var. glabra.* var. nov. (Fig. 2, B).

Sporangia distributed on the host either singly or in dense clusters, usually club-shaped, rarely cylindrical, bent or straight, pale blue-green with homogeneous contents. Sheath thin, hyaline and smooth. Exospore one.

Lat. sporang., 2.4–3.2 (– 4) μ; long. sporang., 4–14.4 μ; lat. sporang. cum vag., 3.2–3.5 μ; long. sporang. cum vag., 4.8–17.6 μ.

Habitat:—On *Lynghya gracilis* in the reserve water tank of the Benares Water Works.

The variety agrees with the type in the possession of club-shaped or cylindrical sporangia with one exospore and a foot formed by the enveloping sheath, but differs in the sporangia possessing much shorter range of dimensions and the sheath being always smooth, hyaline and without any calcareous impregnation.
Fig. 2. *A*—Synechocystis aquatilis Sauvageau; *B*—Chæmosiphon sideriphilus Star mach var. glabra var. nov.; *C & D*—Hapalosiphon Welwitschii W. et G. S. West forma; *E*—Portions of the filament of Calothrix marchica (Lemm.) var. crassa var. nov.; *F & G*—Calothrix marchica, Lemm. var. intermedia var. nov.

* B × 1,475; all the rest × 875.
III. Hormogoneales.

1. Stigonemataceae.

Genus Hapalosiphon Naegeli.


*Forma* (Fig. 2, C and D).

Plant-mass dark green; filaments closely entangled. Sheath thin, firm and hyaline. Cells spherical, quadratic or longer than broad. Branches short and narrower than the main axes. Heterocysts rare, long-cylindrical. Spores more or less spherical or longer than broad.

Main axis: Lat. cell., 3–7.5, rarely 9 μ; long. cell., 4.5–15, rarely 16.8 μ. Branches: lat. cell., 3–6 μ, the basal cell being 7.5 μ; long. cell., 2.2–16.5 μ. Lat. het., 4.5–7 μ; long. het., 7.5–10 μ; lat. spor., 6–12 μ; long. spor., 5.2–12.5 μ; crass. vag., 0.2 μ.

Habitat:—Closely adhering to the moist bricks at the edge of a rain-water pool.

The form differs from the type in the terrestrial habitat and in the filaments being closely entangled.

2. Rivulariaceae.

Genus Calothrix Agardh.

20. Calothrix marchica Lemm. Geitler, op. cit., 1930–32, p. 607, Fig. 382 a.

*Var. crassa* var. nov. (Fig. 2, E).

Filaments in groups, irregularly bent and closely entangled. Sheath thin, firm, yellowish or hyaline. Trichomes with constrictions at septa; with tapering ends but without any hair-like prolongation; end-cell conical with a rounded apex, sometimes pointed. Cells quadratic, as well as shorter or longer than broad. Heterocysts single, basal, spherical or sub-spherical.

Lat. fil., 9.6–14.4 μ; long. trich., upto 450 μ; lat. trich., 8.4–12.8 μ; long. cell., 2–3.2 μ, at top 4.8 μ; lat. het., 8.2–12.5 μ; long. het., upto 5 μ.

Habitat:—On the plinth of the College building, near the outlet of a drain, along with *Calothrix linearis* forma.

The variety agrees with the type in (1) the tapering trichomes without any hair-like prolongation, (2) the barrel-shaped cells, (3) the rounded or sometimes pointed end-cells and (4) the single spherical or sub-spherical basal heterocysts; but it differs in the broader, irregularly bent and closely
entangled filaments, arranged in groups, in the much broader trichomes and heterocysts, and in the yellow sheath.

Var. *intermedia* var. nov. (Fig. 2, F and G).

Filaments epiphytic on other algae, placed singly or in groups of two or three, with slight attenuation, without formation of a terminal hair. Sheath thin, firm and hyaline. Cells quadratic, as well as shorter or longer than broad, with constrictions at the joints; end-cell rounded. Heterocysts single, basal and usually spherical.

Lat. fil., 6-8 μ; long. trich., upto 350 μ; lat. trich., 5.8-7.8 μ; long. cell., 3.2-8 μ; lat. het., 5.6-7.8 μ.

Habitat:—In a pond on the University grounds, along with *Dactylococcopsis raphidioides* forma, *Anabaena fertilissima* sp. nov., *A. Iyengari* var. *tenuis*, *Oscillatoria animalis*, *Lyngbya Digeuti* forma and sterile filaments of *Spirogyra* and *Oedogonium*.

This form comes close to *Calothrix atricha* Frémy (Frémy, *op. cit.*, 1930, p. 263, Fig. 233) which Geitler (*op. cit.*, p. 625) considers to be identical with *Calothrix marchica* Lemmermann. It resembles *Calothrix marchica* Lemm. in the free filaments, the absence of a hair-like prolongation at the ends of the trichomes, the constrictions at the joints, the thin and hyaline sheath, and in the single, spherical or sub-spherical basal heterocysts. But it differs from this form in the trichomes possessing only slight attenuation, in the rounded end-cell and in the bigger dimensions of all parts. The dimensions of this form are intermediate between those of the type and the var. *crassa*.


*Forma.*

Lat. fil., at base 10-12 μ, at top 4-5 μ; long. trich., upto 450 μ; lat. trich., at base 6.6-9.5 μ, at top 3-3.3 μ; long. cell., 2.5-5 μ; lat. het., 6.6-8 μ; long. het., 5-7 μ.

Habitat:—On the plinth of the College building, near the outlet of a drain, along with *Calothrix marchica* var. *crassa*.

The form differs from the type in the trichomes being broader at the base and the cells in the terminal portions of the trichomes being quadratic or shorter than broad.

22. *Calothrix brevissima* G. S. West. "Report on the Fresh-water Algae, including Phytoplankton of the Third Tanganyika Expedition conducted by
Dr. W. A. Cunnington, 1904–1905, Journal of the Linnean Society Bot., 1907, 38, p. 180, Pl. 10, Fig. 8.

Lat. fil., 4.8–6.6 μ; long. fil., 40–85 μ; lat. trich., 3.8–4.5 μ; long. cell., 1.6–3.5 μ; lat. het., 3.8–4.8 μ; long. het., 4.4–5 μ.

Habitat:—Epiphytic on Hydrodictyon reticulatum growing in a rain-water pool, along with Spirogyra chunia forma.

Genus Gloeotrichia Agardh.

23. Gloeotrichia Raciborskii Woloszynska. Geitler, op. cit., 1930–32, p. 637, Fig. 405 a and b; Geitler, op. cit., 1925, p. 233, Fig. 281 b.

Var. kashiense var. nov. (Fig. 3, A–E).

Thallus forming large irregularly-lobed blue-green masses, 2–10 cm. thick. Filaments with a thick, stratified and hyaline sheath. Trichomes with constrictions at joints, ending in a long hair. Cells at the base of the trichome barrel-shaped, much shorter than broad or almost as long as broad, higher up cylindrical, in the hair long cylindrical. Heterocysts single, spherical to ellipsoidal. Spores long, ellipsoidal to cylindrical with a hyaline smooth outer wall.

Lat. trich., at base 8.4–10 μ, higher up 4.8–6.4 μ, at apex 2.4 μ; long. trich., 800–1,000 μ; long. cell., at base 2.4 μ, later 3.3–10 μ, in the hair upto 15 μ, at apex upto 35 μ; lat. het., 8–12.8 (–13.2) μ; long. het., 8.4–15 (–16.5) μ; lat. spor., 11.5–16 μ, average 13.2 μ; long. spor., 42–66 μ.

Habitat:—In a rain-water puddle amidst crop-fields.

The variety agrees with the type in all respects except that the former has much bigger thallus, broader trichomes, hyaline sheath, bigger heterocysts, that may be ellipsoidal, and narrower spores of a wider range in length with a hyaline outer wall. This form is also comparable to var. Liliendfeldiana (Wol.) Geitler on account of the spherical or ellipsoidal heterocysts and cylindrical spores with a colourless outer wall, but here also it differs in possessing bigger heterocysts and narrower spores.

3. Microchaetaeae.

Genus Microchaete Thuret.

24. Microchaete tenera Thuret. Frémy, op. cit., 1930, p. 281, Fig. 248; Tilden, op. cit., 1910, Pl. X, Fig. 11.

Lat. fil., 5–7.1 μ; lat. cell., 4–5 μ; long. cell., 4.8–8 μ; lat. het., 4.5–6.4 μ; long. het., 6.4–10 μ.

Habitat:—On wet soil of the lawns, Benares Hindu University.
Fig. 3. A—Terminal, B—middle and C–E—lower portions of the filament of Glorotrichia Raciborskii Woloszynska var. kashiense var. nov.; F & G—vegetative and H & I—sporogenous portions of the filaments of Aulosira fertilissima Ghose var. tenuis var. nov. 
A–E × 875; F–I × 1,475.
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Genus *Aulosira* Kirchner.


Lat. fil., 11.2-16.5 μ; crass. vag., upto 3 μ; lat. cell., 8-11.8 μ; long. cell., 5-26 μ; lat. het., 11.2-13.2 μ; long. het., 11.8-40 μ; lat. spor., 10-13.2 μ; long. spor., 6.6-30 μ.

Habitat: In a stagnant rain-water puddle, by the side of the B.N.W. Railway line, about 2 miles off Benares Cantonment Station, along with *Lyngbya confervoides*, *Oscillatoria princeps* and several others.


Var. *tenuis* var. nov. (Fig. 3, F-I).

Plant-mass fibrous and greyish-blue. Filaments free, more or less straight and closely crowded together, with a thin, firm and brown sheath, that may sometimes be enveloped by diffluent mucilage. Trichomes slightly tapering at the ends, rarely constricted at the septa; end-cell with a rounded apex. Cells cylindrical, sometimes quadratic. Heterocysts cylindrical, with rounded end-walls broader than the trichome and causing the filament to bulge. Spores in long chains, ellipsoidal to cylindrical, intercalated by moribund cells.

Lat. fil., 5.6-6.4 μ; lat. trich., 3.3-4.8 μ; long. cell., 3.3-19.8 μ; lat. het., 4.5-7 μ; long. het., 8.2-19.8 μ; lat. spor., 4.8-8.8 μ; long. spor., 10.5-19.2 μ; crass. vag., 0.3-0.8 μ.

Habitat: In the stagnant water of a paddy field.

The variety agrees with the type in having (1) cylindrical or quadratic cells, (2) cylindrical heterocysts, (3) ellipsoidal spores in chains and (4) moribund cells in between the spores; but it differs from it in the fibrous stratum, the much narrower trichomes, the narrower heterocysts and the much smaller spores (that are also cylindrical), with a colourless outer wall.

4. *Scytonemataceae*.

Genus *Tolypothrix* Kützing.

27. *Tolypothrix nodosa* Bhâradwâja. Bharadwaja, "The Taxonomy of *Scytonema* and *Tolypothrix* including some new records and new species from India and Ceylon," *Revue Algalogique*, 1933, n. 1-2, p. 176, Fig. 7c.
Lat. fil., 5.4–8 μ; lat. trich., 4.8–6.8 μ, at apices 4 μ; long. cell., 3.2–12.8 μ; lat. het., 4.8–9.6 μ; long. het., 6.4–16.8 μ, rarely upto 23 μ.

Habitat:—In rain-water pools.


*Forma.*

Lat. fil., 8.2–11.2 μ; lat. trich., 6–8.2 μ; long. cell., (5–) 6.4–10.4 μ; lat. het., 6.6–8.2 μ; long. het., 10.5–16.5 μ.

Habitat:—In a cemented water reservoir in a private garden, along with *Nostoc spongiciforme* var. *tennis*, *Tolypothrix distorta* var. *samoënsis*, *Gloeocapsa punctata* and *Oedogonium* sp.

The form differs from the type in having narrower trichomes and in the absence of heterocysts in chains.

29. *Tolypothrix distorta* Kütz. var. *samoënsis* Wolle. Bhäradwâja, *op. cit.*, 1933, p. 176, Fig. 7 b; Bhäradwâja, "False branching and Sheath-structure in Myxophyceæ, with special reference to the Scytoneumataceæ," *Archiv für Protistenkunde*, Band 81, Heft 2, 1933, Fig. 3, E and Fig. 4, G.

Lat. fil., 14–19.8 μ, when old upto 22 μ; crass. vag., 3.3–4 μ, when old and unhealthy upto 6 μ; lat. trich., 12.2–15 μ, when old narrowed down to 10.2 μ; long. cell., 3.2–12 μ; lat. het., 11.8–13.2 μ; long. het., 10–23 μ.

Habitat:—In a cemented water reservoir in a private garden, along with *Nostoc spongiciforme* var. *tennis*, *Tolypothrix lanata* forma, *Gloeocapsa punctata* and *Oedogonium* sp.


*Forma.*

Diam. fil., 13–17 μ, when old upto 20 μ; crass. vag., 2.4–5 μ, when old and unhealthy upto 6.6 μ; diam. trich., 9–12 μ, when old and unhealthy narrowed down to 6.6 μ, at growing apices upto 15 μ; long. cell., 10–12 μ; when old and unhealthy upto 30 μ, at growing apices upto 5 μ; lat. het., 10–13.2 μ; long. het., 13–42 μ.

Habitat:—Floating in a stagnant pond.

The form differs from the type in the presence of narrower filaments and trichomes and in the heterocysts being frequently longer and found singly or in chains of 2 to 3.

Lat. fil., 5.5–7 μ; lat. trich., 4.9–6 μ; long. cell., 3–5 μ; lat. het., 6.6–7 μ; long. het., 4–10 μ.

Habitat:—On the white-washed wall of the temple at Kanwa, Benares, along with *Lyngbya trunicola* and others.

Genus *Scytonema* Agardh.

32. *Scytonema coactile* Mont. Geitler, *op. cit.*, 1930–32, p. 753, Fig. 479 a–c.

Lat. fil., 17–19.8 μ, when old upto 23 μ; crass. vag., 2–3 μ, when old upto 4.8 μ; lat. trich., 10–15 μ, when old narrowed down to 7 μ; lat. het., 13.2–15 μ; long. het., 11.8–17.3 μ.

Habitat:—Free-floating in a tank of a private garden.

33. *Scytonema stuposum* (Kütz.) Born. Frémy, *op. cit.*, 1930, p. 305, Fig. 260; Tilden, *op. cit.*, 1910, Pl. XII, Figs. 13 and 14.

Lat. fil., 19.8–23 μ, when old upto 26 μ; crass. vag., 2–4.8 μ, when old and unhealthy upto 6 μ; lat. trich., 10–14 μ, when old and unhealthy narrowed down to 8 μ; long. cell., 3.3–13.2 μ; lat. het., 13.2–15 μ; long. het., 11.8–19 μ.

Habitat:—On clayey soil by the side of the road leading to Saranath. The sheath in this form is yellowish-brown and stratified.

34. *Scytonema ocellatum* Lyngbye. Frémy, *op. cit.*, 1930, p. 309, Fig. 263.

Lat. fil., 17.6–19.2 μ, when old upto 20 μ; crass. vag., 2.4–3.2 μ, when old upto 5 μ; lat. trich., 9.6–14.4 μ, when old and unhealthy narrowed down to 8 μ; long. cell., 5–14.4 μ, when old and unhealthy upto 19 μ; lat. het., 14.4–16 μ; long. het., 11.2–16 μ.

Habitat:—On moist soil in shade; on the bark of *Tamarindus indica* and *Mangifera indica*.


Lat. fil., 13.2–16.5 μ, when old upto 18 μ; crass. vag., 0.9–1.8 μ, when old upto 3.5 μ; lat. trich., 11.8–13.2 μ, when old narrowed down to 8 μ; long. cell., 2–11.8 μ; lat. het., 11.8–13.2 μ; long. het., 10–16.5 μ.

Habitat:—On shaded soil at the edge of a rain-water pool.
36. Scytonema guyanense (Mont.) Born. et Flah. Frémy, *op. cit.*, 1930, p. 312, Fig. 265.

Lat. fil., (13.2–) 15–16.5 µ, when old upto 20 µ; crass. vag., 2–3 µ, when old upto 4 µ, at apices thinned out to 1 µ; lat. cell., 11–14 µ, when old narrowed down to 9 µ; long. cell., 4.8–19.8 µ; lat. het., 10–14 µ; long. het., 13–20 µ.

Habitat:—On moist rocks, among liverworts and mosses, Mussoorie.

37. Scytonema Hofmanni Ag. Frémy, *op. cit.*, 1930, p. 313, Fig. 266; Geitler, *op. cit.*, 1925, p. 268, Fig. 317.

Lat. fil., 6.4–8 µ, when old upto 10 µ; crass. vag., 1–1.5 µ, when old upto 2–2.2 µ; lat. cell., 4.7–6.4 µ; long. cell., 4.8–9 µ; lat. het., 6.4 µ; long. het., 9.6–12 µ.

Habitat:—On the cemented compound wall of a private garden.

38. Scytonema mirabile (Dillw.) Born. Geitler, *op. cit.*, 1930–32, pp. 776 and 777, Fig. 498 a–f; Frémy, *op. cit.*, 1930, p. 318, Fig. 268; Bhāradwāja, "The Taxonomy of Scytonema and Tolypothrix including some new records and new species from India and Ceylon," *Revue Algologique*, 1933, n. 1–2, p. 171, Fig. 5, A.

Lat. fil., 13.2–16.5 µ, when old upto 19 µ; crass. vag., 3.3–4 µ, when old upto 6.6 µ and thinned out at apices to 1.2 µ; lat. trich., 6.6–9.5 µ, when old narrowed down to 4 µ; long. cell., 3–6.6 µ; lat. het., 6.6–8 µ; long. het., 6.6–10 µ.

Habitat:—On the moist bricks of a wall in the shade of a tree; on moist soil in a field.


Lat. fil., 10–16 µ, when old upto 19 µ; crass. vag., in old healthy filaments upto 4.9 µ, in old unhealthy ones upto 7 µ; lat. trich., 4.8–7 µ, in old unhealthy ones narrowed down to 3.2 µ, at growing apices upto 10 µ; long. cell., 11.2–23 µ, at apices 3.5–4.8 µ; lat. het., 6.6–10 µ; long. het., 6.6–16.5 µ.

Habitat:—On the mud settled down on the rocks near the dam at Latif Shah, Benares State.

The stratification of the sheath in this form is mostly diverging.
Fig. 4. A—Nostoc Linckia (Roth.) Born. et Flah. var. arvense var. nov.; B—Nostoc spongiforme Ag. var. varians var. nov.; C—Nostoc ellipsosporum Rabenh. var. violacea var. nov.

All × 875.
5. *Nostocaceae*.

Genus *Cylindrospermum* Kuetzing.

40. *Cylindrospermum muscicola* Kütz. Frémy, *op. cit.*, 1930, p. 377, Fig. 313; Tilden, *op. cit.*, 1910, Pl. X, Fig. 6; Ghose, *op. cit.*, 1926, Pl. VII, Fig. 15.

Lat. cell., 2.8–3 μ; long. cell., 2.8–5 μ; lat. het., 3.7–4.5 μ; long. het., 4.5–6 (–7.5) μ; lat. spor., 9–10.5 μ; long. spor., 13.2–16.5 (–21.4) μ.

Habitat:—On moist soil, singly or along with *Microcoleus chthonoplastes*, *Chroococcus pallidus* and others.

Another form collected a few miles off Benares possesses heterocysts, which sometimes measure as much as 10.5 μ long.

Genus *Nostoc* Vaucher.

41. *Nostoc paludosum* Kütz. Frémy, *op. cit.*, 1930, p. 333, Fig. 275; Tilden, *op. cit.*, 1910, Pl. VI, Fig. 38.

*Forma.*

Lat. cell., 3–4 μ; long. cell., 3.8–4.8 μ; lat. het., 5.6–6.4 μ; long. het., 6.6–8 μ; lat. spor., 4.6–6.4 μ; long. spor., 6.4–10 μ.

Habitat:—In the stagnant water of a crop-field along with *Nostoc piscinale* forma and others.

The form differs from the type in having bigger spores.

42. *Nostoc Linckia* (Roth.) Born. et Flah. Frémy, *op. cit.*, 1930, p. 333, Fig. 276; Tilden, *op. cit.*, 1910, Pl. VII, Fig. 1; West, *Algae*, 1916, Vol. I, p. 43, Fig. 31, A–C.

Var. *arvense* var. nov. (Fig. 4, A).

Plant-mass gelatinous, expanded, presenting an uneven surface, yellowish-brown to blue-green; filaments numerous, flexuous; trichomes frequently enveloped by a lamellated and yellowish-brown mucilaginous sheath that follows their contour; cells spherical or barrel-shaped; heterocysts almost spherical, usually not enveloped by any mucilage; spores in long chains, more or less spherical with a brown outer wall.

Lat. cell., 4.5–6 μ; long. cell., 4.8–6.4 μ; lat. het., 4.8–7.2 μ; long. het., 4.8–6.4 μ; lat. spor., 6.4–7.2 μ; long. spor., 7–8 μ.

Habitat:—On water-logged soil in a crop-field.

The variety is comparable to the type on account of its possessing (1) flexuous trichomes, (2) spherical or barrel-shaped cells, (3) almost spherical heterocysts and spores with a brown outer wall; but it differs
from the same in the broader trichomes and heterocysts, and in commonly possessing a lamellated and brown mucilaginous sheath following the contour of the trichomes.

43. *Nostoc piscinale* Kütz. Frémy, *op. cit.*, 1930, p. 334, Fig. 277.

*Forma.*

Lat. cell., 4-6 µ; lat. het., 6·4-7·2 µ; lat. spor., 6-10 µ.

*Habitat:*—In the stagnant water of a crop-field along with *Nostoc paludosum* and others.

The form differs from the type in the slightly bigger dimensions of all parts.

44. *Nostoc spongiceforme* Ag. Frémy, *op. cit.*, 1930, p. 338, Fig. 279a and b; Tilden, *op. cit.*, 1910, Pl. VII, Figs. 4 and 5.

*Var. varians* var. nov. (Fig. 4, B).

Plant-mass thin, spreading, blue-green; trichomes loosely entangled, sometimes individually enveloped by yellowish-brown mucilage; cells barrel-shaped, end-cell conical with a rounded apex; heterocysts barrel-shaped or cylindrical with rounded or flat ends, broader than the trichomes; spores in long chains, cylindrical with rounded ends, sometimes ellipsoidal, rarely spherical, with a smooth hyaline outer wall.

Lat. cell., 3-3·5 µ; long. cell., 2-3·5 µ; lat. het., 4·8-6·4 µ; long. het., 5·6-8 µ; lat. spor., 4·4-8 µ; long. spor. 4·8-10 µ.

*Habitat:*—On moist soil at the edge of a rain-water pool.

The variety resembles the type in the loosely entangled filaments, the barrel-shaped cells, the barrel-shaped or cylindrical heterocysts, and the chains of ellipsoidal spores; but it differs in having a thin, blue-green and spreading stratum without any firm mucilaginous envelope, narrower cells that are never cylindrical and smaller heterocysts and spores, the latter being cylindrical or sometimes spherical with a hyaline outer wall.


*Var. violacea* var. nov. (Fig. 4, C).

Plant-mass gelatinous, irregularly expanded, dark-violet; filaments flexuous, loosely entangled, light-violet; cells almost quadratic or cylindrical, with constrictions at the joints; heterocysts almost spherical or barrel-shaped or cylindrical, with rounded or flat ends; spores ellipsoidal, almost spherical or cylindrical, with a hyaline smooth outer wall.

Lat. cell., 3·2-3·5 µ; long. cell., 2·4-8 µ; lat. het., 4-6·4 µ; long. het., 4·8-8 µ; lat. spor., 4·8-6·4 µ; long. spor. 5·6-15 µ.
Fig. 5. *Anabena* Iyengari Bhāradwāja var. *tenuis* var. nov.; D–E—*Anabena* *unispora* Gardner var. *crassa* var. nov.; F–G—*Anabena* *aphanizomenoides* Forti var. *elipsospora* var. nov. All × 875.
Habitat:—On the sides of the steps of a village tank, above water-level.

The variety agrees with the type in the flexuous and laxly entangled filaments, in the cylindrical cells, in the spherical or cylindrical heterocysts, and in the long ellipsoidal or cylindrical spores with a hyaline smooth outer wall; but it differs in having a dark-violet stratum, narrower trichomes of light violet colour, comparatively shorter cells, smaller heterocysts that are also barrel-shaped, and in the smaller dimensions of the spores possessing a hyaline outer wall.

Genus *Anabaena* Bory.


Long. vag., 300–500 (–1,000) μ; crass. vag., 10–50 μ; long. trich., 250–300 μ; lat. cell., 4·9–6·6 μ; long. cell., 3·3–5 μ; lat. het., 6·4–9 (–10) μ; lat. spor., 8·4–10·9 μ; long. spor., 13·3–16·2 μ.

Habitat:—Free-floating or attached to grass-blades and roots of *Lemna* and *Trapa* in some ponds near the Banaras Hindu University.


Var. *tenuis* var. nov. (Fig. 5, A–C).

Plant-mass floccose, thin, free-floating, pale blue-green. Trichomes single, straight or irregularly curved; end-cells conical with rounded apices. Cells barrel-shaped, as long as broad or slightly shorter or longer than broad. Heterocysts more or less barrel-shaped, sometimes subspherical. Spores ellipsoidal or cylindrical with rounded ends, single or in pairs on either side of a heterocyst, with a smooth hyaline outer wall.

Lat. cell., 3·5–4·5 μ; long. cell., 3·6–4 μ, rarely 7·5 μ; lat. het., 4·8–6·4 μ; long. het., 5·2–9 μ; lat. spor., 7·5–9·6 μ, rarely 10·5 μ; long. spor., 9–19·5 μ, rarely 21 μ.

Habitat:—In a pond on the University grounds, along with *Dactylococcopsis raphidioides* forma, *Calothrix marchica* var. *intermedia*, *Anabaena fertilissima* sp. nov., *Oscillatoria animalis*, *Lyngbya Digesti* and sterile filaments of *Oedogonium* and *Spirogyra*.

The variety resembles the type in the barrel-shaped cells, conical end-cells with rounded apices, barrel-shaped heterocysts and ellipsoidal spores, that are on either side of a heterocyst; but differs from the same
in having narrower trichomes, smaller heterocysts and comparatively smaller spores (that are also cylindrical) with a hyaline outer wall and situated singly or in pairs on either side of a heterocyst.


Var. *crassa* var. nov. (Fig. 5, D and E).

Plant-mass soft, mucilaginous. Trichomes free, long, more or less straight, tapering at extreme ends, constricted at joints; end-cells with rounded apices. Cells cylindrical, sometimes almost quadratic. Heterocysts single, cylindrical or ellipsoidal, sometimes pressed from both ends. Spores single, adjoining heterocysts, long ellipsoidal, sometimes pressed from both ends, with a smooth hyaline outer wall.

Lat. cell., 4·8–6·6 μ; long. trich., 500–700 μ; long. cell., 4·5–13·2 μ; lat. het., 5–8·2 μ; long. het., 7·4–16·5 μ; lat. spor., 9·6–15 μ; long. spor., 23–31·5 μ.

Habitat:—In a rain-water pool, along with sterile filaments of *Spirogyra* and *Oedogonium*; floating on the stagnant water of a rice-field.

The variety agrees with the type in possessing cylindrical cells, constrictions at septa, end-cells with rounded apices and single ellipsoidal spores on only one side of a heterocyst*; but it differs from the same in having broader trichomes and narrower spores with a hyaline outer wall.

49. *Anabaena aphanizomenoides* Forti. Geitler, *op. cit.*, 1930–32, p. 876, Fig. 556.

Var. *ellipsosphora* var. nov. (Fig. 5, F and G).

Thallus free-floating, thin, floccose, pale blue-green. Trichomes single, straight or bent, tapering at the ends, with constrictions at the joints; end-cells conical with rounded apices. Cells quadratic or up to three times as long as broad. Heterocysts single, intercalary, ellipsoidal, rarely spherical. Spores ellipsoidal sometimes pressed from both ends, one or two on each side of a heterocyst, with a hyaline outer wall.

Lat. trich., 3·3–4 μ, at top 1·6 μ; long. cell., 3·3–11 μ; lat. het., 6·6–6·6 μ; long. het., 6–11·6 μ; lat. spor., 9·6–13·5 μ; long. spor., 11·6–19·8 (–23) μ.

* Since the author of *Anabaena unispora* has not given any idea of the shape and the actual dimensions of the heterocysts, it is not possible to compare them with those of the present form. But the original figure of the type shows that the heterocysts are cylindrical as found in the form under discussion. The Benares alga, however, possesses ellipsoidal heterocysts as well.
Habitat:—In a rain-water pool, along with *Aulosira Fritschii*, *Cosmarium* sp., *Closterium* sp., and several others.

The variety agrees with the type in possessing quadratic and cylindrical cells, ellipsoidal heterocysts and one or two spores on each side of a heterocyst, the former with a hyaline outer wall; but it differs in the slightly narrower trichomes, in the absence of gas-vacuoles in the cells, in the longer heterocysts and in the bigger ellipsoidal spores.


Lat. trich., 3·3–5 μ; long. cell., 3·3–4 μ; lat. het., 4·8–6·4 (–7·5) μ; lat. spor., 10–12 μ; long. spor., 9·8–14·6 μ.

Habitat:—On soil submerged in water at the edge of a pool.

This variety, as originally reported, possessed only single spores on either side of a heterocyst, but in the present form, spores are also met with in pairs on each side of a heterocyst.

51. *Anabaena fertilissima* sp. nov. (Fig. 6, A–C).

Trichomes single, straight or bent, with almost rounded end-cells; cells barrel-shaped; heterocysts almost spherical; spores in long chains, often making the whole trichome sporogenous, adjoining the heterocysts but developed centrifugally; almost spherical, with a smooth hyaline outer wall.

Long. trich., upto 350 μ; lat. trich., 5–5·6 μ, at apex 4 μ; long. cell., 4·8–8 μ; lat. het., 6·4–8·4 μ; lat. spor., 4·8–8 μ; long. spor., 3·2–8·8 μ.

Habitat:—In a pond on the University grounds, along with *Dactylococcopsis raphidioides* forma, *Calothrix marchica* var. intermedia, *Anabaena Iyengari* var. *tenuis*, *Oscillatoria animalis*, *Lyngbya Digenti* and sterile filaments of *Spirogyra* and *Oedogonium*.

The important feature in this alga is the formation of spores in long chains, so much so that practically the whole of the trichome becomes sporogenous. It comes close to *Anabaena sphærica* Born. et Flah. on account of the barrel-shaped cells, rounded end-cells and spherical heterocysts and spores; but it differs in the spores being smaller and formed in long chains. In the presence of spherical heterocysts and spores in chains, the present alga agrees with *Anabaena gelatinicola* Ghose, but it differs from the Lahore form in the presence of narrower trichomes that are never coiled, rounded end-cells and much longer chains of smaller spores adjoining the heterocysts. The barrel-shaped cells and the chains of spores
characteristic of this alga also recall *Anabarna variabilis* Kütz., *A. ærugi-nosa* Gardner, *A. Iyengari Bhāradwāja*, and *A. doliolum* Bhāradwāja, but it differs from all these four species in the spores being spherical. It further differs from the former two species in the presence of spores adjoining the heterocysts and from the latter two species in possessing spherical heterocysts.

![Diagram of *Anabarna fertilissima* filaments](image)

**Fig. 6.** *A-* vegetative and *B* & *C*-sporogenous portions of filaments of *Anabarna fertilissima* sp. nov. All × 875.
6. Oscillatoriaceae.

Genus *Spirulina* Turpin.

52. *Spirulina platensis* (Nordst.) Gom. Geitler, *op. cit.*, 1930-32, p. 922, Fig. 590 d; Frémy, *op. cit.*, 1930, p. 232, Fig. 205.

Var. *tenuis* var. nov. (Fig. 7, A and B).

Plant-mass greyish-brown; trichomes pale blue-green, of uniform width, in regular spirals, without constrictions at the joints; end-cells with rounded apices; cells disc-shaped.

Lat. trich., 5·1-6·4 μ; long. cell., 1·6-2·5 (-3·3) μ; lat. spir., 30-43 μ; spat. inter duo. spir., 40-52 μ.

Habitat: — In a waste-water drain; in a pond, along with *Oscillatoria chalybea*, Rajghat.

The variety agrees with the type in the uniform width of the trichomes, in the rounded apices of the end-cells, in the spirals being regular, and in the distance between the spirals; but it differs on account of the narrower trichomes, the broader spirals, the comparatively shorter cells, and the absence of constrictions at the septa.

53. *Spirulina major* Kütz. Geitler, *op. cit.*, 1930-32, p. 930, Fig. 595; Frémy, *op. cit.*, 1930, p. 235, Fig. 208; Tilden, *op. cit.*, 1910, Pl. IV, Fig. 46; Frémy, *op. cit.*, 1934, Pl. 31, Fig. 18; Carter, "A comparative study of the algal flora of two salt marshes, Part II," *Journal of Ecology*, Vol. XXI, I, 1933, p. 159, Fig. 2; Ghose, *op. cit.*, 1926, Pl. VI, Fig. 3.

Lat. trich., 1-1·4 μ; lat. spir., 3·2-3·5 μ; spat. inter duo. spir., 2·4-3·2 μ.

Habitat: — On moist soil along with other algae; planktonic in the tank of the Benares Electric Light and Power Supply Co., Ltd., along with *Chroococcus turgidus*, *C. minutus* and *Merismopedia tenuissima*.

Genus *Oscillatoria* Vauch.

54. *Oscillatoria sancta* (Kütz.) Gom. Frémy, *op. cit.*, 1930, p. 210, Fig. 177; Tilden, *op. cit.*, 1910, Pl. IV, Fig. 5; Carter, *op. cit.*, 1933, p. 159, Figs. 11 and 12; Geitler, *op. cit.*, 1925, p. 356, Fig. 418.

Lat. cell., 10-16 μ; long. cell., 2·5-4·8 μ.

Habitat: — On moist soil amidst flower pots in the Green House, University Botanical Garden, along with *Oscillatoria Ulrichii*; on moist soil along with *Oscillatoria formosa*. 
Forma.
Lat. cell., 9·6-11·2 μ; long. cell., 2-4 μ.
The form has no constrictions at the joints.
Lat. cell., 4·1-4·8 μ; long. cell., 1-1·3 μ.
Habitat:—On wet soil along with Navicula sp.
56. Oscillatoria anguina (Bory) Gom. Geitler, op. cit., 1930-32, p. 945, Fig. 599 b.
Lat. trich., 6·6-8·2 μ; long. cell., 1·5-2·5 μ.
Habitat:—In a waste-water drain; in a rain-water puddle, Chunar.
57. Oscillatoria chalybea Mertens. Geitler, op. cit., 1930-32, p. 956, Fig. 608 b.
Lat. cell., 7-9·6 μ, at top 6·6 μ; long. cell., 3-6·6 μ.
Habitat:—On wet soil, along with Oscillatoria homogenea, Mussoorie.
58. Oscillatoria tenuis Ag. Geitler, op. cit., 1930-32, p. 960, Fig. 611 g; Tilden, op. cit., 1910, Pl. IV, Fig. 17.
Lat. cell., 4·5-6·6 μ; long. cell., 2·5-5 μ.
Habitat:—On moist soil; in a road-side water course, Shivpur, Benares, along with other algae; in rain-water ditches on waste ground.
59. Oscillatoria pseudogeminata G. Schmidle. Geitler, op. cit., 1930-32, p. 966, Fig. 616.
Lat. cell., 1·6-1·8 μ; long. cell., 1-2 μ.
Habitat:—On moist soil.
Forma.
Lat. trich., 1·6-2 μ; long. cell., 1·8-5 μ.
Habitat:—In stagnant water of a ditch near a well.
The form possesses much longer cells as well.
Lat. trich., 1·6-1·8 μ; long. cell., 3-6·4 μ.
Habitat:—On moist soil along with other algae; in a pond along with other algae.
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61. Oscillatoria homogenea Frémy. Frémy, op. cit., 1930, p. 221, Fig. 184.
    Lat. cell., 3.3–3.5 μ; long. cell., 3.5–4.6 μ.
    Habitat:—On wet soil, along with Oscillatoria chalybea, Mussoorie.

62. Oscillatoria Okeni Ag. Tilden, op. cit., 1910, Pl. IV, Fig. 35; Geitler, op. cit., 1925, p. 372, Fig. 463.
    Lat. cell., 5.5–6.6 μ; long. cell., 3–4.5 μ.
    Habitat:—On moist soil along with Oscillatoria sancta and others; on water-logged soil.

63. Oscillatoria formosa Bory. Geitler, op. cit., 1930–32, p. 970, Fig. 619 b.
    Lat. trich., 4.5–6.6 μ; long. cell., 1.8–4.5 μ.
    Habitat:—On moist soil, along with Oscillatoria pseudogeminata; on moist rocks, along with Phormidium subfuscum, Mussoorie; on moist soil, along with Oscillatoria sancta and O. princeps; on soil, along with other algae, in a waste-water drain.

64. Oscillatoria claricentrosa Gardner. Geitler, op. cit., 1930–32, p. 964, Fig. 615 c.
    Forma bigranulata form. nov. (Fig. 7, C).
    Lat. trich., 2–2.5 μ; long. cell., 5–10 μ.
    Habitat:—In stagnant water of a drain, along with sterile filaments of Spirogyra and Oedogonium.

    The form differs from the type in the presence of two granules on either side of a cross-wall and in the trichomes showing a more gradual tapering.

65. Oscillatoria rubescens D.C. Geitler, op. cit., 1930–32, p. 973, Fig. 620 a and b.
    Forma.
    Lat. trich., 4.8–6.4 μ; long. cell., 1.2–4 μ.
    Habitat:—On wet soil, Chunar.

    But for the presence of narrower trichomes, the Benares form agrees with the type in all respects.

66. Oscillatoria Lemmermanni Wolosz. Geitler, op. cit., 1930–32, p. 969, Fig. 618 i.
    Lat. trich., 2.2–2.8 μ; long. cell., 2.5–5 μ.
    Habitat:—On moist soil along with Phormidium Jadinianum forma.

67. Oscillatoria animalis Ag. Geitler, op. cit., 1930–32, p. 950, Fig. 603 e.
Habitat:—On the moist sides of the cemented pavement of a well; in a pond on the University grounds, along with Dactylococcopsis raphidioides forma, Calothrix marchica var. intermedia, Anabaena fertilissima sp. nov., A. Iyengari var. tenuis, Lyngbya Digeuti forma and sterile filaments of Spirogyra and Oedogonium; in a ditch along with Oscillatoria sancta and others.

68. Oscillatoria acuminata Gom. Tilden, op. cit., 1910, Pl. IV, Fig. 29. 
Forma.
Lat. cell., 3–3.8 μ; long. cell., 1–3.8 μ.
Habitat:—On moist soil.

69. Oscillatoria salina Brühl and Biswas. Geitler, op. cit., 1930–32, p. 979, Fig. 624.
Lat. cell., 3.3–4.8 μ; long. cell., 1.5–2 μ.
Habitat:—In earthen water-pans in a green house, along with Cylindrospermum indica and Cocconies sp.; on moist soil in a drain, Cantonment area; on moist soil, University area.
Unlike the type, the Benares alga is a fresh-water form.

Genus Phormidium Kütz.

70. Phormidium Bohneri Schmidle. "Beitrage zur Algenflora Afrikas," Engler's Botanische Jahrbucher, 1902, 30, Taf. II, Fig. 11.
Forma.
Lat. fil., 3–3.7 μ; lat. cell., 2.2–2.8 μ; long. cell., 1.6–2.8 μ.
Habitat:—On the cemented surface near the waste-water outlet of a house, Ramnagar.

71. Phormidium cebennense Gom. Frémy, op. cit., p. 147, Fig. 129.
Lat. trich., 1.8–2 μ; long. cell., 1–2 μ.
Habitat:—On the plinth of the College building near the outlet of a drain, along with Phormidium anomala sp. nov.

72. Phormidium mucosum Gardner. Geitler, op. cit., 1930–32, p. 1012, Fig. 646 b.
Var. arvense var. nov. (Fig. 7, D and E).
Plant-mass thick, fragile, blue-green to greyish-blue. Filaments loosely entangled. Sheath thick, firm, hyaline, unstratified. Trichomes of uniform
width, not constricted at the joints; apical cells with rounded apices, without calyptra or cap. Cells quadratic or almost quadratic or slightly longer than broad.

Lat. fil., 3·2-5·2 μ; crass. vag., upto 2 μ; lat. trich., 1·8-2·5 μ; long. cell., 1·5-3·6 μ.

Habitat:—In stagnant rain-water of a crop-field.

The variety agrees with the type in all respects except that it has narrower filaments and trichomes, the latter possessing shorter cells.

73. Phormidium Retzii (Ag.) Gom. Geitler, op. cit., 1930-32, p. 1012, Fig. 647 a-d.

Lat. fil., 4·5-7 μ; long. cell., 4·5-8 μ.

Habitat:—On the sides of the water storage tanks of the Benares Water Works; on moist stones near the dam, Latif Shah, Benares State.


Forma.

Lat. cell., 3·4 μ; long. cell., 1·5-2·8 μ.

Habitat:—On the sides of the cemented water reservoir, University Botanical Garden.

The form has slightly narrower trichomes than those of the type.


Lat. trich., 4·7-5·8 μ; crass. vag., upto 0·5 μ; long. cell., 2·5-8 μ.

Habitat:—On moist soil, along with Microcoleus chthonoplastes and others.

76. Phormidium subfuscum Kütz. Geitler, op. cit., 1930-32, p. 1023, Fig. 652 d-g.

Lat. cell., 8·4-11·7 μ; long. cell., 1·8-3·μ.

Habitat:—On moist soil, along with Oscillatoria formosa.

The calyptra in this form is rounded instead of being pointed.

77. Phormidium favosum (Bory) Gom. Geitler, op. cit., 1930-32, p. 1023, Fig. 652 a and b.

Forma.

Lat. cell., 4-6 μ; long. cell., 2·4-3·5 μ.

Habitat:—On the sides of a big water reservoir.
Fig. 7. A—Terminal portion of the trichome and B—entire plant of *Spirulina platensis* (Nordst.) Gem. var. *tenuis* var. nov.; C—Terminal portions of *Oscillatoria claricentrosa* Gardner forma *bigranulata* form. nov.; D & E—portions of filaments of *Phormidium mucosum* Gardner var. *arvense* var. nov.; F—I—portions of filaments of *Phormidium anomala* sp. nov. B × 425; all the rest × 875.
The form exactly resembles the type except for the presence of shorter cells.

78. *Phormidium autumnale* (Ag.) Gom. Geitler, *op. cit.*, 1930-32, p. 1023, Fig. 652 k and l; Frémy, *op. cit.*, 1934, Pl. 24, Fig. 4; Carter, *op. cit.*, 1933, p. 156, Fig. 7.

Lat. cell., 4·4-8.8 μ; long. cell., 2.4-4.8 μ.

Habitat:—On the stony steps of a tank near water-level.

79. *Phormidium anomala* sp. nov. (Fig. 7, F-1).

Thallus thick, expanded, soft, mucilaginous, deep blue-green to green. Trichomes sub-parallel, of uniform width, without constrictions at the joints. Sheath thin, colourless, unstained with chlor-zinc-iodide, persistent or dissolved. Cells disc-shaped, much broader than long; end-cells bluntly rounded, without cap or calyptra.

Crass. strat., 3-6 mm.; lat. trich., 8-10 μ; long. cell., 0.8-1.2 (-2) μ.

Habitat:—On the plinth of the College building, near the outlet of a drain, along with *Phormidium cebennense*.

This alga approaches *Phormidium ambiguum* Gom. and *Phormidium subincrustatum* Fritsch and Rich in the presence of an expanded stratum, the uniform width of the trichomes, the absence of constrictions at the joints, and the rounded apices for the end-cells, which are without a cap or calyptra; but it differs from both these species in having shorter and wider cells.* It further differs from the former species in the filaments being more or less parallel, the sheath being always thin and unstratified, and remaining unstained with chlor-zinc-iodide, the absence of granules near the septa and of the gas-vacuoles in the cells. The Benares alga, while further agreeing with *Phormidium subincrustatum* in the sub-parallel trichomes and the thin, diffuent and unstratified sheath, differs from it in the thallus being thicker and without any impregnation of lime.

Genus *Lyngbya* Agardh.

80. *Lyngbya gracilis* Rabenh. Geitler, *op. cit.*, 1930-32, p. 1040, Fig. 657 a; Frémy, *op. cit.*, 1934, Pl. 26, Fig. 3.

Lat. fil., 8-11.8 μ; crass. vag., 0.8-1.8 μ; lat. trich., 5.6-8.3 μ; long. cell., 2-6.4 μ.

Habitat:—In the water storage tank of the Benares Water Works, along with *Chaemosiphon sideriphilus* var. glabra.

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* Fritsch and Rich have not mentioned the length of the cells in *Phormidium subincrustatum*, but their figures show them to be shorter than broad or almost quadratic.
81. *Lyngbya spiralis* Geitler. Geitler, *op. cit.*, 1930–32, p. 1042, Fig. 659.
Lat. fil., 5·5–8 μ; crass. vag., 0·3 μ; lat. trich., 4·8–5 μ; long. cell., 1·5–2·5 μ.
Habitat:—Planktonic in a rain-water pool, along with *Aphanothece bullosa*.

82. *Lyngbya limnetica* Lemm. Lemmermann, *op. cit.*, 1910, p. 102, Fig. 8.
Lat. fil., 1·5–2 μ; lat. cell., 1·2–1·6 μ; long. cell., 1–2·5 μ.
Habitat:—In an ornamental water reservoir of a private garden, along with *Microcystis aeruginosa* var. *elongata*, *Oscillatoria Annea* and *Oedogonium* sp.

83. *Lyngbya dendrobia* Brühl and Biswas. *Commentationes Algologicæ ii. algae epiphytice epiphloie indicæ or Indian Bark Alge,* *Jour. Dept. Sci., Cal. Univ.*, 1923, 5, Pl. III, Fig. 11 a–c; Geitler, *op. cit.*, 1930–32, p. 1051.
Forma.
Lat. fil., 9·6–13.2 μ; crass. vag., 0·8–3 μ; lat. trich., 6·6–8·8 μ; long. cell., 4–8 μ.
Habitat:—On moist soil, spreading among *Riccia* sp. and grass blade.
The form differs from the type in possessing narrower trichomes and thicker sheath.

Forma.
Lat. fil., 18·4–25·6 μ; crass. vag., 2·4–8 μ; lat. cell., 10·4–12·8 μ; long. cell., 4–8 μ.
Habitat:—On moist soil, University area.
The form differs from the type in the sheath being very thick and stratified.

Lat. fil., 22·8–26·4 μ; crass. vag., 2·5–4 μ; lat. trich., 16–18 μ; long. cell., 4·5–8 μ.
Habitat:—On the bark of *Eujenia Jambolana* by the side of the road leading to Allahabad.

86. *Lyngbya arboricola* Brühl and Biswas. Brühl and Biswas, *op. cit.*, 1923, Pl. III, Fig. 10 a–e; Geitler; *op. cit.*, 1932, p. 1053.
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Lat. fil., 19.2–23 μ; crass. vag., 2–4 μ; lat. trich., 16–17 μ; long. cell., 4–6.4 (-9) μ.

Habitat:—On the bark of *Mangifera indica* along with *Lyngbya trunicola*.

87. *Lyngbya trunicola* Ghose. Ghose, *op. cit.*, 1923, Pl. 31, Fig. 6.
   Lat. fil., 15–16.5 μ; crass. vag., 0.8 μ; lat. trich., 12–15 μ; long. cell., 1.5–4.5 μ.
   Habitat:—On the bark of *Bassia latifolia* and *Mangifera indica*, either singly or along with *Lyngbya arboricola*, University Botanical Garden.

88. *Lyngbya rubida* Frémy. Frémy, *op. cit.*, 1930, p. 185, Fig. 155.
   Forma.
   Lat. fil., 6–8 μ; lat. trich., 4.8–5 μ; long. cell., 4–8 μ.
   Habitat:—In a stagnant pond.

The form differs from the type in having slightly broader trichomes, shorter cells and a hyaline sheath.

   Lat. fil., 12.8–19 μ; crass. vag., 3.2–4 μ; lat. trich., 9.6–11.2 μ; long. cell., 4.8–6.4 μ.
   Habitat:—On moist soil along with *Microcoleus chthonoplastes*.

The sheath in the Benares form is thicker than that of the type.

90. *Lyngbya lutea* (Ag.) Gom. Geitler, *op. cit.*, p. 1058, Fig. 670 a and b; Frémy, *op. cit.*, 1934, Pl. 28, Fig. 4 a–c; Carter, *op. cit.*, 1933, p. 164, Figs. 5 and 6.
   Lat. fil., 4.8–5 μ; lat. trich., 3.8–4 μ; long. cell., 2.4–3.8 μ.
   Habitat:—In a cemented drain, University Botanical Garden.

The sheath in this form is thin and unstratified.

91. *Lyngbya Digeuli* Gom. Geitler, *op. cit.*, 1930–32, p. 1038, Fig. 656 e.
   Forma.
   Lat. fil., 1.5–2.3 μ; lat. trich., 1.4–2.2 μ; long. cell., 1.5–3.2 μ.
   Habitat:—In a pond on the University grounds, along with *Dactylococcopsis raphidioides* forma, *Calothrix marchica* var. *intermedia*, *Anabaena Iyengari* var. *tenuis*, *A. fertilissima* sp. nov., *Oscillatoria animalis* and sterile filaments of *Spirogyra* and *Oedogonium*.

The form is characterised by the possession of narrower filaments.
92. *Lyngbya conservoides* Ag. Tilden, *op. cit.*, 1910, Pl. V, Fig. 39; Frémy, *op. cit.*, 1934, Pl. 28, Fig. 2; Carter, *op. cit.*, 1933, p. 162, Fig. 11, 1 and 2.

Lat. fil., 19.8–23.2 μ; crass. vag., upto 5 μ; lat. trich., 13.2–19.2 μ; long. cell., 2–4 μ.

Habitat:—In an ornamental reservoir of a private garden under the shade of the closely spreading leaves of *Nelumbium* sp.

93. *Lyngbya aerugineo-cerulea* (Kütz.) Com. Frémy, *op. cit.*, 1930, p. 193, Fig. 157; Ghose, *op. cit.*, 1926, Pl. VI, Fig. 7.

Lat. fil., 6.4–8 μ; lat. trich., 5.1–6.4 μ; long. cell., 1.8–4.8 (–5.6) μ.

Habitat:—In a stagnant pond, Chunar.

94. *Lyngbya putoalis* Mont. Geitler, *op. cit.*, 1930–32, p. 1063, Fig. 675 b; Frémy, *op. cit.*, 1930, p. 193, Fig. 159 a and b.

Lat. fil., 8–11.2 μ; crass. vag., upto 0.8 μ; lat. trich., 6.4–9.6, average 8 μ; long. cell., 3–10.5 μ.

Habitat:—In the stagnant water of an irrigation channel, Ramnagar.

95. *Lyngbya Martensiana* Menegh. Geitler, *op. cit.*, 1930–32, p. 1064, Fig. 676.

*Forma.*

Lat. fil., 8–8.8 μ; crass. vag., 0.8 μ; lat. trich., 5.6–6.4 μ; long. cell., 2–4.8 μ.

Habitat:—On water plant at the edge of a rain-water pool. The form differs from the type in the sheath being always smooth and the cells being sometimes longer.

96. *Lyngbya stagnina* Kütz. Geitler, *op. cit.*, 1930–32, p. 1066, Fig. 679 b.

*Forma.*

Lat. fil., 10–12 μ; lat. trich., 8.5–9.5 μ; long. cell., 5–10 μ.

Habitat:—In a stagnant puddle by the side of the River Ganges along with *Cladophora* sp. and *Gomphonema* sp.

The form differs from the type in having narrower trichomes and longer cells* without granules near the septa.

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* From the description of the type it is clear that the cells are much shorter than broad, but Skuja's figure shows the cells to be almost quadratic or only slightly shorter than broad, just like those of the form under discussion.
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97. *Lyngbya major* Menegh. Tilden, *op. cit.*, 1910, Pl. 5, Fig. 46; Geitler, *op. cit.*, 1930–32, p. 1066, Fig. 679a; West, *op. cit.*, 1916, p. 42, Fig. 28 A.

Lat. fil., 19·2–20·8 μ; crass. vag., 3·2–4 μ; lat. trich., 12·8–14·4 μ; long. cell., 2–4 μ.

Habitat:—On moist soil in shade.

Genus *Symploca* Kützing.

98. *Symploca muralis* Kütz. 1 Geitler, *op. cit.*, 1930–32, p. 1125, Fig. 732; Frémy, *op. cit.*, 1930, p. 129, Fig. 113 a and b; West, *op. cit.*, 1916, p. 23, Fig. 15 E.

*Forma.*

Lat. fil., 5·2–7·5 μ; crass. vag., upto 2·5 μ; lat. trich., (3·2–) 4–5 μ; long. cell., 2·4–5·6 μ.

Habitat:—On moist soil, University area.

The form differs from the type in having broader trichomes and sometimes longer cells.

Genus *Microcoleus* Desmazieres.


Diam. fil., 30–100 μ; lat. vag., 15–65 μ; lat. cell., 4–5 μ; long. cell. 4–8 μ.

Habitat:—On moist soil along with other algae.

100. *Microcoleus sociatus* W. et G. S. West. Frémy, *op. cit.*, 1930, p. 83, Fig. 85 a and b.

Diam. fil., 30–45 μ; lat. vag., 2–10 μ; lat. trich., 2·4–2·8 μ; long. cell., 4·8–6 μ.

Habitat:—On moist soil along with other algae.

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