

Genus *Oscillatoria* Vaucher (Cyanoprokaryota) in Maldah District, West Bengal, India

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Abstract

Genus *Oscillatoria* Vaucher is the ubiquitous Cyanoprokaryote, growing in almost all habitats in fresh-water ecosystem like bils, dighis, lakes, ponds, wetlands, and marine water system like - salt marshes and pans, estuaries, brackish waters and ocean. It also occurs on inter-tidal rocks, snow and even in cold lakes underneath 5 m of ice pack as well as in thermal springs. During systematic investigations recorded altogether 25 species, 4 variety and 2 forms from Maldah District viz. *Oscillatoria acuta* Bürl & Biswas, *Oscillatoria agardhii* Gomont, *Oscillatoria amoena* (Kütz.) Gomont, *Oscillatoria amphibia* C. Agardh ex Gomont, *Oscillatoria amphigranulata* Goor, *Oscillatoria angusta* Koppe, *Oscillatoria chalybea* G. Mertens ex Gomont, *Oscillatoria formosa* Bory ex Gomont, *Oscillatoria formosa* f. *loktakensis* Bürl & Biswas, *Oscillatoria geitleriana* Elenkin, , *Oscillatoria geminata* Menegh. ex. Gomont, *Oscillatoria limnetica* Lemmerm., *Oscillatoria limosa* C. Agardh ex Gomont, *Oscillatoria minnesotensis* Tilden, *Oscillatoria okenii* C. Agardh ex Gomont, *Oscillatoria ornata* var. *crassa* C.B. Rao, *Oscillatoria perornata* f. *attenuata* Skuja, *Oscillatoria princeps* Vaucher ex Gomont, *Oscillatoria prolifica* Gomont, *Oscillatoria proteus* Skuja, *Oscillatoria pseudogeminata* var. *unigranulata* Biswas, *Oscillatoria quadripunctulata* Bürl & Biswas, *Oscillatoria raoi* DeToni, *Oscillatoria redekei* Goor, *Oscillatoria rubescens* DC. ex Gomont, *Oscillatoria splendida* Grev. ex Gomont, *Oscillatoria subbrevis* Schmidle, *Oscillatoria tenuis* C. Agardh ex Gomont, *Oscillatoria tenuis* var. *natans* Gomont, *Oscillatoria tenuis* var. *tergestina* Rabenh. ex Gomont and *Oscillatoria willei* N.L. Gardner. However, *Oscillatoria subbrevis* Schmidle, *Oscillatoria tenuis* C. Agardh ex Gomont are the most common species followed by *Oscillatoria amphigranulata* Goor, *Oscillatoria acuta* Bürl & Biswas, *Oscillatoria amphibia* C. Agardh ex Gomont, *Oscillatoria amphigranulata* Goor in water bodies of Malda District. *Oscillatoria redekei* Goor is reported new from India.

1. Introduction

Cyanoprokaryotes are the oldest organisms with oxygen generating photosynthesis. Quantum of work has been done by the Indian workers which is very much scattered. Taxonomic studies of the filamentous, nonheterocytous cyanobacteria are critically important for any algal ecologist or taxonomist who needs to identify cyanoprokaryotes genus and species. The genera follows the earlier revisions in the Oscillatoriales was done by Anagnostidis and Komárek. As per Komárek and Anagnostidis (2005) this knowledge is to be updated. During investigation the genus *Oscillatoria* Vaucher has been taken into account. It is represented by over 76 species (Desikachary, 1959; Anand, 1989, 1998) in India. The distributional records need to be checked all over the India because of its various roles in climatic conditions in various ways and due to its wide ecological adaptability. This genus is distributed worldwide, but several species are geographically more confined. Physiologically some *Oscillatoria* species have been implicated in Nitrogen

fixation, especially under microaerophilic or anoxic conditions. Keeping this fact in mind, the present investigation has been undertaken. During systematic investigations altogether following 25 species, 4 variety and 2 forms have been recorded from Maldah District, West Bengal.

Cyanoprokaryotes studied in diverse habitats, it is evident that enormous work on quantitative and qualitative along with taxonomic studies, indicator of water pollution / environmental assessments and R & D studies using selected species have been carried out in different parts of India. So far, out of 19 districts of West Bengal such studies have been carried out only in some of the Districts and surrounding areas comprising Bankura by Sinha and Mukherjee (1984) and Mukherjee (1986), Burdwan by Gupta and Sen (1978), Chatterjee and Choudhury (1980) and Chatterjee and Chatterjee (1983), Hooghly by Gupta and Sen (1987), Banerjee (1998) and Sikdar and Keshri (2014), Howrah by Mukhopadhyay and Chatterjee (1981), Sabata and Nayer (1992) and Sen and Gupta (1993), Kolkata by

Biswas (1925, 1926), Santra (1987), Banerjee (1997) and Sen (2006), Midnapur by Pal and Santra (1985), Murshidabad by Pal and Santra (1982), Pal and Santra (1984) and Pal *et al.* (1986), 24-Paraganas by Mukhopadhyay and Chatterjee (1981), Maity and Santra (1985) and Sunderban by Pal *et al.* (1988) and Banerjee and Santra (2001) and in continuation for further exploration in remaining Districts of the West Bengal, Maldah District was considered first as it was remain untouched.

2. Material and Methods

Maldah District is situated in West Bengal of north-east India and lies between 24°41'20" and 25°32'08" North Latitude and 87°45'50" and 88°28'10" East Longitude, extends over 3733.17 km² with total population 32,90,468 as per Census, 2001 (BAES, 2004) and English Bazar is the District Administrative Headquarter. The District is bounded to its south by the District of Murshidabad across the river Ganga, by Rajshahi District of Bangladesh and Dakshin Dinajpur District to its east and north-east, by Uttar Dinajpur District to its direct north and by the Purnea of Bihar to its direct west and by Sahibganj of State of Jharkhand across the Ganga to the south-west (Fig. 1).

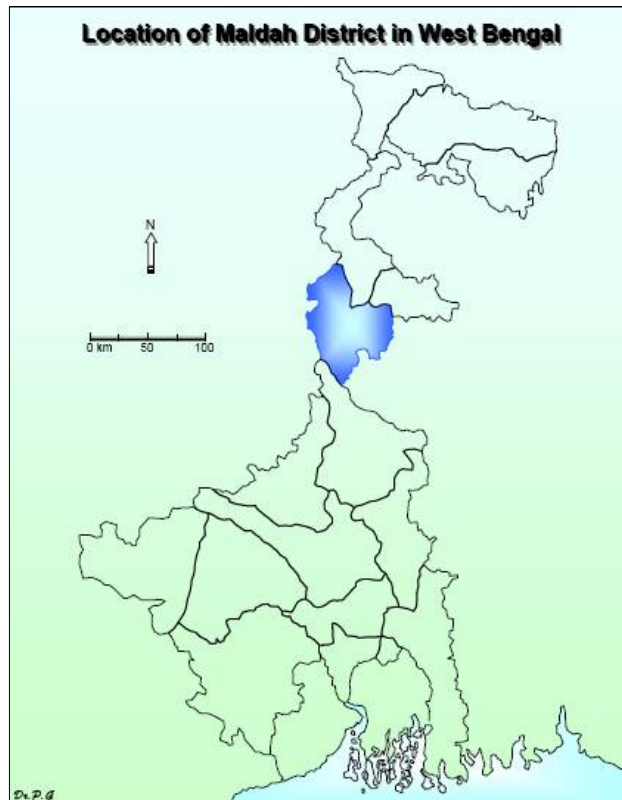


Fig. 1: Location map of Maldah District in West Bengal

During the survey all administrative blocks of Maldah District namely Ratua I, Ratua II, Harishchandrapur I, Harishchandrapur II, Chanchal I, Chanchal II, Manikchak, Gazol, Habibpur, Bamangola, Old Maldah, English Bazar and Kaliachak were visited and Cyanophycean forms were sampled from 55 places / water bodies. Out of 55 water bodies, Oscillatoria species have been recorded from 22 water bodies. Samples were sampled randomly and by towing Phytoplankton net to a distance of 1.0 - 5.0 m depending up on depth of water bodies. The samples were preserved in 15.0 ml screw cap Borosil glass specimen vials to avoid any chemical reaction. Specimens were observed under Leica DM 2500 Microscope having magnification range of 4x, 10x, 20x, 40x, 63x and 100x and photomicrographs of each specimens was taken by Leica DFC 500 digital camera with annotation using Leica QWin V 3.2 Image Processing and Analysis Software. Specimens were identified by consulting standard books, monograph like Geitler (1932), Tiffany and Britton, (1952), Desikachary (1959), Prescott (1982) and Komárek and Anagnostidis (2005). The authority name of each species is cited in the text as described in 'Authors of Plant Names' (Brummitt and Powell, 1992).

3. Results

Following 25 species, 4 variety and 2 forms of Oscillatoria have been recorded during investigation:

Oscillatoria acuta Bürlh & Biswas, J. Dept. Sci. Calcutta Univ. 5: 3, t. 1, f. 6a - b. 1922; Desikachary, Cyanophyta 240, t. 39, f. 5, 8. 1959. *Phormidium acutum* (Bürlh & Biswas) Anagn. & Komárek, Arch. Hydrobiol., Suppl. 80: 404, 1988.

Trichome solitary or sometimes many in numbers, parallel to each other, not constricted at the cross-walls, usually straight, narrow or acuminate towards the subobtuse, not capitate; calyptra absent but many times trichome rather abruptly bent aside; cell contents bluish green, granular.

Dimension: Trichome 4.1 - 6.1 µm broad and cells 2.6 - 4.5 µm long. Pl. I, Photo 1.

Distribution: Bil (Jalsukha, Kuchala and Meetna) and Pond (Damua).

Distribution in India: Andaman & Nicobar, Assam, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal.

Oscillatoria agardhii Gomont, Monogr. Oscill. 205, 1892; Desikachary, Cyanophyta 235, 1959. *Planktothrix agardhii* (Gomont) Anagn. & Komárek, Arch.

Hydrobiol., Suppl. 80: 416, 1988.

Trichome straight or somewhat curved, not constricted at the cross-walls; cells quadrate, granulated at the septa; end cell convex to broadly round. Pl. II, Photo 1.

Dimension: Trichome 4.0 - 5.9 µm broad and cells 2.4 - 4.0 µm long.

Distribution: Bil (Jalsukha).

Distribution in India: Andhra Pradesh, Assam, Bihar, Gujarat, Karnataka, Kerala, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal.

Oscillatoria amoena (Kütz.) Gomont, Monogr. Oscill. 225, t. 7, f. 9. 1892; Desikachary, Cyanophyta 230, t. 40, f. 12. 1959. *Phormidium amoena* Kütz., Phycol. general. 192, 1843.

Trichome usually straight, very slightly constricted at the cross-walls; end gradually attenuated, dull blue-green; septa granulated; end cell capitate, conical. Pl. II, Photo 2.

Dimension: Trichome 2.1 - 4.8 µm broad and cells 2.2 - 4.2 µm long.

Distribution: Bil (Chattara) and Dighi (Raikhan).

Distribution in India: Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Punjab, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal.

Oscillatoria amphibia C. Agardh ex Gomont, Flora 10: 632, 1827; Desikachary, Cyanophyta 229, t. 37, f. 6. 1959. *Geitlerinema amphibia* (C. Agardh) Anagn., Pl. Syst. Evol. 164: 38, 1989.

Trichome straight, not tapering towards the apex; apical cell rounded, smooth, not capitate, not constricted at the cross-walls; generally two granules at the septa, single large granule on either side or sometimes paired granules; calyptra absent. Pl. I, Photo 2.

Dimension: Trichome 2.0 - 3.0 µm broad and cells 2.7 - 6.0 µm long.

Distribution: Bil (Barabilla and Chattara) and Dighi (Paradhala).

Distribution in India: Assam, Bihar, Gujarat, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Odisha, Rajasthan, Uttar Pradesh, Uttarakhand and West Bengal.

Oscillatoria amphigranulata Goor, Recueil. Trav. Bot. Néerl. 15: 255, t. 2, f. 2. 1918; Desikachary, Cyanophyta 226, t. 37, f. 4. 1959.

Trichome almost straight, constricted at the cross-walls with prominent granules; end not attenuated, not capitates; end cell rounded, calyptra absent. Pl. I, Photo 3.

Dimension: Trichome 1.2 - 2.0 µm broad and cells 1.8 - 5.6 µm long.

Distribution: Bil (Barabilla), Lake (Mahadhap) and Pond (Jorkuppa).

Distribution in India: Andhra Pradesh, Andaman & Nicobar, Himachal Pradesh, Karnataka, Madhya Pradesh, Punjab, Tamil Nadu and Uttar Pradesh.

Oscillatoria angusta Koppe, Arch. Hydrobiol. Planktonk. 14: 641, 1923; Desikachary, Cyanophyta 227, 1959.

Jaaginema metaphyticum Komárek, Arch. Hydrobiol., Suppl. 80: 396, 1988.

Trichome solitary, blue-green, not constricted at the cross-walls; cells cylindrical, longer than broad; cell contents homogenous; apical cell almost cylindrical rounded. Pl. I, Photo 4.

Dimension: Trichome 1.0 - 1.8 µm broad and cells 5.0 - 7.5 µm long.

Distribution: Bil (Jalsukha).

Distribution in India: Andhra Pradesh, Bihar, Gujarat, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Uttar Pradesh and Uttarakhand.

Oscillatoria chalybea G. Mertens ex Gomont, G. Mertens in Jürg., Alg. aquaticae, Decas. 12: 4, 1822; Desikachary, Cyanophyta 218, t. 38, f. 3. 1959. *Phormidium chalybeum* (G. Mertens ex Gomont) Anagn. & Komárek, Arch. Hydrobiol., Suppl. 80: 405, 1988.

Trichome straight, slightly constricted at the cross-walls, attenuated at the apex and somewhat bent, blue-green; cells ½ - ⅓ times as long as broad; septa not granulated; end cell obtuse; calyptra absent. Pl. III, Photo 1

Dimension: Trichome 6.6 - 9.6 µm broad and cells 3.6 - 6.5 µm long.

Distribution: Bil (Balotuli).

Distribution in India: Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Tamil Nadu, Uttar Pradesh and West Bengal.

Oscillatoria formosa Bory ex Gomont, Bory, Dict. class. hist. nat. 12: 474, 1827; Desikachary, Cyanophyta 232, t. 40, f. 15. 1959. *Phormidium formosum* (Bory) Anagn. & Komárek, Arch. Hydrobiol., Suppl. 80: 405, 1988.

Trichome straight, curved and slightly tapering towards the apex; apical cell conical, not capitate; without calyptra. Pl. I, Photo 5.

Dimension: Trichome 4.0 - 5.5 μm broad and cells 2.1 - 3.0 μm long.

Distribution: Bil (Jalsukha).

Distribution in India: Andhra Pradesh, Andaman & Nicobar, Assam, Bihar, Delhi, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal.

Oscillatoria formosa f. **loktakensis** Brühl & Biswas, Mem. Asiat. Soc. Bengal 8: 264, t. 1, f. 5. 1926; Desikachary, Cyanophyta 233, t. 39, f. 4. 1959.

Trichome almost straight or slightly bent, flexible, slightly constricted at the cross-walls; end cell slightly attenuated; septa prominent. Pl. II, Photo 3.

Dimension: Trichome 4.0 - 6.0 μm broad and cells 2.2 - 3.0 μm long.

Distribution: Bil (Jalsukha).

Distribution in India: Assam, Bihar, Maharashtra and Uttar Pradesh.

Oscillatoria geitleriana Elenkin, Monogr. Alg. Cyano. 2: 1288, 1949; Desikachary, Cyanophyta 230, t. 40, f. 9. 1959.

Jaaginema geitleri (Frémy) Anagn. & Komárek, Arch. Hydrobiol., Suppl. 80: 395, 1988. *Oscillatoria geitleri* Frémy, Arch. Bot. Mém. 3(2): 216, f. 185. 1930.

Trichome single, long, blue-green, not constricted at the cross-walls; end erect, not attenuated, subcapitate; septa not granulated. Pl. I, Photo 6.

Dimension: Trichome 2.2 - 2.7 μm broad and cells 3.0 - 3.9 μm long.

Distribution: Bil (Kuchla).

Distribution in India: Karnataka, Maharashtra and Tamil Nadu.

Oscillatoria geminata Menegh. ex. Gomont, Ann. Sci. Nat. Bot. ser. 7(16): 222, t. 7, f. 6. 1892; J. Thomas & Gonzalves, Hydrobiologia 26: 51, 1965. *Jaaginema geminatum* (Menegh. ex Gomont) Anagn. & Komárek, Arch. Hydrobiol., Suppl. 80: 395, 1988.

Trichome curved or sometimes straight, blue-green, constricted at the cross-walls; not attenuated at the end; cells usually longer than broad; apical cell more or less rounded without calyptra. Pl. I, Photo 7.

Dimension: Trichome 2.3 - 3.3 μm broad and cells 2.2 - 5.6 μm long.

Distribution: Bil (Jalsukha).

Distribution in India: Gujarat, Maharashtra and Uttarakhand.

Oscillatoria limnetica Lemmerm., Ber. Duetsch. Bot. Ges. 18: 310, 1900; Desikachary, Cyanophyta 226, t. 37, f. 3. 1959. *Pseudanabaena limnetica* (Lemmerm.) Komárek, Sborn. Jihočesk. Muz. Českých Budějovicich, Přír. Vedy 14: 162. 1974.

Trichome pale blue-green, straight sometimes slightly bent, distinctly constricted at the cross-walls, not attenuated and capitates; end cell rounded; calyptra absent. Pl. I, Photo 9.

Dimension: Trichome 2.0 - 2.7 μm broad and cells 4.0 - 6.0 μm long.

Distribution: Bil (Balutuli) and Lake (Mahadhap).

Distribution in India: Assam, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Maharashtra, Rajasthan, Tamil Nadu, Uttar Pradesh and Uttarakhand.

Oscillatoria limosa C. Agardh ex Gomont, C. Agardhi, Disp. alg. suec. 35, 1812; Desikachary, Cyanophyta 206, t. 42, f. 11. 1959.

Thallus usually dark blue or brownish; trichome straight, not constricted at the cross-walls or slightly constricted; cross-walls usually granular; end cell flatly rounded with slightly thickened outer membrane. Pl. III, Photo 2.

Dimension: Trichome 14.0 - 15.6 μm broad and cells 3.0 - 5.8 μm long.

Distribution: Lake (Rambari).

Distribution in India: Andhra Pradesh, Andaman & Nicobar, Assam, Bihar, Chhattisgarh, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Nagaland, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal.

Oscillatoria minnesotensis Tilden, American algae 596, 1902; Desikachary, Cyanophyta 225, t. 40, f. 19. 1959. *Phormidium minnesotense* (Tilden) F.E. Drouet, Publ. Field Mus. Nat. Hist. Bot. Ser. 20: 136, 1942.

Trichome slightly curved, constricted at the joints, apex of the trichome usually slightly bent, not tapering and capitate; apical cell round; cell contents homogeneous; calyptra absent.

Dimension: Trichome 2.1-5.0 μm broad and cells 2.2 - 5.5 μm long. Pl. I, Photo 10.

Distribution: Bil (Barabilla) and Dighi (Bara Sagar).

Distribution in India: Chhattisgarh, Himachal Pradesh, Rajasthan, Sikkim, Tamil Nadu and Uttar

Pradesh.

Oscillatoria okenii C.Agardh ex Gomont, Flora 10: 633, 1827; Desikachary, Cyanophyta 231, t. 38, f. 17. 1959. ('okeni'). *Phormidium okenii* (C.Agardh) Anagn. & Komárek, Arch. Hydrobiol., Suppl. 80: 405, 1988.

Trichome straight, delicate, constricted at the cross-walls, ends gradually attenuated, undulating, slightly bent; cells up to $\frac{1}{2}$ as long as broad; end cell obtuse not capitate; calyptra absent. Pl. I, Photo 11.

Dimension: Trichome 4.1 - 6.0 μm broad and cells 2.1 - 3.0 μm long.

Distribution: Bil (Jalsukha).

Distribution in India: Andhra Pradesh, Arunachal Pradesh, Gujarat, Himachal Pradesh, Maharashtra, Manipur, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal.

Oscillatoria ornata var. ***crassa*** C.B.Rao, Proc. Indian Acad. Sci., B. 8: 165, f. 20. 1938; Desikachary, Cyanophyta 206, t. 39, f. 11. 1959. *Oscillatoria crassa* (C.B.Rao) Anagn., Preslia 73: 372, 2001.

Trichome straight and uniform in thickness, constricted at the cross-walls, granulated, dark blue-green in colour; cells shorter than broad; end cell convex, not capitate; calyptra absent. Pl. III, Photo 3.

Dimension: Trichome 12.0 - 15.0 μm broad and cells 2.8 - 5.2 μm long.

Distribution: Pond (Damua).

Distribution in India: Andhra Pradesh, Assam, Bihar, Karnataka, Maharashtra, Odisha and Uttarakhand.

Oscillatoria perornata f. ***attenuata*** Skuja, Nova Acta Regiae Soc. Sci. Upsal. ser. 4(14): 47, t. 8, f. 10. 1949; Desikachary, Cyanophyta 205, t. 41, f. 7. 1959.

Trichome narrow, apices slightly attenuated and bent or curved, pale blue-green with or sometimes without gas-vacuoles; cells highly granular including septa. Pl. II, Photo 4.

Dimension: Trichome 9.3 - 11.8 μm broad and cells 2.8 - 5.8 μm broad.

Distribution: Bil (Hazartakiya).

Distribution in India: Jammu & Kashmir, Karnataka, Sikkim and Uttar Pradesh.

Oscillatoria princeps Vaucher ex Gomont, Vaucher, Hist. conferv. 190, t. 15, f. 2. 1803; Desikachary, Cyanophyta 210, t. 37, f. 1, 10 - 11 & 13 - 14. 1959.

Trichome blue-green to brownish, generally straight or very slightly tapering at the apex, not constricted at the cross-walls; cell contents densely

granular; end cell flatly rounded, slightly capitate without or with thickened membrane. Pl. I, Photo 12.

Dimension: Trichome 16.0 - 60.0 μm broad and cells 3.5 - 7.0 μm long.

Distribution: Dighi (Sukan).

Distribution in India: Andhra Pradesh, Andaman & Nicobar, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Gujarat, Haryana, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Odisha, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand and West Bengal.

Oscillatoria prolifica Gomont, Monogr. Oscill. 205, t. 6, f. 8. 1892; Desikachary, Cyanophyta 234, 1959. *Planktothrix prolifica* (Gomont) Anagn. & Komárek, Arch. Hydrobiol., Suppl. 80: 416, 1988.

Trichome straight or slightly curved or slightly tapering towards the apex, not constricted at the cross-walls; cells almost quadrate or longer, sometimes shorter than broad; apical cell capitate with flattened calyptra; cell contents granular. Pl. I, Photo 14.

Dimension: Trichome 2.2 - 5.0 μm broad and cells 3.9 - 6.0 μm long.

Distribution: Pond (Kuppa).

Distribution in India: Andhra Pradesh, Assam, Maharashtra, Odisha and West Bengal.

Oscillatoria proteus Skuja, Nova Acta Regiae Soc. Sci. Upsal. Ser. 4(14): 48, t. 8, f. 11 - 13. 1949; Desikachary, Cyanophyta 221, t. 41, f. 15 - 16, 18. 1959. *Phormidium proteus* (Skuja) Umezaki & M.Watan., Jap. J. Phycol. 42: 196, 1994.

Trichome more or less straight, sometimes slightly curved apices very briefly attenuated, adequately constricted at the cross-walls, commonly granulated; cell contents pale olivaceous or blue-green; apical cell rounded. Pl. II, Photo 5.

Dimension: Trichome 5.4 - 6.9 μm broad and cells 2.1 - 3.2 μm long.

Distribution: Pond (Jorkuppa).

Distribution in India: Andhra Pradesh, Assam, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal.

Oscillatoria pseudogeminata var. ***unigranulata*** Biswas, J. Fed. Malay States Mus. 14: 409, t. 9, f. 7. 1929; Desikachary, Cyanophyta 229, t. 39, f. 19 & t. 41, f. 17. 1959. *Jaaginema unigranulatum* (Biswas) Anagn., Preslia 73: 363, 2001.

Trichome straight or somewhat curved, not constricted at the cross-walls; not attenuated at the apices, rounded, not capitate; calyptra absent; cell wall distinct with one large granule situated at the centre of the partition wall on either side. Pl. II, Photo 6.

Dimension: Trichome 2.0 - 2.7 μm broad and cells 3.0 - 4.5 μm long.

Distribution: Bil (Kuchla).

Distribution in India: Bihar, Delhi, Gujarat, Kerala, Maharashtra, Uttar Pradesh and West Bengal.

Oscillatoria quadripunctulata Brühl & Biswas, J. Dept. Sci. Calcutta Univ. 4: 5, t. 1, f. 6. 1922; Desikachary, Cyanophyta 227, t. 37, f. 5. 1959. *Jaaginema quadripunctulatum* (Brühl & Biswas) Anagn. & Komárek, Arch. Hydrobiol., Suppl. 80: 396, 1988.

Trichome almost straight or slightly curved, not constricted at the cross-walls marked by a pair of somewhat larger granules on either side; not attenuated at the end; cell contents finely granular; apical cell rounded. Pl. I, Photo 15.

Dimension: Trichome 1.0 - 3.0 μm broad and cells 4.0 - 6.0 μm long.

Distribution: Bil (Barabilla).

Distribution in India: Assam, Gujarat, Himachal Pradesh, Kerala, Maharashtra, Uttar Pradesh and West Bengal.

Oscillatoria raoi DeToni, Diagn. alg. nov. 6: 560, 1939; Desikachary, Cyanophyta 223, t. 42, f. 16 - 19. 1959.

Trichome slightly bent or straight, usually uniform in thickness and sometimes rarely tapering at the end, pale blue-green; septa in distinct, but with very distinct granules compactly arrange; end cell rounded sometimes conical and with constriction at the septum, not capitate; calyptra absent. Pl. I, Photo 8.

Dimension: Trichome 5.5 - 6.3 μm broad and cells 2.7 - 5.7 μm long.

Distribution: Lake (Rambari).

Distribution in India: Assam, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal.

Oscillatoria redekei Goor, Recueil. Trav. Bot. Néerl. 15: 258, t. 2, f. 3. 1918; Komárek & Anagn., Cyanoprokaryota Part 2: Oscillatoriales 19(2): 440, f. 641. 2005. *Limnothrix redekei* (Goor) M.E.Meffert, Arch. Hydrobiol., Suppl. 80 (Algol. Stud. 50 - 53): 274, 1988.

Trichome solitary, straight or slightly curved, pale blue-green or yellow-green, not or slightly constricted at the cross-walls; not attenuated at the end, not

capitate; cells usually longer than broad with two small or large polar aerotopes at the septa; apical cell almost rounded; calyptra absent. Pl. I, Photo 8.

Dimension: Trichome 1.4 - 2.5 μm broad and cells 2.5 - 6.0 μm long.

Distribution: Jheel (Mahadhap).

Oscillatoria rubescens DC. ex Gomont, Mém. Soc. Phys. Genève 3(2): 37, f. 3 - 4. 1826; Desikachary, Cyanophyta 235, t. 42, f. 12. 1959. *Planktothrix rubescens* (DC. ex Gomont) Anagn. & Komárek, Arch. Hydrobiol., Suppl. 80: 416, 1988.

Trichome narrow, solitary or forming small fascicles, slightly tapering towards the apex, not constricted at the cross-walls; cells granulated, often granulated at the septa; apical cell capitate with convex calyptra. Pl. III, Photo 5.

Dimension: Trichome 4.6 - 6.2 μm broad and cells 2.1 - 4.1 μm long.

Distribution: Dighi (Sukan).

Distribution in India: Assam, Bihar, Gujarat, Jammu & Kashmir, Karnataka, Maharashtra, Meghalaya, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal.

Oscillatoria splendida Grev. ex Gomont, in Grev., Fl. Edin. 305, 1824; Desikachary, Cyanophyta 234, t. 37, f. 7 - 8, t. 38, f. 10 & t. 40, f. 11. 1959. *Geitlerinema splendidum* (Grev.) Anagn., Pl. Syst. Evol. 164: 43, 1989.

Trichome mostly solitary, straight or curved, tapering at the apex, not constricted at the cross-walls; cells longer than broad; end more or less bent, end cell capitate, nearly rounded; cell contents finely granular or homogeneous, pale blue green. Pl. I, Photo 3.

Dimension: Trichome 1.9 - 2.9 μm broad and cells 3.9 - 6.5 μm long.

Distribution: Pond (Kuppa).

Distribution in India: Assam, Bihar, Delhi, Gujarat, Karnataka, Kerala, Maharashtra, Odisha, Uttar Pradesh and West Bengal.

Oscillatoria subbrevis Schmidle, Bot. Jahrb. 30: 243, t. 4, f. 7. 1901; Desikachary, Cyanophyta 207, t. 37, f. 2 & t. 40, f. 1. 1959.

Trichome single, nearly straight, not attenuated at the apices; apical cell rounded, without calyptra; cross-walls not granular; cell contents pale gray-green. Pl. III, Photo 6.

Dimension: Trichome 5.0 - 6.0 μm broad and cells 1.8 - 3.0 μm long.

Distribution: Bil (Balotuli, Madhaipur, Meetna, Pulintola and Saluka) and Pond (Damua and Shivrampalli).

Distribution in India: Andhra Pradesh, Andaman & Nicobar, Arunachal Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Maharashtra, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal.

Oscillatoria tenuis C.Agardh ex Gomont, Ann. Sci. Nat. Bot. ser. 7(16): 220, t. 7, f. 2 - 3. 1892; Desikachary, Cyanophyta 222, t. 42, f. 15. 1959.

Phormidium limosum (Dillwyn) P.C.Silva, Univ. Calif. Pub. Bot. 79: 52, 1996. *Conferva limosa* Dillwyn, Brit. Conferv. fasc. 2, t. 20, 1802.

Thallus slimy, blue-green or olive green; trichome straight, slightly constricted at the cross-walls; not attenuated at the apices, not capitate; septa mostly granulated; apical cell more or less hemispherical; outer membrane sometimes slightly thickened. Pl. III, Photo 7.

Dimension: Trichome 5.0 - 6.2 μm broad and cells 2.5 - 3.5 μm long.

Distribution: Bil (Amkhki and Jalsukha) and Lake (Rambari).

Distribution in India: Andaman & Nicobar, Assam, Bihar, Chhattisgarh, Delhi, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Odisha, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal.

Oscillatoria tenuis* var. *natans Gomont, Ann. Sci. Nat. Bot. ser. 7(16): 221, f. 2 - 3. 1892; Prescott, Algae of the Western Great Lakes Area 491, t. 110, f. 11. 1982; S.Sharma & M.L.Naik, Phykos 35: 140, 1996.

Trichome straight, blue-green; cells broader than long; apical cell almost rounded. Pl. III, Photo 8.

Dimension: Trichome 5.2 - 8.5 μm broad and cells 3.4 - 4.2 μm long.

Distribution: Pond (Damua).

Distribution in India: Chhattisgarh, Uttarakhand and Uttar Pradesh.

Oscillatoria tenuis* var. *tergestina Rabenh. ex Gomont, Ann. Sci. Nat. Bot. 16: 221, 1892; Prescott, Algae of the Western Great Lakes Area 492, t. 110, f. 12 - 13. 1982. *Phormidium tergestinum* (Rabenh. ex Gomont) Anagn. & Komárek, Arch. Hydrobiol. Suppl. (Algol. Stud. 50 - 53) 80: 406. 1988.

Trichome almost straight, dark blue-green, not attenuated at the apex; apical cell slightly bent. Pl. I, Photo 16.

Dimension: Trichome 5.5 - 6.8 μm broad.

Distribution: Bil (Jalsukha).

Distribution in India: Kerala, Maharashtra, Tamil Nadu and Uttar Pradesh.

Oscillatoria willei N.L.Gardner, Mem. New York Bot. Gard. 7: 36, t. 7, f. 67. 1927; Desikachary, Cyanophyta 217, t. 38, f. 4 - 5 & t. 40, f. 5. 1959. *Phormidium willei* (N.L.Gardner) Anagn. & Komárek, Arch. Hydrobiol., Suppl. 80: 406, 1988.

Trichome pale blue-green in colour, slightly bent at the end, not constricted and granulated at the cross-walls; end not attenuated and capitate; cell slightly rounded at the tip without a thickened membrane. Pl. III, Photo 8.

Dimension: Trichome 3.4 - 4.2 μm broad and cells 2.4 - 3.9 μm long.

Distribution: Bil (Lakshmipur).

Distribution in India: Andaman & Nicobar, Assam, Bihar, Gujarat, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Meghalaya, Odisha, Punjab, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal.

4. Conclusion

During investigation altogether 25 species, 4 variety and 2 forms have been reported from 22 water bodies of Maldah District, West Bengal and it was observed that *Oscillatoria subbrevis* Schmidle, *Oscillatoria tenuis* C.Agardh ex Gomont are the most common species followed by *Oscillatoria amphigranulata* Goor, *Oscillatoria acuta* Bürl & Biswas, *Oscillatoria amphibia* C.Agardh ex Gomont, *Oscillatoria amphigranulata* Goor in water bodies of Malda District. *Oscillatoria subbrevis* Schmidle has been reported from maximum 7 water bodies. However, maximum species of *Oscillatoria* has been reported from Bil Jalsukha followed by Damua pond. From these studies one can easily explain the ecological preferences of various species of *Oscillatoria* and role in various significant ways. Six species of *Oscillatoria* (*Oscillatoria amphigranulata* Goor, *Oscillatoria angusta* Koppe, *Oscillatoria geitleriana* Elenkin, *Oscillatoria geminata* Menegh. ex. Gomont, *Oscillatoria limnetica* Lemmerm., *Oscillatoria minnesotensis* Tilden), three variety (*Oscillatoria ornata* var. *crassa* C.B.Rao, *Oscillatoria tenuis* var. *natans* Gomont, *Oscillatoria tenuis* var. *tergestina* Rabenh. ex Gomont) and two forms (*Oscillatoria formosa* f. *loktakensis* Brühl & Biswas, *Oscillatoria perornata* f. *attenuata* Skuja) have been reported for the first time from West Bengal. However, *Oscillatoria redekei* Goor is reported new from India. This study fills the gap in our existing knowledge of the biodiversity of the cyanoprokaryota of this area as well as in this country.

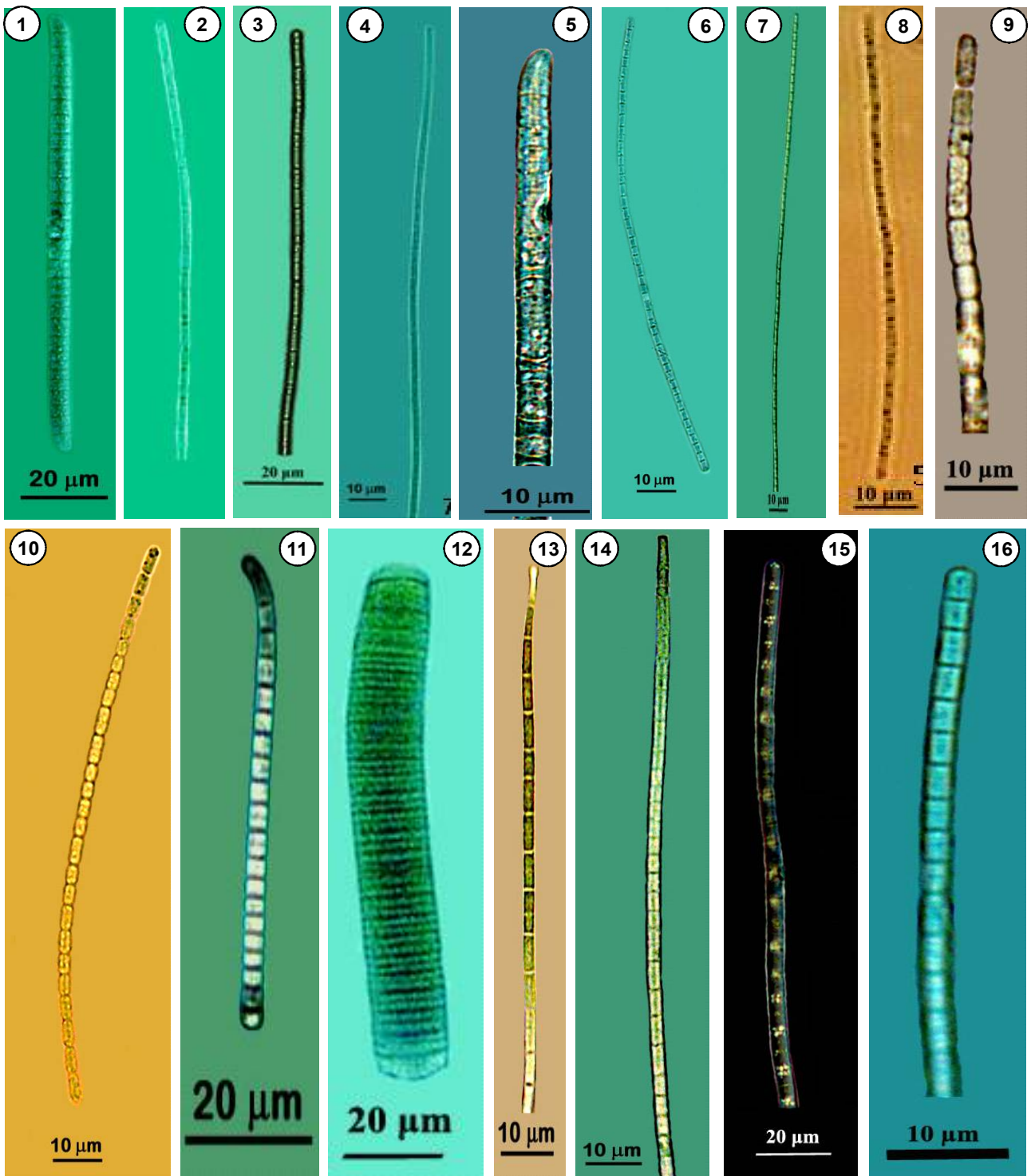


Plate I (Photo 1-16)

1. *Oscillatoria acuta* Bürhl & Biswas, 2. *O. amphibia* C.Agardh ex Gomont, 3. *O. amphigranulata* Goor, 4. *O. angusta* Koppe, 5. *O. formosa* Bory ex Gomont, 6. *O. geitleriana* Elenkin, 7. *O. geminata* Menegh., 8. *O. redekei* Goor, 9. *O. limnetica* Lemmerm., 10. *O. minnesotensis* Tilden, 11. *O. okenii* C.Agardh ex Gomont, 12. *O. princeps* Vaucher ex Gomont, 13. *O. splendida* Grev. ex Gomont, 14. *O. prolifica* Gomont, 15. *O. quadripunctulata* Brühl & Biswas and 16. *O. tenuis* var. *tergestina* (Kütz.) Rabenh

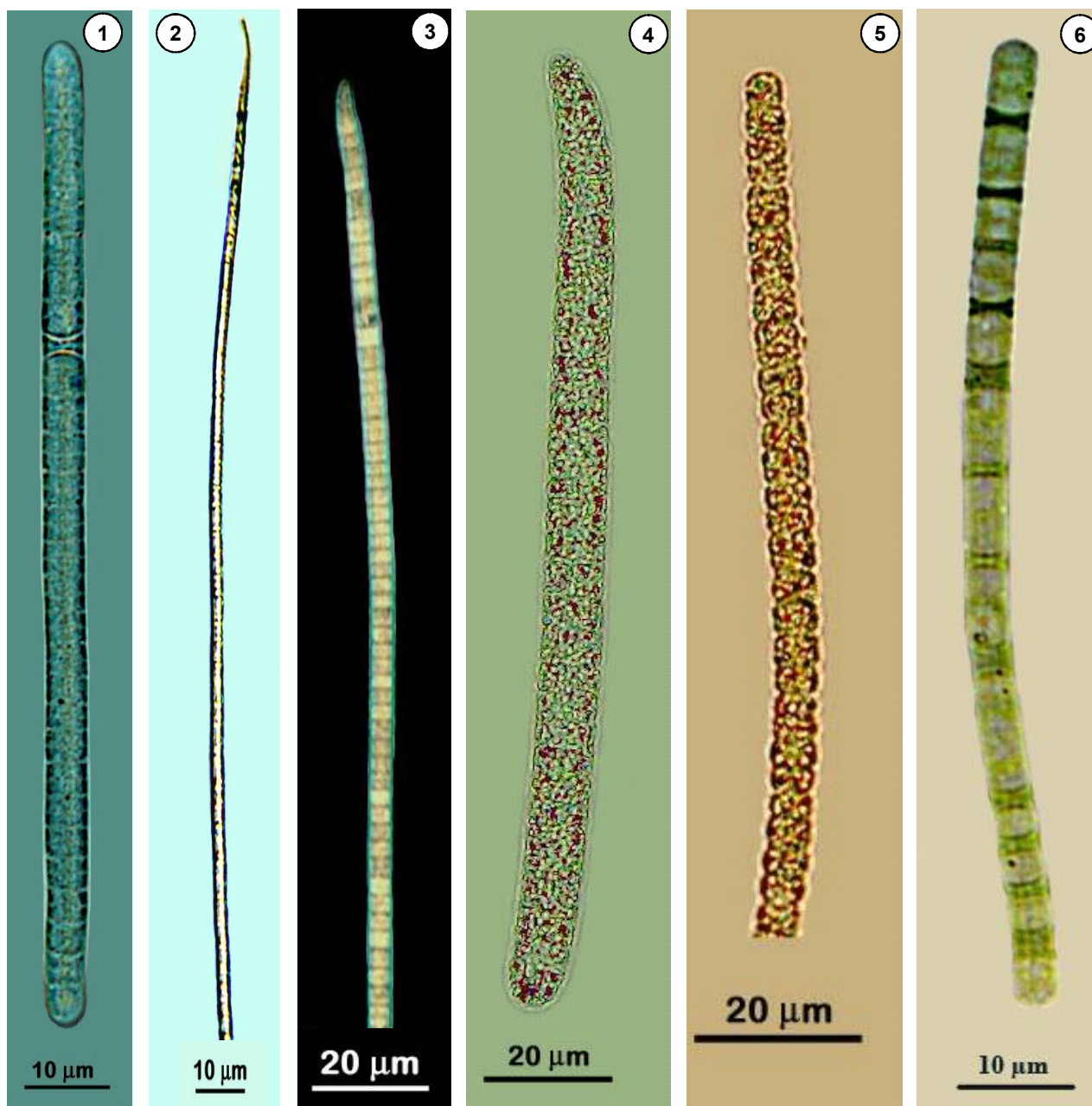


Plate II (Photo 1-6)

1. *Oscillatoria agardhii* Gomont, 2. *O. amoena* (Kütz.) Gomont, 3. *Oscillatoria formosa* f. *loktakensis* Brühl & Biswas, 4. *Oscillatoria perornata* f. *attenuata* Skuja, 5. *Oscillatoria proteus* Skuja and 6. *Oscillatoria pseudogeminata* var. *unigranulata* Biswas

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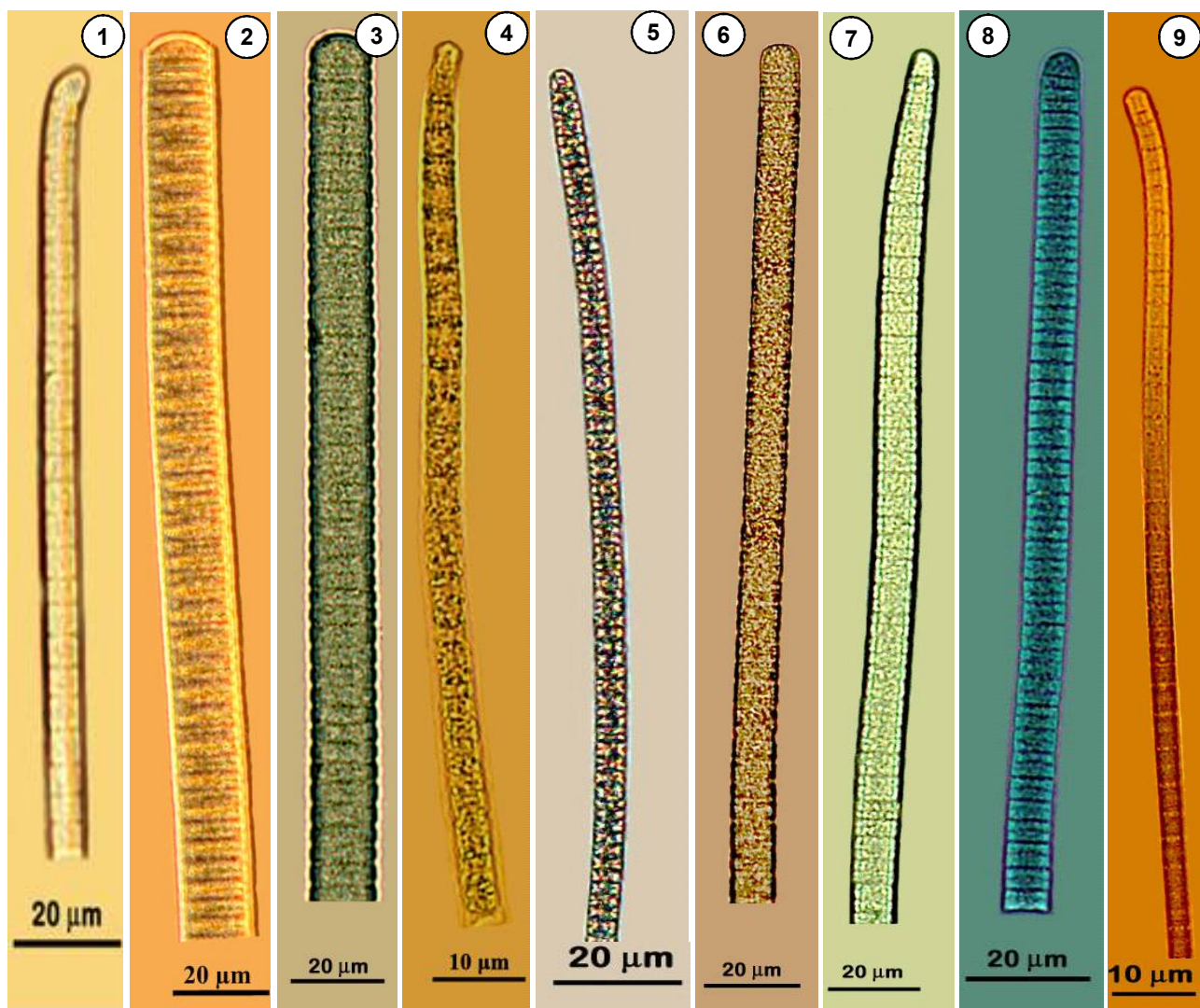


Plate III (Photo 1-9)

1. *Oscillatoria chalybea* G. Mertens ex Gomont, 2. *Oscillatoria limosa* C. Agardh ex Gomont, 3. *Oscillatoria ornata* var. *crassa* C.B.Rao, 4. *Oscillatoria raoi* DeToni, 5. *Oscillatoria rubescens* DC. ex Gomont, 6. *Oscillatoria subbrevis* Schmidle, 7. *Oscillatoria tenuis* C. Agardh ex Gomont, 8. *Oscillatoria tenuis* var. *natans* Gomont and 9. *Oscillatoria willei* N.L.Gardner

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