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FRESH WATER CYANOPHYCEAN ALGAE FROM NORTH-EASTERN UTTAR PRADESH, INDIA

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The algal flora of various parts of Northern India still remains unexplored and without first knowing the status of our aquatic resources especially algae of this area, we cannot have projections for their utilization. Blue green algae or Cyanobacteria are of great economic value.The morpho-taxonomic survey of fresh water algae of Northern-Eastern Uttar Pradesh has revealed large number of blue green algae.

In the present paper, 27 taxa of class Cyanophyceae (heterocystous and non heterocystous forms) have been described from various localities of Gonda and Bahraich/ Shrawasti districts of North-Eastern Uttar Pradesh. These taxa belong to orders Chroococcales (6 taxa), Nostocales (20 taxa) and Stigonematales (1taxon) of class Cyanophyceae. These taxa include 16 genera, 19 species and 8 varieties.

Keywords : Fresh water, Cyanophyceae, N.E.U.P., India.

Cyanophycean forms are prokaryotic in nature and also known as Cyanobacteria. However, due to presence of oxygen evolving photosystem, these organisms have been placed along with other algae and retained under class Cyanophyceae (Anand, 1998).

Pandey and Chaturvedi (1979) Pandey and Pandey (1982), Prasad (1952, 1962, 1964-65), Prasad and Mehrotra (1976, 1976a, 1977, 1978, 1979, 1979a, 1980), Prasad and Suxena (1980), Tewari (1975, 1979, 1979a), Tewari and Panday (1971, 1972, 1976) have reported large number of Cyanophycean algae from Uttar Pradesh. Recently Verma et al. (2000), Misra et al. (2001) and Singh and Srivastava (2002) have worked on these algae of Central, Eastern and South-WesternUttar Pradesh. In the present communication, twenty seven texa of class Cyanophyceae have been described. These algae have been collected from different aquatic habitats of Bahraich/Shrawasti and Gonda districts of North-Eastern Uttar Pradesh. The Baharaich/Shrawasti district lies between latitude 27^0-04′ and 28-14′north and longitude 81^0-03′ and 82^0-13′ east. District Gonda lies 26^0- 47′ and 27-51′ north latitude and 81^0-46′ east longitude.

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MATERIALS AND METHODS

Algal collections have been done with the help of planktonic mesh net and forceps during 1998-2002 from different aquatic habitats of Bahraich/ Shrawasti and Gonda districts .Collected samples have been preserved in 4% Formalin. Algal forms are stained with Methylene blue and mounted in glycerine. Taxonomic consideration of algal species has been done on the basis of trichomes / filaments shape, cells dimensions, sheath thickness, shape, size and position of akinetes/ heterocysts.Algal taxa are identified and systamatized according to Geitler (1932), Tiffany and Briton (1952), Desikachary (1959) and Prasad and Srivastava (1992).

MORPHO-TAXONOMIC RESULTS

Microcystis aeruginosa Kuetz.

Colonies irregular in shape, cell 7-8μm in diameter, spherical generally with gas vacuole, mucilage sheath of colonies indistinct.

(Pl. 1, fig. 2,6)

Locality- Temporary pond near Mahamda Canal

Collection No. and Date- BAH. 79 (9.4.99)

***Microcystis viridis* (A.Br.) Lemm.**

Colonies a rectangular, consist large number of

Plate I

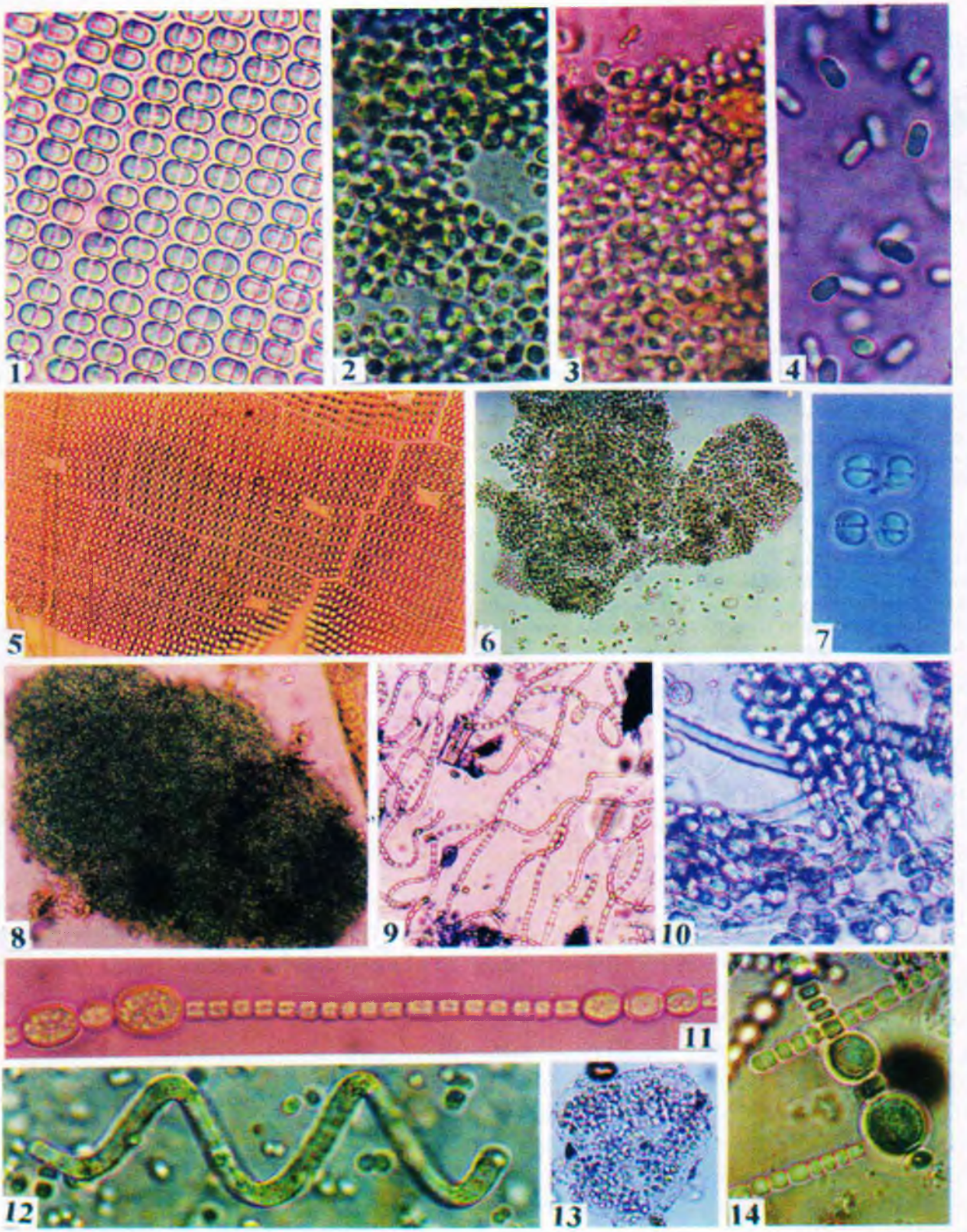

Fig. 1 *Merismopedia elegans* A.Br. x 600 Fig. 2 *Microcystis aeruginosa* Kuetz x 500 Fig. 3 *M. viridis* (A.Br.) Lemm x 500 Fig. 4 *Aphanothece castagnei* (Breb.) Rebenth. x 700 Fig. 5 *M. elegans* A.Br. x 200 Fig. 6 *M. aeruginosa* Kuetz. x 100 Fig. 7 *Chroococcus schizodermaticus* West x 800 Fig. 8 *M. viridis* (A.Br.) Lemm. x 100 Fig. 9 *Nostoc ellipsosporum* (Desm.) Rabenh. ex Born et. Flah x 150 Fig. 10 *N. punctiforme* Hariot var. *populorum* Geitler x 700 Fig. 11 *Anabaena iyengarii* Bharadwaja var. *unispora* Singh, R.N. x 800 Fig. 12 *Arthrospira platensis* (Nordst) Gom. var. *tenuis* (Rao) comb. x 700 Fig. 13 *Aphanocapsa pulchra* (Kuetz.) Rabenh. x 300 Fig. 14 *Wollea bharadwajae* Singh, x 1000.

partial or daughter colonies, surrounded by a common mucilaginous sheath. Margin of colonial mucilage definite and highly refractive, colonies 400μm long, 240μm broad, cell spherical, 5-6μm in diameter, gas vacuole present.

(Pl. 1, figs. 3, 8)

Localities- Railway crossing pond, Malhipur Road pond

Collection No. and Date- GON. 2 (10.11.99), BAH-149 (2.6.99) Chroococcus schizodermatics West

Cells in group of 2-4, blue green without sheath, 12-15μm in diameter, with sheath 50-52μm in diameter, sheath yellow to brown, distinct lamellated.

(Pl. 1, fig. 7)

Localities- Manorama pond, Golua Ghat

Collection No. and Date- GON. 9 (10.11.99), BAH. 97 (16.4.99)

Aphanocapsa pulchra (Kuetz.) Rabenh.

Thallus gelatinous, homogenous, blue green, free, cells spherical 4.7-6.1μm in diameter, loosely arranged, single or in twos, pale blue green individual sheath of cell indistinct.

(P. 1, fig. 13)

Locality- Ghingha Ghat

Collection No. and Date- BAH. (3.10.98).

Aphanothece castagnei (Breb.) Rabenh.

Thallus gelatinous without any shape, slimy, blue green, cells ellipsoidal to cylindrical, 5μm broad, 5μm long, densely arranged, blue green, sheath colourless.

(Pl.1, fig. 4)

Locality- Manorama pond

Collection No. and Date- GON. 201 (7.6.2000).

Merismopedia elegans A. Br.

Colonies small to large, 16-4000 celled, cells spherical or oblong more or less closely arranged, 5.5-6.5μm broad and 8μm long, bluish green

(Pl. 1, fig. 1,5)

Localities- Belser Road side Pond, Gilaula Canal

Collection No. and Date GON. 39 (29.11.99), BAH. 103 (20.4.99).

Arthrospira platensis (Nordst) Gom. ***var. tenuis*** (Rao, C.B.) comb.

Plant mass graeyish brown, trichomes, pale blue-green uniform width, 6-7μm broad, in regular spirals, spirals 32μm broad, 40-52μm distant, not constricted at joints, cells disc shaped, end cell with rounded apices.

(Pl. 1, fig. 12)

Localities- Manorama pond, Malhipur Road pond

Collection No. and Date- GON. 10 (10.11.99), BAH. 149 (2.6.99).

Oscillatoria chalybea (Martens) Gomont ***var. insularis*** Gardner

Trichomes lightly twisted, cross walls not constricted, broadly rounded at apex and bent, 15μm broad, pale green, 3.2μm long. Septa not granulated, end wall obtuse, not capitate, without calyptra.

(Pl. 2, fig. 5)

Localities- Golua Ghat, Umarpur

Collection No. and Date- BAH. (9.5.99), BAH. 132 (1.6.99).

Remark- Desikachary (1959) has reported Oscillatoria chalybea (Martens) Gomont having trichomes 8-13μm broad, and slightly constricted at cross wall, but its variety Oscillatoria chalybea var. insularis Gardner has trichome as 6.4-7.2μm broad and cross walls not constricted.

Oscillatoria limosa Ag ex Gomont

Trichome more or less straight, blue-green or olive green, not constricted at the cross wall, 22μm broad, cell 7μm long, cross wall frequently

granulated, end walls flatly rounded with slightly thickened membrane.

(Pl. 2, fig. 10)

Loclities- Radha Kund, Ghingha Ghat.

Collection No. and Date- BAH-115 (4.5.99), BAH. 161 (5.6.99).

Oscillatoria princeps Vaucher ex Gomont

Trichome blue-green straight, not constricted at the cross wall, 60μm broad, slightly attenuated at the apices, cell 6μm long, end cell flatly rounded, capitate.

(Pl. 2, fig. 14)

Locality- Gauda Ghat

Collection No. and Date- GON. 57 (29.11.99).

Oscillatoria tenuis Ag. ex Gomont

Thallus thin blue green or olive green, slimy, trichome straight, fragile, slightly constricted at the cross wall, 12μm broad, blue green, bent at the end, not attenuated, not capitate, cell up to 1/3 as long as broad, 2.8-3.2μm long, granulation at septa not clear, end cell more or less hemispherical.

(Pl. 2, fig. 7)

Localities-Golua Ghat, Radha Kund

Collection No. and Date- BAH. 123 (9.5.99), BAH. 114 (4.5.99).

Lyngbya ceylanica Wille ***var. constricta*** Fremy

Filament 15μm broad, slightly bent, sheath thin colourless trichome blue green, trichome constricted at the cross wall, not attenuated at the end. 12μm broad. Cell rectangular, 1/2to 1/3 as long as broad, end cell rounded without calyptra.

(Pl. 2, fig. 2)

Locality- Golua Ghat

Collection No. and Date- BAH. 172 (7.6.99).

Lyngbya holdenii Forti

Filaments attached to other algae by their middle, ends free, about 12-14μm broad, sheath thin, delicate, trichome pale green, distinctly constricted at the cross wall, 6-7μm broad, cell sub quadrate 3-4 μm long, end cell rounded.

(Pl. 2, fig. 11)

Locality- Gaula Ghat-

Collection No. and Date- BAH. 171 (7.6.99).

Lyngbya hieronymusii Lemm.

Filament single, free floating, straight or slightly bent 37μm broad, sheath firm, homogenous, colourless, not coloured by violet chlor-zinc iodide, trichome 32μm broad, cells 6-7μm long, not constricted at joints end cell broadly rounded.

(Pl. 2, fig. 6)

Localities- Umarpur, Belser Road Pond

Collection No. and Date. BAH-140 (1.6.99), GON. 48 (29.11.99)

Nostoc ellipsosporum (Desm.) Rabenh. ex Born. et Flah

Thallus gelatinous, irregularly expanded, attached by the lower surface reddish brown, filament flexous, loosly entangled, trichome about 3.8μm broad, light blue green or olivacecus, cell cylindrical, 11-12μm long, heterocyst subspherical or oblong 5.8-6μm broad, 9μm long, spore ellipsoidal to oblong, cylindrical, 7μm broad, and 14μm long epispore not seen.

(Pl. 1, fig. 9)

Locality- Belser Road, temporary Pond

Collection No. and Date- GON. 55 (27.12.99).

Nostoc punctiforme Hariot ***var. populorum*** Geitler

Thallus sub globose, scattered or confluent, cell short barrel shaped or ellipsoidal, blue green 6-7μm in diameter. Heterocyst and Akinete not seen.

(Pl. 1, fig. 10)

Localities- Dhanepur Road Pond, Mirzapur Pond (east bridge)

Collection No. and Date- GON. 27 (25.11.99), BAH-179 (10.11.99).

Anabaena ambigua Roa, C.B.

Trichome enclosed in a mucilaginous sheath, two trichome present in a common sheath, sheath usually firm, hyline with smooth or rough out line, usually 550μm long, 30-35μm broad, trichome bent, slightly tapering at end, end cells with rounded apices, cell barrel shaped with deep constriction at joints, 5.8-5.9μm broad, 4.9-5.3μm long, cell content deep blue green, hetrocyst at intervals, almost spherical, 9μm diameter.

(Pl. 2, fig. 3)

Localities- Manorama pond, Umarpur.

Collection No. and Date- GON 12 (12.11.99), BAH. 138 (1.6.99).

Anabaena iyengarii Bharadwaja ***var. unispora*** Singh, R.N.

Plant mass mucilaginous, deep blue green, trichome single free swimming straight 3.6-4.4μm broad with a conical apical cell, possessing rounded apex. Cell barrel shaped or almost quadratic 3.5-5.3μm long. Hetrocyst spherical to oval shaped, 6.9μm broad and 6.8-8.9μm long, spores ellipsoidal or sub spherical, one on either side of heterocyst, 13μm broad and 16μm long, inner wall smooth rust colour.

(Pl. 1, fig. 11)

Localities- Malhipur,Golua Ghat

Collection No. and Date- BAH. 152 (2.6.99), BAH. (9.5.99).

Wollea bharadwajae Singh, R.N

Thallus club shaped, vesicle, later more or less cylindrical attached, later free floating. Trichomes straight parallel, sometimes curved, cell barrel shaped 5μm broad, and 5.3μm long, apical cell conical, heterocyst pale blue green, 7μm broad, spore on either side of hetrocyst, spores 8-13μm broad, and 8-14μm long.

(Pl. 1, fig. 14)

Locality- Malhipur

Collection No. and Date- BAH. 156 (2.6.99).

Nodularia harveyna (Thwaites) Thuret var. **sphaerocorpa** Elenkin

Filaments single, free swimming, straight, 22μm broad, sheath thin colourless, cell short, 7μm long, heterocyst somewhat broader than the vegetative cell, 25μm broad,spores in series 28μm broad, compound.

(Pl. 2, fig. 12)

Locality- Mahamda Canal

Collection No. and Date- BAH. 73 (9.4.99).

Microchaete uberrima Carter, N.

Filaments elongated, cylindrical, decumbent at their base stellately arranged 16μm broad, sheath firm, brown trichomes 12μm broad, not attenuated, cell generally subquadrate, spores and heterocyst are not seen.

(Pl. 2, fig. 15)

Locality- Golua Ghat

Collection No. and Date- BAH. 172 (7.6.99).

Remark: In the present specimen Heterocyst were not forms in general morphology it resembles with the type described by Desikachary, (1959 p. 51).

Gloeotrichia pilgeri Schmiddle

Thallus hemispherical, filament radiating, about 170μm long, not branched, base with 2-3 heterocyst, trichome 7μm broad ending in a short hair, cell isodiametric, apex rounded, hetrocyst intercalary, 10μm broad, between spores, spores ellipsoidal or cylindrical with rounded ends, outer walls smooth, dark brown, 12-14μm broad, 25-52μm long.

(Pl. 2, fig. 9)

Locality- Mahamada Canal

Collection No. and Date- BAH. 76 (9.4.99).

Plate 2

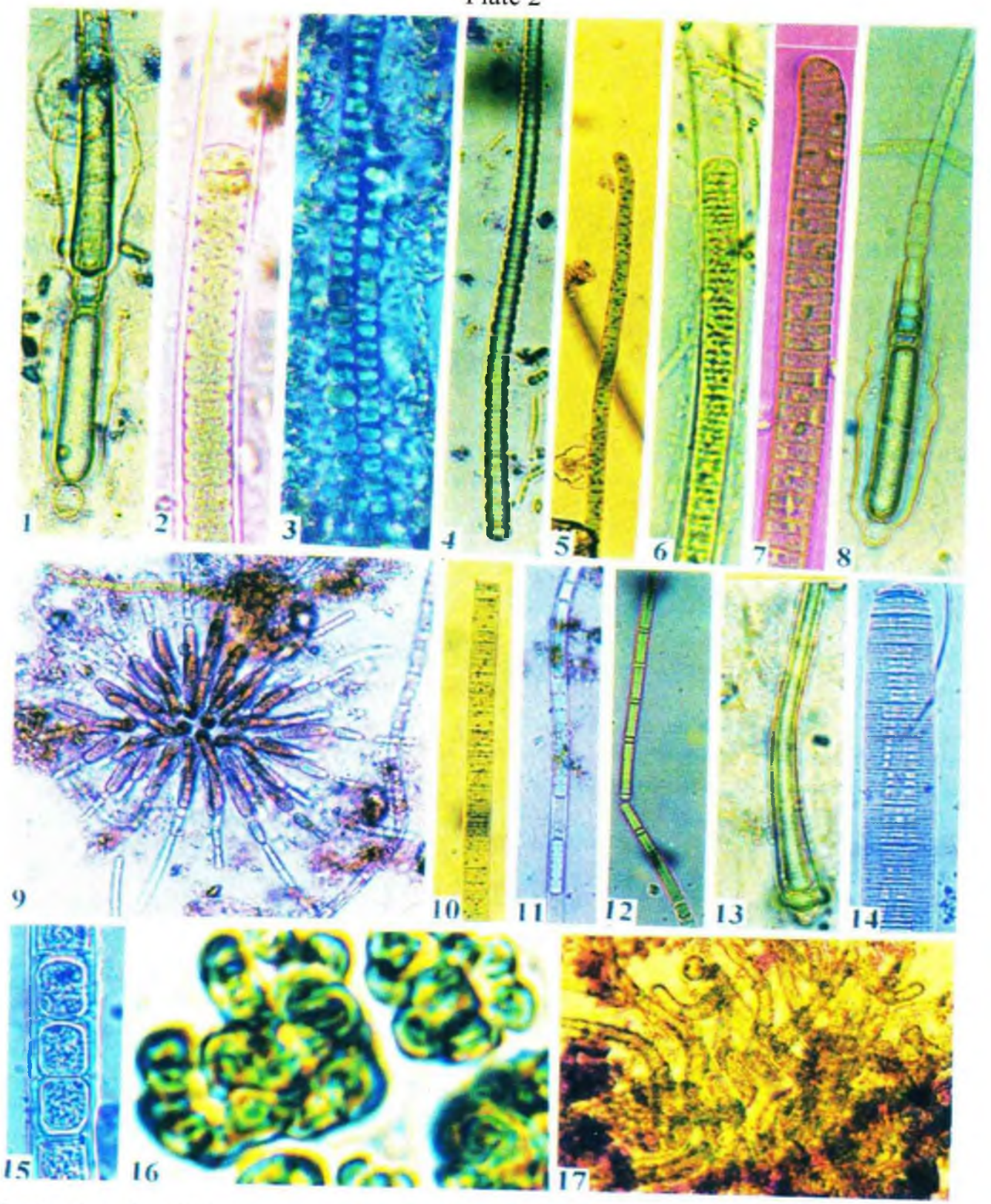

Fig. 1 *Gloeotrichia raciborskii* Woloszynska var. *conica* Dixit x 800 Fig. 2 *Lyngbya ceylanica* Wille var. *constricta*, Fremy x 750 Fig. 3 *Anabaena ambigua* Rao, C.B. x 1000 Fig. 4 *Calothrix* sp. x 600 Fig. 5 *Oscillatoria chalybea* (Mertens) Gomont var. *insularis* Gardner x 250 Fig. 6 *L. hieronymusii* Lemm. x 200 Fig. 7 *O. tenuis* Ag. Ex. Gomont x 600 Fig. 8 *G* . *raciborskii* Woloszynska var. *longispora*, Rao x 900 Fig. 9 *G. pilgeri* Schmiddle x 400 Fig. 10 *O. limosa* Ag ex Gomont x 200 Fig. 11 *L. holdenii* Forti x 500 Fig. 12 *Nodularia harveyana* (Thwaites) Thuret var. *sphaerocarpa* Elenkin x 100 Fig. 13 *Calothrix viguieri* Fermy x 400 Fig. 14 *O. princeps* Vaucher ex Gomont x 200 Fig. 15 *Microchaete uberrima* Cartex x 750 Fig. 16 *Camptylonema indicum* Schmidle x 1000 Fig. 17 *C. indicum Schmidle* x 600

Gloeotrichia raciborskii Woloszynska var. **conica** Dixit

Trichomes 7μm broad, hetrocyst 11μm broad and 8μm long, spores 12μm broad and 48-60μm long with a sheath, often cover the basal heterocyst, sheath thining out from base towards apex giving a more or less conical shape.

(Pl. 2, fig. 1)

Locality- Gauda Ghat

Collection No. and Date- GON 57 (29.11.99)

Remark- Rao C.B. (1937) reported this variety from Namdur Road side pond with filament 26-40μm broad, trichome 6.6-9μm broad heterocyst (10-13μm) broad and spores 10-16μm broad and 40-70μm long Desikachary (1959).

Gloeotrichia raciborskii Woloszynska *var. longispora* Rao, C.S.

Trichomes constricted at the joints 9μm broad at the base, higher upto 7μm broad, cell at the base barrel shape hetrocyst single, spherical or ellipsoidal, 13-15μm broad, spore cylindrical with smooth outer wall 12μm broad 78μm long, sheath, 6-9μm broad.

(Pl. 2, fig. 8)

Locality- Gauda Ghat

Collection No. and Date- GON – 58 (28.11.99).

Calothrix viguieri Fermy

Thallus irregular, filament nearly straight or slightly bent 220μm long, slightly broader at the base, above sub-cylindrical and 12-15μm broad, gradually attenuated, sheath thin, firm colourless; trichome 8-9μm broad gradually tapering, heterocyst basal, single 10μm long, 13μm broad, hemispherical or compressed.

(Pl. 2, fig. 13)

Locality- Mirzapur Pond.

Collection No. and Date- BAH. 180 (22.10.99).

Calothrix sp.

Young trichome, broad, at base narrow towards apex. basal cell hemispherical, other cells barrel shaped constricted at middle, a light strip visible through out the, trichomes, both side of trichome are dark colored. Cell 8.7μm broad, 9μm long basal cell, 9.2μm broad.

(Pl. 2, fig. 4)

Locality- Mirzapur pond east at bridge.

Collection No. and Date- BAH. 179 (10.11.99).

Camptylonema indicum Schmidle

Plant mass brownish, filament crescent shaped in the middle protion, 9.8μm broad, in the basal protion 12.5μm broad, sheath lamellate, heterocyst and hermocyst not seen.

(Pl. 2, fig. 16, 17)

Locality- Mirzapur pond (east bridge)

Collection No. and Date- BAH. 179 (22.10.99).

Remark: In this taxon Heterocyst were not found but habit of the thallus shape and size of filaments and laminated sheath supports is inclusion in Camptylonema indicum Schmidle.

DISCUSSION

Cyanophycean forms ranging from order Chroococcales to highly advanced order Stigonematales are well flourishing in the tarai region of North-Eastern Uttar Pradesh. Members of order Nostocales are dominating and representing 20 taxa while the family Oscillatoriaceae is the most dominating one with 14 taxa.

According to Strategic Research and Extension Plan (S.R.E.P.) of Bahraich/Shravasti district, the fertilizer consumption in agriculture crops of Bahraich/Shravasti district is less (32.97 kg/hect.) as compared to state average of the district (82.97 kg/ha.). From this data it can be assumed that nitrogen fixing strains like Nostoc, Anabaena and other members of Oscillatoriaceae are abundant in this low-land area. Water loging is frequent at different places, which helps in abundant growth of Cyanophycean sp., These taxa fix the atmospheric nitrogen, which reduced the demand for chemical fertilizers.

Thus reported Cyanophycean flora along with their natural habitat, may have local application in rice and paddy fields as a biofertilizer.

Genera like Aphanocapsa Naeg; Wollea Born et. Flah, Calothrix Ag; Nodularia Mertens Camptylonema Schmidle are present only at Bahraich/Shravasti district while the genera Aphanothece Naeg. and Microchaete Thuret are confined to Gonda District.

Genus Gloeotrichia Ag. is the only genus of Cyanophyceae that grows richly at Mahamda canal and Golua Ghat, but at Mirzapur pond, the young colonies of Gloeotrichia were found intermingled with other genera like Calothrix Ag, Nostoc Vaucher etc.

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