



**Research article**

## **New record of Cyanoprokaryotes from West Bengal in Maldah district**

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**Abstract:** Systematic survey and collection of Cyanoprokaryotes were carried out from different water bodies of Maldah District, West Bengal. During survey samples were sampled from 55 different water bodies of this area comprising 05 sites in rivers, 32 bils, 07 dighis, 02 Jheels, 09 ponds for which surveyed 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. During the study, altogether 22 genera and 105 species (comprising 93 species, 09 varieties and 03 forms) were identified from different types of water bodies of Maldah District. Out of these 105, 27 species have been recorded from West Bengal. These species have been described here along with nomenclature and distribution.

**Keywords:** Cyanoprokaryotes - New Record - Maldah District - West Bengal.

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### **INTRODUCTION**

Maldah district is one of important district among 19 districts of West Bengal. The major river the Ganges flows along south-western boundary of the district followed by another major rivers like Mahananda, Fulhar and Kalindri. All above rivers originated basically from the Himalayan or sub-Himalayan region and flow Southerly direction whereas some seasonal rivers like Tangoan, Punarbhaba, Pagla and Bhagirathi are also flowing through district territory. Thus, in terms of duration and frequency of flood and its recurrences is concerned, Maldah district is defined as a chronically flood-affected area. Swamps (bils) are extending along the right bank of Mahananda from Kalindri. The practice of aquaculture, cultivation of rice and Makhana (*Eurayle ferox* Salisb.) are other aspects on which socio-economic condition and livelihood of the district depend. To meet the requirements, a huge number of big and small size ‘dighi’ and ‘ponds’ depending upon land area available to individuals are made by them. Such water bodies often get eutrophicated by micro and macrophytes as a result of contaminants from various non-point and point sources like runoff of agriculture fields in which huge quantity of fertilizers and pesticides is used and civic as well as industrial pollutants respectively. Among the aquatic flora, diversity and distribution of microscopic flora is much greater having both beneficial and harmful properties. Therefore, exploration of all forms of different community is warranted which is not possible to be studied by any individual. Thus, during the study, particularly concentrated on Cyanoprokaryota for proper exploration of the unexplored area *i.e.* Maldah District of the State of West Bengal.

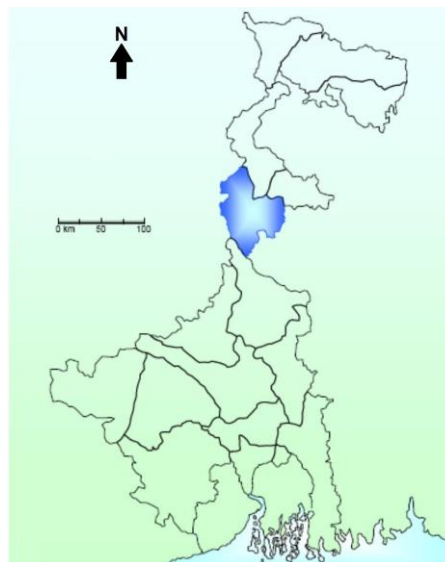
The ancient Cyanoprokaryota likely produced much of oxygen in the Earth's atmosphere, as they dominantly metabolise and fix carbon in the form of sugars by using carbon dioxide. Increase in concentration of oxygen on the earth crust, recorded during 2.4 billion years ago considered as an architect of earth's atmosphere as they are “nature’s first and foundational mother and father for causing photosynthesis”, entail to form pure ecological niche on our planet and precisely stands as the founder of the aquatic food-chain. As per findings, they have been distributed all over land and water system often in such an environment where there is no other vegetation possibly due to their adaptive capability to extreme adverse environmental conditions with respect to different environmental factors like temperature, pH, salinity, availability of nutrients, pollution load, etc (Sridhar *et al.* 2006, Bajpai *et al.* 2013). Their occurrence even in the wide range of ecologically stress conditions and extreme

habitats proves that they are very tolerant and thus placed in a unique group of micro-organisms. They occur in a fresh-water ecosystem like bils, dighis, lakes, rivers, wetlands, waterfall, etc. and marine water system like - salt marshes and pans, estuaries, brackish waters and ocean. Besides, it also occur on inter-tidal rocks, snow and even in cold lakes underneath 5 m of ice pack as well as in thermal springs, soil, acid bogs and alkaline soils or more, in sub-aerial habitats like tree trunks, moist walls and all other objects which remain moisten and get solar light from any angle even in a short span of time.

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 (Mohan *et al.* 2007, Bajpai *et al.* 2013, Malathi *et al.* 2014, Srivastava *et al.* 2014, Halder 2015, Jitendra & Anand 2016, Patel *et al.* 2017). So far, out of 19 districts of West Bengal such studies have been carried out only in some of the Districts and surrounding area comprising Bankura (Sinha & Mukherjee 1984, Mukherjee 1986), Burdwan (Gupta & Sen 1978, Chatterjee & Choudhury 1980, Chatterjee & Chatterjee 1983), Hooghly (Gupta & Sen 1987, Banerjee 1998, Sikdar & Keshri 2014), Howrah (Mukhopadhyay & Chatterjee 1981, Sabata & Nayer 1992, Sen & Gupta 1993), Kolkata (Biswas 1925, 1926, Santra 1987, Mitra & Gupta 1994, Banerjee 1997, Sen 2006), Midnapur (Pal & Santra 1985), Murshidabad (Pal & Santra 1982, 1984, Pal *et al.* 1986), 24-Paraganas (Mukhopadhyay & Chatterjee 1981, Maity & Santra 1985, Singh *et al.* 2001, Naskar *et al.* 2008), Sunderban (Pal *et al.* 1988, Banerjee & Santra 2001) and in continuation for further exploration in remaining Districts of the West Bengal, Maldah district was considered first keeping in view to explore Cyanoprokaryotes forms taxonomically.

## MATERIALS 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 km<sup>2</sup> 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).



**Figure 1.** Location of the study site.

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 samples containing cyanophycean forms were sampled from 55 water bodies comprising 5 sites in rivers like Kalindri (Bhaluka), Fulhar (Sankatala Ghat), Ganga (Mahadhap and Gopalpur) and Mahananda (Alal Bridge); 32 bils (Amkhaki, Liltua, Barabilla, Singera, Ghogha, Chakla, Bochamari, Ashi Dob, Makaiya, Hazartakia, Janipukur, Adhsoi, Manna, Dekul, Meetna, Singsar, Sanak, Singer, Kendha, Kuchla, Bhatia, Chand, Tarkeshwar, Nawabganj, Balotuli, Jalsukha, Laxmipur, Chattara, Garhal, Adhsoi, Pulintola and Madhaipur); 7 dighis (Raikhan, Thinnagar, Kalua, Paradhala, Sukan, Bara and Chota

Sagar); 2 Jheels (Bochahi and Mahadhap) and 9 ponds / Pukurs (Bhadobartola, Damua, Shivrampalli, Rohni, Meenatulla, Jorkuppa, Kuppa, Samda and Salamidarwaza).

Samples were sampled randomly towing Phytoplankton net to a distance of 1.0–5.0 m depending upon the depth of water bodies. The samples were preserved in 15.0 ml screw cap Borosil glass specimen vials to avoid any chemical reaction. To take samples from another water bodies, Phytoplankton net was thoroughly washed with clean water after collection of each sample. Samples were preserved by adding 2–3 drops of 4% Formalin solution. Specimens were observed under Leica DM 2500 Microscope and photomicrograph of each specimen was taken by DFC 500 digital camera with annotation using Leica QWin V 3.2 Image Processing and Analysis Software and Leica Application Suit V4. Specimens were identified by consulting standard books, monograph (Geitler 1932, Tiffany & Britton 1952, Desikachary 1959, Prescott 1982, Anand 1989, 1998, Komárek & Anagnostidis 1998, 2005). The authority name of each species is cited in the text as described in ‘Authors of Plant Names’ (Brummitt & Powell 1992), title of the books in citation is cited in accordance with Stafleu & Cowan (1976, 1979, 1981, 1983, 1985, 1986, 1988) and supplements as described by Stafleu & Mennege (1992, 1993, 1995, 1997, 1998, 2000), whereas Journals, Periodicals with Botanical content as described in “Botanico-Periodicum-Huntianum”, BPH-2 (Bridson 2004a, b).

## RESULTS

Details of each new record of Cyanoprokaryotes of West Bengal from different water bodies of Maldah District in various blocks depicted in table 1 along with the geographical location.

**Table 1.** Cyanoprokaryotes new record from West Bengal in Maldah district.

S. No.	Name of the Block	Latitude, Longitude	Name of the Water Bodies	Name of the species
1	Ratua I	25°12'01.98"N, 87°56'56.26"E	Bhadobartola Pond	<i>Microcystis ichthyoblabe</i> Kütz. <i>Microcystis panniformis</i> Komárek
2	Ratua II	25°08'12.11"N, 88°00'56.69"E	Barabilla Bil Mahadhap Lake	<i>Pseudanabaena amphigranulata</i> (Goor) Anagn. <i>Nostoc ellipsosporum</i> var. <i>violaceum</i> C.B.Rao <i>Pseudanabaena amphigranulata</i> (Goor) Anagn. <i>Pseudanabaena limnetica</i> (Lemmerm.) Komárek <i>Pseudanabaena redekei</i> (Goor) B.A. Whitton
3	Harishchandr apur I	25°24'48.15"N, 87°53'11.43"E	Damua Pond Adhsoi Bil Hazartakiya Bil	<i>Oscillatoria crassa</i> (C.B.Rao) Anagn. <i>Oscillatoria tenuis</i> var. <i>natans</i> Gomont <i>Dactylococcopsis raphidioides</i> Hansg. <i>Oscillatoria perornata</i> f. <i>attenuata</i> Skuja <i>Anabaena inaequalis</i> Bornet & Flahault
4	Harishchandr apur II	25°24'22.46"N, 87°52'00.23"E	Manna Bil	<i>Gloeocapsa nigrescens</i> Nägeli <i>Aphanocapsa elachista</i> var. <i>conferta</i> W. West & G.S. West
5	Chanchal II	25°20'08.65"N, 88°01'09.92"E	Chakla Bil	<i>Komvophoron crassum</i> (Vozzhenn.) Anagn. & Komárek
6	Gazol	25°13'10.64"N, 88°10'13.19"E	Kuchla Bil Raikhan Dighi	<i>Jaaginema geitleri</i> (Frémy) Anagn. & Komárek <i>Heteroleibleinia mesotricha</i> (Skuja) Anagn. & Komárek
7	Old Maldah	25°00'31.46"N, 88°09'29.21"E	Sukan Dighi Paradhala Dighi Balutuli Bil Nawabganj Bil	<i>Microcystis wesenbergii</i> (Komárek) Komárek <i>Synechocystis pevalekii</i> Erceg. <i>Pseudanabaena limnetica</i> (Lemmerm.) Komárek <i>Anabaena vaginicola</i> f. <i>fertilissima</i> B.N.Prasad
8	English Bazar	25°01'08.41"N, 88°14'10.98"E	Bara Sagar Dighi Laxmipur Bil Jorkuppa Pond Jalsukha Bil	<i>Microcystis novacekii</i> (Komárek) Compère <i>Aphanocapsa rivularis</i> (Carmich.) Rabenh. <i>Pseudanabaena dictyothalla</i> (Skuja) Anagn. <i>Cyanosarcina burmensis</i> (Skuja) Kováčik <i>Pseudanabaena amphigranulata</i> (Goor) Anagn. <i>Oscillatoria angusta</i> Koppe <i>Oscillatoria formosa</i> f. <i>loktakensis</i> Brühl & Biswas <i>Jaaginema geminatum</i> (Schwabe ex Gomont) Anagn. & Komárek <i>Phormidium rimosum</i> (Komárek) Anagn. & Komárek

**Systematic Enumeration:**

Systematic studies carried out on Cyanoprokaryotes from diverse water bodies of Maldah district, West Bengal. Taxonomic enumeration of identified new record of Cyanoprokaryotes of West Bengal from Maldah district is described here along with their details.

**Chroococcales** Wettst.  
**Chroococcaceae** Nägeli  
**Cyanosarcina** Kováčik

**Cyanosarcina burmensis** (Skuja) Kováčik, Arch. Hydrobiol. Suppl. 80 (Algol. Stud. 50-53): 176. 1988. **(Fig. 2A)**  
*Myxosarcina burmensis* Skuja, Zur Süßwasseralgenflora Burmas 21, t. 1, f. 12. 1949.

Cells more or less angular with rounded corners, almost arranged in transverse and vertical series, pale blue-green or olive-green, homogenous or finely granular; sheath very thin, mucilaginous, hyaline; colonies when young 4 cells.

Dimension: Cells 2.0–3.5 µm in diameter.

Distribution: Bil (Laxmipur).

**Dactylococcopsis** Hansg.

**Dactylococcopsis raphidioides** Hansg., Notarisia 590, 1888; Desikachary, Cyanophyta 158, t. 29, f. 1-2. 1959.

**(Fig. 2B)**

Cells light blue-green, spindle shaped, sigmoid or lunulately bent, single to a few together; species highly polymorphic.

Dimension: Cells 1.3–3.0 µm broad and 14.0–18.2 µm long.

Distribution: Bil (Adhsoi).

**Microcystaceae** Elenkin  
**Gloeocapsa** Kütz.

**Gloeocapsa nigrescens** Nägeli, in Rabenh., Alg. Sachs. 63, 629, 1857; Desikachary, Cyanophyta 117, t. 24, f. 15, 17. 1959. **(Fig. 2C)**

Cells spherical, surrounded by individual envelopes, not lamellated, hyaline; cells uniting laterally, contents blue-green.

Dimension: Cells 3.0–6.0 µm in diameter.

Distribution: Bil (Manna).

**Microcystis** Lemmerm.

**Microcystis ichthyoblabe** (G.Kunze) Kütz., Phycol. general. 921, 1843; Komárek & Anagn., Cyanoprokaryota Part 1: Chroococcales 19(1): 226, f. 297. 1998. **(Fig. 2D)**

*Granularia ichthyoblabe* G.Kunze in E.Schmalz. Flora 6: 566. 1823.

Colony large, irregular, compact, without holes, mostly flattened, often form cell clusters or sub colonies in common mucilage, later on disintegrated in to small groups of aggregated cells; margins of colonies irregular, indistinct, diffuse, irregularly overlapping cells; cells spherical, densely homogeneously and evenly accumulated.

Dimension: Cells 2.0–3.7 µm in diameter.

Distribution: Pond (Bhadobartola).

**Microcystis novacekii** (Komárek) Compère, Bull. Jard. Bot. Natl. Belg. 44: 19, 1974; Komárek & Anagn., Cyanoprokaryota Part 1: Chroococcales 19(1): 220, f. 302. 1998. **(Fig. 2E)**

*Diplocystis novacekii* Komárek, in Komárek & Ettl., Alg. Stud.: 63, t. 6, f. 1-4. 1958.

Colony almost spheroidal and slightly flattened, sometimes cells aggregated together; cells densely agglomerated in the centre of the colony, few solitary cells in enveloping mucilage.

Dimension: Cells 2.3–6.0 µm in diameter.

Distribution: Dighi (Bara Sagar).

**Microcystis panniformis** Komárek, Komárk.-Legn., C.L. Sant'Anna, M.T.P. Azevedo & Senna, Crypto. Algol. 23: 165, f. 14–28. 2002; Komárek & Anagn., Cyanoprokaryota Part1: Chroococcales 19(1): 226, f. 297. 1998. **(Fig. 2F)**

Colony flat, irregular with small holes; margins of the colonies smooth or irregular; cells regularly densely and smoothly accumulated.

Dimension: Cells 2.5–4.9 µm in diameter.

Distribution: Pond (Bhadobartola).

**Microcystis wesenbergii** (Komárek) Komárek ex Komárek, in Kondrateva Cvetenie vody, Naukova Dumka Kiev 32, 1968; Komárek & Anagn., Cyanoprokaryota Part 1: Chroococcales 19(1): 232, f. 305. 1998.

(Figs. 2G–K)

*Diplocystis wesenbergii* Komárek, Komárek & Ettl., Alg. Stud.: 68, t. 7, f. 1-4. 1958.

Colony irregular, spheroidal to lobate or elongate with holes when old; mostly composed with connected spheroidal sub-colonies; cells sparsely to densely accumulated often near the surface of sub-colonies.

Dimension: Cells 4.0–8.6 µm in diameter.

Distribution: Dighi (Sukan).

#### Nostocales Borzi

#### Nostocaceae Eichler

#### Anabaena Bory de Saint-Vincent ex Bornet & Flahault

**Anabaena inaequalis** Bornet & Flahault, Ann. Sci. Nat. Bot. ser. 7(7): 225, 231, 1886 (1888); N.D.Kamat, Hydrobiologia 22: 277, 1963. (Fig. 2O)

Trichome almost straight or sometimes slightly twisted; cells short, barrel-shaped or truncate globose; heterocysts globose; spore not found in the sample.

Dimension: Cells 4.0–5.3 µm broad; heterocysts 5.0–6.8 µm broad.

Distribution: Bil (Hazartakiya).

**Anabaena vaginicola** f. **fertilissima** B.N.Prasad, J. Indian Bot. Soc. 31: 361, f. 14-17. 1952; Desikachary, Cyanophyta 401, t. 73, f. 3. 1959. (Fig. 2P)

Trichome single or in a common mucilaginous sheath, blue-green; cells quadratic barrel-shaped, constricted at the cross-walls; heterocysts barrel-shaped slightly flattened; spore ellipsoidal, more than one or in the chain.

Dimension: Trichome 4.8–5.7 µm broad and cells 3.2–5.4 µm long; heterocysts 5.8–6.8 µm broad and 5.0–6.0 µm long; spores 5.6–8.2 µm broad and 6.8–9.0 µm long.

Distribution: Bil (Nawabganj).

#### Nostoc Vaucher ex Bornet & Flahault

**Nostoc elliposporum** var. **violaceum** C.B.Rao, Proc. Indian Acad. Sci., B. 6: 359, f. 4C, 1937; Desikachary, Cyanophyta 383, t. 68, f. 4. 1959. ('violacea'). (Fig. 2Q)

Thallus gelatinous, irregularly expanded; filament flexuous, loosely entangled; trichome constricted at the cross-walls; cells cylindrical or almost quadrate; heterocysts almost spherical or cylindrical with the rounded flat end; spores ellipsoidal, almost spherical or cylindrical with the smooth outer wall.

Dimension: Trichome 3.2–3.6 µm broad and cells 2.5–7.9 µm long; heterocysts 4.0–6.2 µm broad and 4.8–7.8 µm long; spores 5.0–7.0 µm broad and 5.6–12.0 µm long.

Distribution: Bil (Barabilla).

#### Oscillatoriales Schaffner

#### Gomontiellaceae Elenkin ex Geitler

#### Komvophoron Anagn. & Komárek

**Komvophoron crassum** (Vozzhenn.) Anagn. & Komárek, Arch. Hydrobiol., Suppl. (Algol. Stud. 50-53) 80: 373. 1988. (Fig. 2R)

*Pseudanabaena crassa* Vozzhenn., Bot. Mater. Bot. Inst. Akad. Nauk. SSSR, Spor. Rast. 9: 73, f. 1: 2. 1953.

Trichome curved sometimes more or less straight, short 8 to 80 celled, rarely more cells, distinctly constricted at the cross-walls; cells cylindrical; apical cell almost rounded.

Dimension: Trichome 4.1–4.9 µm broad and cells 4.4–5.6 µm long.

Distribution: Bil (Chakla).

#### Oscillatoriaceae Kirchn.

**Oscillatoria** Vaucher ex Gomont

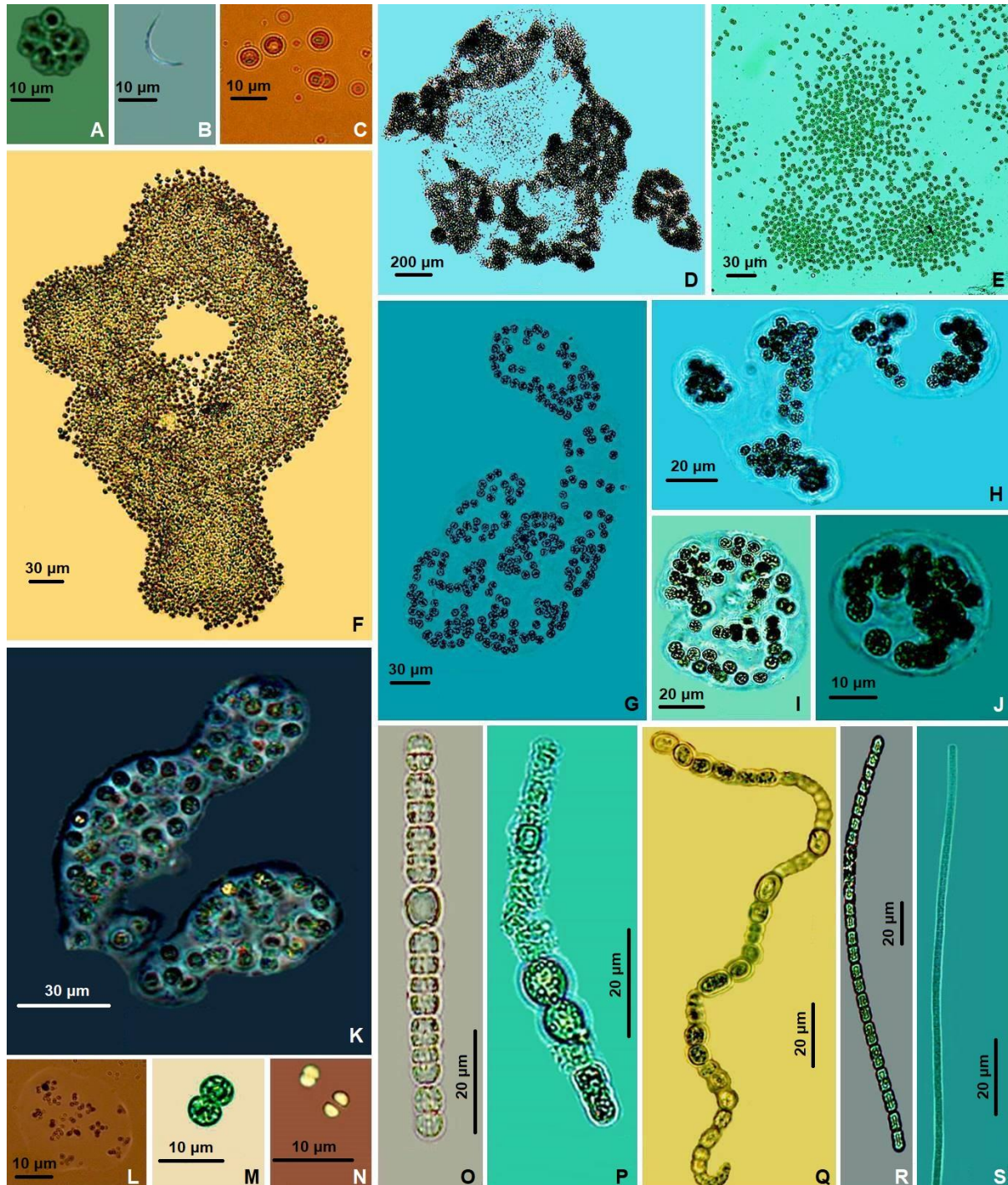
**Oscillatoria angusta** Koppe, Arch. Hydrobiol. Planktonk. 14: 641, 1923; Desikachary, Cyanophyta 227, 1959.

(Fig. 2S)

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

Dimension: Trichome 1.0–1.8  $\mu\text{m}$  broad and cells 5.0–7.5  $\mu\text{m}$  long.

Distribution: Bil (Jalsukha).



**Figure 2.** A, *Cyanosarcina burmensis* (Skuja) Kováčik; B, *Dactylococcopsis raphidioides* Hansg.; C, *Gloeocapsa nigrescens* Nägeli; D, *Microcystis ichthyoblabe* Kütz.; E, *M. novacekii* (Komárek) Compère; F, *M. panniformis* Komárek; G–K, *M. wesenbergii* (Komárek) Komárek; L, *Aphanocapsa elachista* var. *conferta* W.West & G.S.West; M, *A. rivularis* (Carmich.) Rabenh.; N, *Synechocystis pevalekii* Erceg.; O, *Anabaena inaequalis* Bornet & Flahault; P, *Anabaena vaginicola* f. *fertilissima* B.N.Prasad; Q, *Nostoc ellipsosporum* var. *violaceum* C.B.Rao; R, *Komvophoron crassum* (Vozzhenn.) Anagn. & Komárek; S, *Oscillatoria angusta* Koppe.

**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. (Fig. 3A)

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

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

Distribution: Bil (Jalsukha).

**Oscillatoria crassa** (C.B.Rao) Anagn., Preslia 73: 372, 2001. (Fig. 3B)

*Oscillatoria ornata* var. *crassa* C.B.Rao, Proc. Indian Acad. Sci., B. 8: 165, f. 20. 1938.

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.

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

Distribution: Pond (Damua).

**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. (Fig. 3C)

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

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

Distribution: Bil (Hazartakiya).

**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. (Fig. 3D)

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

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

Distribution: Pond (Damua).

#### Phormidium Kütz. ex Gomont

**Phormidium rimosum** (Komárek) Anagn. & Komárek, Arch. Hydrobiol., Suppl. (Algol. Stud. 50-53)80: 408, 1988; Komárek & Anagn., Cyanoprokaryota Part 2: Oscillatoriales 19(2): 440, f. 641. 2005. (Fig. 3E)

*Lyngbya rimosa* Komárek, Preslia 28: 374, f. 3 T - U & f. 4. 1956.

Thallus dark blue-green; filament short; sheath firm, attached to trichome, confluent within the colony; trichome cylindrical, not constricted or sometimes very slightly constricted at the cross-walls; not attenuated towards ends; cells usually broader than long, granulated; apical cell usually rounded; calyptra absent.

Dimension: Trichome 2.8–4.0 µm broad and cells 1.6–2.8 µm long.

Distribution: Bil (Jalsukha).

#### Synechococcales L.Hoffm., Komárek & J.Kastovsky

##### Heteroleibleiniaceae (Komárek & Anagn.) Komárek, J.Kastovsky, J.Mares & J.R.Johans.

##### Heteroleibleinia (Geitler) L.Hoffm.

**Heteroleibleinia mesotricha** (Skuja) Anagnostidis & Komárek, Arch. Hydrobiol., Suppl. 80: 434, 1988. (Fig. 3F)

*Lyngbya mesotricha* Skuja, Nova Acta Regiae Soc. Sci. Upsal. ser. 4, 14(15): 54, t. 9, f. 1-7. 1949.

Filament more or less curved, fixed to the substratum by the basal portion; sheath thin to moderately broad, firm, colourless; trichome end not attenuated, not constricted at the cross-walls, marked with one or two large granules on either side of cross-walls; cell contents pale blue-green, homogeneous; apical cell round or rounded conical; calyptra absent.

Dimension: Trichome 2.0–3.5 µm broad and cells 4.0–7.0 µm long.

Distribution: Dighi (Raikhan).

#### Pseudanabaenaceae Anagn. & Komárek

##### Jaaginema Anagn. & Komárek

**Jaaginema geitleri** (Frémy) Anagn. & Komárek, Arch. Hydrobiol. Suppl. 80 (Algol. Stud. 50-53): 395. 1988.

(Fig. 3G)

*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.

Dimension: Trichome 2.2–2.7  $\mu\text{m}$  broad and cells 3.0–3.9  $\mu\text{m}$  long.

Distribution: Bil (Kuchla).

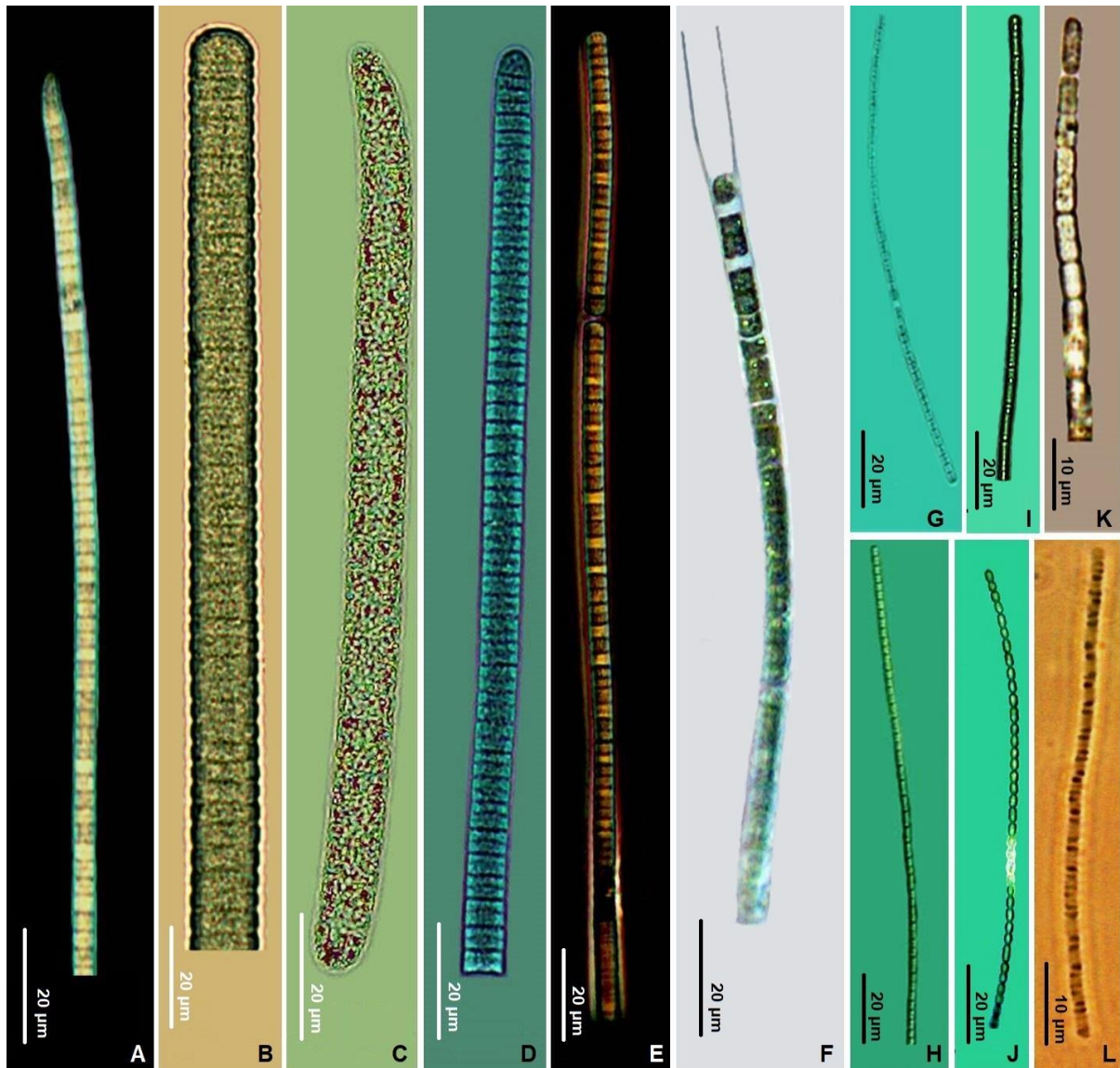
**Jaaginema geminatum** (Schwabe ex Gomont) Anagnostidis & Komárek, Arch. Hydrobiol. Suppl. 80 (Algol. Stud. 50-53): 395. 1988. (Fig. 3H)

*Oscillatoria geminata* Schwabe ex Gomont, Ann. Sci. Nat. Bot. ser. 7(16): 222, t. 7, f. 6. 1892.

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.

Dimension: Trichome 2.3–3.3  $\mu\text{m}$  broad and cells 2.2–5.6  $\mu\text{m}$  long.

Distribution: Bil (Jalsukha).



**Figure 3.** A, *Oscillatoria formosa* f. *loktakensis* Brühl & Biswas; B, *Oscillatoria crassa* (C.B.Rao) Anagn.; C, *O. perornata* f. *attenuata* Skuja; D, *O. tenuis* var. *natans* Gomont; E, *Phormidium rimosum* (Komárek) Anagn. & Komárek; F, *Heteroleibleinia mesotricha* (Skuja) Anagnostidis & Komárek; G, *Jaaginema geitleri* (Frémy) Anagn. & Komárek; H, *J. geminatum* (Schwabe ex Gomont) Anagnostidis & Komárek; I, *Pseudanabaena amphigranulata* (Goor) Anagn.; J, *P. dictyothalla* (Skuja) Anagn.; K, *P. limnetica* (Lemmerm.) Komárek; L, *P. redekei* (Goor) B.A. Whitton.

#### **Pseudanabaena** Lauterborn

**Pseudanabaena amphigranulata** (Goor) Anagn., Preslia 73: 360. 2001.

(Fig. 3I)

*Oscillatoria amphigranulata* Goor, Recueil. Trav. Bot. Néerl. 15: 255, t. 2, f. 2. 1918.



Trichome almost straight, constricted at the cross-walls with prominent granules; end not attenuated, not capitate; end cell rounded, calyptra absent.

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

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

**Pseudanabaena dictyothalla** (Skuja) Anagn., Preslia 73: 360, 2001; Komárek & Anagn., Cyanoprokaryota Part 2: Oscillatoriales 19(2): 80, f. 52. 2005. (Fig. 3J)

*Phormidium dictyothallum* Skuja, Symb. Bot. Upsal. 9(3):51, t. 5, f. 8-11. 1948.

Trichome more or less straight or slightly bent; constricted at the cross-walls, not attenuated at the end; cells almost cylindrical, blue-green with rounded ends; cell contents homogenous; apical cell rounded; calyptra absent.

Dimension: Trichome 1.2–2.0 µm broad and cells 2.8–5.0 µm long.

Distribution: Dighi (Bara Sagar).

**Pseudanabaena limnetica** (Lemmerm.) Komárek, Sborn. Jihočesk. Muz. Českých Budějovicich, Přír. Vedy 14: 162. 1974. (Fig. 3K)

*Oscillatoria limnetica* Lemmerm., Ber. Duetsch. Bot. Ges. 18: 310, 1900.

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

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

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

**Pseudanabaena redekei** (Goor) B.A. Whitton, Cyanobacteria (Cyanophyta) 110, 2011. (Fig. 3L)

*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.

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.

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

Distribution: Jheel (Mahadhap).

#### Merismopediaceae Elenkin

##### Aphanocapsa Nägeli

**Aphanocapsa elachista** var. **conferta** W. West & G.S. West, J. Linn. Soc., Bot. 40: 432, t. 19, f. 1. 1932; Desikachary, Cyanophyta 133, t. 22, f. 10. 1959. (Fig. 2L)

Colony ellipsoidal or almost oval or spherical; mucilage colourless; cells more or less closely arranged.

Dimension: Cells 1.4–2.0 µm in diameter and colony 56.0–71.0 µm in diameter.

Distribution: Bil (Manna).

**Aphanocapsa rivularis** (Carmich.) Rabenh., Fl. eur. alg. 11: 49, 1865. Prescott, Algae of the Western Great Lakes Area 454, t. 101, f. 17. 1982. (Fig. 2M)

*Palmella rivularis* Carmich., in Hook., Brit. Fl. 2(1): 397, 1833.

Cells globose, with bright blue-green granular contents, usually solitary or in pairs, scattered within the colonial mucilage envelope.

Dimension: Cells 5.0–6.0 µm in diameter.

Distribution: Dighi (Bara Sagar).

#### Synechococcaceae Komárek & Anagno.

##### Synechocystis Sauv.

**Synechocystis pevalekii** Erceg., Acta Bot. Inst. Bot. Univ. Zagreb 1: 77, t. 1, f. 8. 1925; Desikachary, Cyanophyta 145, t. 25, f. 11. 1959. (Fig. 2N)

Cells spherical, two together or sometimes single, generally without visible gelatinous matrix.

Dimension: Cells 2.2–3.5 µm in diameter.

Distribution: Dighi (Paradhala).

## DISCUSSION AND CONCLUSION

Altogether 27 species (including 03 variety and 03 forms) have been reported from 18 water bodies of Maldah District, West Bengal. Out of 13 blocks of Maldah District Cyanoprokaryotes were recorded from 03 Ponds, 10 Bils, 01 Lake and 04 Dighi of 08 blocks namely Ratua I, Ratua II, Harishchandrapur I, Harishchandrapur II, Chanchal II, Gazol, Old Maldah and English Bazar. Blockwise maximum 09 new records were observed from different water bodies of English Bazar viz. *Aphanocapsa rivularis* (Carmich.) Rabenh., *Cyanosarcina burmensis* (Skuja) Kováčik, *Jaaginema geminatum* (Schwabe ex Gomont) Anagn. & Komárek, *Microcystis novacekii* (Komárek) Compère, *Oscillatoria angusta* Koppe, *Oscillatoria formosa* f. *loktakensis* Brühl & Biswas, *Phormidium rimosum* (Komárek) Anagn. & Komárek, *Pseudanabaena amphigranulata* (Goor) Anagn. and *Pseudanabaena dictyothalla* (Skuja) Anagn. and again maximum 04 species observed only from Jalsukha Bil of English Bazar followed 02 species from each water bodies of block Gazol, Harishchandrapur I, Harishchandrapur II, Old Maldah, Ratua I and Ratua II. However, single species observed from Chakla Bil of block Chanchal II i.e. *Komvophoron crassum* (Vozzhenn.) Anagn. & Komárek. It was observed that some of the species have been observed in more than one water bodies like *Pseudanabaena amphigranulata* (Goor) Anagn. from Barabilla Bil, Mahadhap Lake and Jorkuppa Pond and *Pseudanabaena limnetica* (Lemmerm.) Komáre from, Balutuli Bil and Mahadhap Lake. From these studies, one can easily explain the ecological preferences of various species of Cyanoprokaryota. These taxonomic studies may be used in experimental as well as ecological studies. This study will fill the gap in our existing knowledge of the biodiversity of the Cyanoprokaryotes of this area. A new distributional record recorded from West Bengal of Maldah District, which we expect to be utilized by experimental and evolutionary researchers worldwide. Further Molecular studies in combination with morphological studies will provide new insights into the real diversity of Cyanoprokaryota and their bio-geographical distribution in this environment. However, many more studies are needed to unravel the enormous diversity of Cyanoprokaryota and to better define their bio-geographical patterns.

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