

## Taxonomical Studies of *Oscillatoriaceae* (Cyanophyta) of Goalpara District, Assam, India

\*S J Deka and G C Sarma

Department of Botany, Gauhati University, Guwahati 14, Assam, India

\*Authors for Correspondence

### ABSTRACT

The present studies enumerated 65 species of the family *Oscillatoriaceae* isolated from freshwater of different sites of Goalpara district, Assam. Total number of species could be grouped into ten numbers of genera like *Katagnymene* 1.54%, *Porphyrosiphon* 1.54%, *Polychlamydom* 1.54%, *Symploca* 1.54%, *Microcoleus* 1.54%, *Hydrocoleum* 1.54%, *Spirulina* 9.23%, *Phormidium* 20%, *Lyngbya* 20% and *Oscillatoria* 41.53%. These species were cultured using Algal Broth Culture & Chu-10 media for isolation. Present investigation has been made for identification and taxonomic account.

**Key Words:** Blue-green algae, *Oscillatoriaceae*, Taxonomy, Goalpara District

### INTRODUCTION

The blue-green algae are the only group of algae which are prokaryotic. The modern cyanobacterial taxonomic studies are based mostly on the combined, phenotypical ultra- structural, ecological and molecular data. However, particularly in extreme tropical biotopes, morphological studies and detailed investigations of its biodiversity remain very little known. On that account, descriptions of evidently new morpho and ecospecies are very important for recognition of cyanobacterial diversity under natural conditions (Sant' Anna *et al.*, 2007).

Algae have a great significance, since these primary producers are used in biomonitoring as indicator organisms of water pollutions (Shekter *et al.*, 2008), in ecological studies of extraordinary environments such as mangroves (Saravanakumar *et al.*, 2008) or in exploring sustainable water resources (Bhuiyan and Gupta, 2007). *Cyanophyceae* are almost universal in distribution but their fluctuation and abundance depend upon their surrounding environment.

A few studies have been made on the fresh water *Cyanophytes* in India (Talukdar, 1997; Sing, 1985; Kaushik, 1987; Tiwari and Chauhan, 2006; Sridhar *et al.*, 2006; Tas and Gonulol, 2007; Santhilkumar and Sivakumar, 2008; Laskar and Gupta, 2009). The present study aims to provide information on the taxonomy of *Oscillatoriaceae* (Cyanophyta) that was recorded for the first time from Goalpara district, Assam.

**MATERIALS AND METHODS** The algal samples were collected at monthly intervals from January 2007

to December 2010 from different spots of Goalpara district, Assam. The samples were identified using photomicroscope and compared with that of Desikachary (1959, 1987); Anand (1998); Kemdirim (2001); and Prescott (1964). Mostly phytoplankton samples were collected using Planktonic net (mesh size 50µm). The collected algal materials were cultured and isolated using Algal Broth Culture media and Chu-10 culture media. All the samples were preserved in 4% formalin solution.

### RESULTS

The following 65 identified species were systematically arranged according to the recently proposed classification.

**Class- *Cyanophyceae* Sachs:** Unicellular, palmelloid or colonial forms.

**Order- *Nostocales* Geitler:** Plants filamentous, with filament and trichome organization, hormogones present; heterocysts, akinetes, endospores, hormocysts present; true branching absent, false branching present.

**Family-*Oscillatoriaceae* Kirchner.** Trichome with a single row of similar and uniformly broad cells, only sometimes tapering at the extreme ends, not forming a hair, not branched, without or with diffluent mucilage or a homogeneous or more or less lamellated firm sheath; generally unbranched but occasionally branched in genera with a firm sheath; growth intercalary in some apical; trichome straight or regularly or irregularly spirally coiled; heterocysts and spores absent;

**Research Paper**

hormogones present, many showing a spiral movement by rotation along the longitudinal axis.

**Key to the genera:**

1. Trichomes cylindrical.....2
2. Trichomes typically many in a sheath; sheath at the apex generally closing after hormogone formation.....3
2. Trichomes without a sheath or single within a sheath; end sheaths open always.....8
3. Trichomes very many in a sheath, densely arranged.....4
3. Trichomes fewer, loosely arranged.....5
4. Sheath more or less slimy: filaments twisted into rope-like bundles.....*Microcoleus*
5. Filaments unbranched.....*Polychlamydom*
5. Filaments branched.....6
6. Sheath and trichome otherwise.....7
7. Sheath slimy, end cell with a calyptra...*Hydrocoleum*
7. Sheath more or less firm, end cell without a calyptra.....1
- 5 8. Trichome with a prominent sheath.....9
8. Trichome without a sheath.....11
9. Sheath firm.....10
9. Sheath mucilaginous.....14
10. Filaments not in bundles.....*Lyngbya*
10. Filaments mostly in erect bundles.....*Symploca*
11. Trichome more or less straight, not regularly spirally coiled.....1
- 2 11. Trichome regularly spirally coiled.....13
12. In free swimming bundles.....*Trichodesmium*
12. Not in bundles.....*Oscillatoria*
13. Cells of trichome not visible or unicellular...*Spirulina*
14. Filaments single.....*Katagnymene*
14. Filaments forming a thallus with more or less confluent sheaths.....*Phormidium*
15. Fewer or only one trichome in each sheath: sparingly branched.....*Porphyrosiphon*

***Spirulina Turpin em. Gardner:*** Trichomes unicellular or multicellular cylindrical, sheath absent; loosely or

tightly coiled into a more or less regular spiral; apex of trichome usually not attenuated; cross-walls if present obscured; terminal cell rounded, without calyptra.

**Key to the species:**

1. Spirals distant.....2
2. Spirals irregular.....*Sp. meneghiniana*
2. Spirals regular.....3
3. Trichomes less than 2µ broad.....4
4. Spirals loose, 17-22µ distant.....*Sp. laxissima*
4. Spirals closer.....5
5. Spirals 1.25-2µ away from each other, trichomes 0.6-0.9µ broad.....*Sp. subtilissima*
5. Spirals farther away, trichomes 1.2-1.7µ broad.....*Sp. major*
6. Trichomes 4.5-5µ broad.....*Sp. princeps*
6. Trichomes narrower.....*Sp. gigantea*

***Spirulina meneghiniana Zanard. Ex Gomont.:***

T.V.Desikachary, 195, pl. 36, fig. 8, 1959. Trichome 1.2-1.8µ broad, flexible, irregularly spirally coiled, bright blue-green, forming a thick blue-green thallus; spirals 3.2-5µ broad and 3-5µ distant from each other.

***Spirulina laxissima forma major f. n.:***

T.V.Desikachary, 196, pl. 26, fig. 1, 1959. Trichome 1.3µ broad, blue-green, spirals not close, about 6.6µ broad and 5.2-6.2µ distant from each other.

***Spirulina princeps West & West.:***

T.V.Desikachary, 101, pl. 36, fig. 5, 1959. Trichome 4.5-5µ broad, short, blue-green, regularly spirally coiled, spirals 11-12µ broad and 9.5-11µ distant.

***Spirulina subtilissima Kütz.:***

T.V.Desikachary, 196, pl. 36, fig. 10, 1959. Trichome 0.5-0.9µ broad, regularly spirally coiled, bright blue-green or yellowish, spirals 1.5-2.5 (-2.8) µ broad, distance between the spirals.

***Spirulina gigantea Schmidle.:***

T.V.Desikachary, 197, pl. 36, fig. 12, 1959. Trichome 3-4µ broad, deep blue-green, regularly spirally coiled, at the end conical attenuated, spirals 11-16µ broad.

***Spirulina major Kütz.:***

T.V.Desikachary, 196, pl. 36, fig. 13, 1959. Trichome 1.2-1.7 (-2) µ broad, regularly spirally coiled, blue-green, spirals 2.5-4µ broad and 2.7-5µ distant.

***Katagnymene Lemm.:*** Trichome single, free-swimming with a thin or broad gelatinous sheath.

**Research Paper**

**Key to the species:**

1. Filaments not spirally coiled.....*K. pelagicakkl*

***Katagnymene pelagica* Lemm.:** T.V. Desikachary, 247, pl. 47, fig. 6, 1959. Trichome straight or bent, 16 μ broad; cells 3-4 μ long; end cells rounded or with a calyptra; gelatinous sheath up to 100 μ thick, colourless.

***Porphyrosiphon Kützinger:*** Trichomes single, rarely two in a sheath; sheath firm, lamellated, red or reddish brown, when old at the extreme ends open; filaments when young with attenuated and closed ends, more or less contorted and forming an expanded thallus, sparingly branched.

***Porphyrosiphon notarisii* (Menegh.) Kütz. Ex Gomont.:** T.V. Desikachary, 248, pl. 47, fig. 9, 1959. Filament vertically bent, densely aggregated, forming a tomentose, expanded, dull reddish brown layer; sheath firm, sometimes thin, mostly very thick and lamellated, orange to purple-red, at the ends often colourless, and narrowing to the apex, the inner lamellae alone coloured, the outer lamellae colourless; sheath coloured violet by chlor-zinc-iodide; trichome constricted at the cross-walls or unconstricted, blue-green; cells 8-19 μ broad, as long or up to 1/3 as long as broad, 4.5-12 μ long; end cell obtuse-attenuated; filaments occasionally branched, or occasionally into two short pieces of trichome.

***Polychlamydom West et West:*** Trichome single or seldom 2-3 in a thick lamellated sheath, inner lamellae of sheath firm, brown, the outer ones colourless, and swollen, or the inner and outer ones of similar structure; filaments unbranched.

**Key to the species:**

1. Trichome 17-22 μ broad.....*P. insigne*

***Polychlamydom insigne* West et West.:** T.V. Desikachary, 249, pl. 47, fig. 1, 1959. Filaments 67-105 μ broad; sheath with 5-7 firm yellowish brown inner lamellae and 2-4 colourless, externally even, outer lamellae diffluent; trichome not constricted at the cross-walls, at the ends obtuse, not capitate, olive-green, 17-22 μ broad, cells 1/9-1/11 as long as broad.

***Phormidium Kütz.:*** Filaments many forming a gelatinous or leathery stratum, thallus attached by the lower side, or floating in water with torn margins; sheath present, more or less firm, sometimes agglutinated, sometimes partly diffluent, thin, colourless; trichomes cylindrical, in some constricted at the joints, apices often attenuated, straight or bent, never regularly spirally

coiled, capitate or non-capitate, apical cells in many species with a calyptra.

**Key to the species:**

1. Trichomes constricted at the cross walls; ends not bent or capitate.....3

2. Trichomes not constricted at the cross walls; ends often bent and capitate.....7 3.

Trichomes broader.....4 4. Trichome broader.....5

5. End cells with a calyptra.....*P. microtomum* 5.

End cells without a calyptra.....6

6. Trichomes 8-11 μ broad.....*rotheanum*

7. Trichomes up to 3 μ broad.....8 7. Trichomes broader.....14

8. End cell so conical more or less pointed.....9 8. End cells not so.....11

9. Trichome ends straight.....10

10. Trichomes 1-2 μ broad, cells up to 3 times as long as broad.....*P. tenue* 11. Trichomes broader.....12

12. Cells longer than broad.....13 13. Trichomes 1.5 -2.5 μ broad, thallus purple to violet.....*P. purpurascens* 14. Trichomes not attenuated at the apices.....15

14. Trichomes attenuated at the apices.....21 15. End cells more or less rounded.....16

15. End cells otherwise.....19 16. End cells with calyptra.....*P. stagnina* 16. End cells without calyptra.....17

17. Trichomes up to 6 μ broad.....18 17. Trichomes up to 8-10.5 μ broad.....*P. anomala*

18. Sheath thick, lamellated, septa granulated, with gas-vacuole.....*P. ambiguum* 19. Trichome otherwise.....20

20. Trichomes 4.5-12 μ broad, not forming a thick calcified thallus.....*P. retzii* 21. Trichomes not spirally coiled.....22

22. End cell capitate.....26 22. End cell not capitate.....23

23. Thallus without calcium incrustation.....24 24. Filaments

**Research Paper**

broader.....25 25.  
Trichomes below  $7\mu$  broad...*P. corium* var. *capitatum*  
26. End cells conical  
pointed.....27 26. End cells  
otherwise.....28 27. In  
freshwater, cells shorter than broad...*P. subfuscum* 28.  
Trichomes apices straight.....29  
28. Trichomes apices  
bent.....31 29. Cells shorter  
than broad.....30 30. Cells  $1\frac{1}{2}$   
as long as broad.....*P. favosum* 31. Cells  
 $5.5\text{--}9\mu$  broad, generally  $\frac{1}{2}\text{--}\frac{1}{3}$  as long as  
broad.....*P.*  
*uncinatum* 31. Cells  $4\text{--}7\mu$  broad,  $1\frac{1}{2}$  as long as  
broad...*P. autumnale*

***Phormidium microtomum* Skuja.:** T.V.Desikachary, 257, pl. 43, fig. 16, 1959. Thallus expanded, coriaceous, lamellose, dark greyish-green or light-bluish; filaments more or less straight,  $6.5\text{--}8\mu$  broad; sheath thin, colourless, later diffluent; trichome ends briefly or prominently attenuated,  $6\text{--}7\mu$  broad, well constricted at the cross-walls, cells  $1/3\text{--}1/8$  as long as broad,  $0.8\text{--}1.5\mu$  long, contents blue-green to olivaceous, septa not granulated or indistinct, and finely granulated; apical cell rounded with a hyaline calyptra.

***Phormidium rotheanum* Itzigsohn.:** T.V.Desikachary, 258, pl. 45, fig. 14, 1959. Thallus thin, dark blue-green; trichome straight or flexuous, slightly constricted at the cross-walls, at the ends attenuated,  $8\text{--}11\mu$  broad, blue-green; sheath thin, coloured violet by chlor-zinc-iodide, cells much shorter than broad,  $2.7\text{--}4\mu$  long, septa granulated, end cells obtuse conical.

***Phormidium tenue* (Menegh.) Gomont.:** T.V.Desikachary, 259, pl. 43, fig. 13, 1959. Thallus pale blue-green, thin, membranous, expanded; trichome straight or slightly bent, densely entangled, slightly constricted at the cross-walls, attenuated at the ends,  $1\text{--}2\mu$  broad, pale blue-green; sheath thin, diffluent, coloured violet by chlor-zinc-iodide; cell up to 3 times longer than broad,  $2.5\text{--}5\mu$  long, septa not granulated, cross-walls not commonly visible; end-cell acute-conical, calyptra absent.

***Phormidium purpurascens* (Kütz.) Gomont.:** T.V.Desikachary, 262, pl. 45, fig. 4, 1959. Thallus compact, leathery, purple to brownish violet; trichome strongly bent, entangled, not constricted at the cross-walls, ends not attenuated,  $1.5\text{--}2.5\mu$  broad, dark violet; sheath more or less diffluent, not coloured violet by chlor-zinc-iodide; cells nearly quadrate or up nearly two

times longer than broad,  $2\text{--}4.5\mu$  long, cross-walls marked by two granules on either side; end-cell rounded, calyptra absent.

***Phormidium stagnina* Rao C. B.:** T.V.Desikachary, 265, pl. 45, fig. 16, 1959. Thallus soft blue-green and membranous; filaments  $12\text{--}8\text{--}14.4\mu$  broad; trichome blue-green, interwoven and not attenuating,  $8\text{--}9.6\mu$  broad; sheath hyaline, unstained by chlor-zinc-iodide, thick, firm, sometimes diffluent; cells small, without constrictions at the joints,  $1.3\text{--}2\mu$  long; end cell broadly rounded with a prominent calyptra.

***Phormidium anomala* Rao, C. B.:** T.V.Desikachary, 266, pl. 45, fig. 12, 1959. Thallus thick expanded, soft, mucilaginous, deep blue-green,  $3\text{--}6$  mm thick; trichome subparallel of uniform width,  $8\text{--}10\mu$  ( $\sim 10.5\mu$ ) broad without constrictions at the cross-walls; sheath thin, colourless, not stained by chlor-zinc-iodide, persistent or dissolved; cells disc-shaped, much broader than long,  $0.8\text{--}1.2$  ( $\sim 2$ )  $\mu$  long; end cells bluntly rounded without cap or calyptra.

***Phormidium ambiguum* Gomont.:** T.V.Desikachary, 266, pl. 45, fig. 5, 1959. Thallus more or less expanded, bright blue-green, dark or yellowish green; filaments flexuous, variously entangled; trichomes slightly constricted at the cross-walls, at the ends not attenuated, not capitate,  $4\text{--}6\mu$  broad, blue-green; sheath thin, firm or diffluent sometimes thick and more or less lemlated, coloured violet by chlor-zinc-iodide; cells shorter than broad,  $1.5\text{--}2.7\mu$  long, rarely granulated at the cross-walls, sometimes with gas-vacuoles; end cell rounded, calyptra absent.

***Phormidium retzii* (Ag.) Gomont.:** T.V.Desikachary, 268, pl. 44, fig. 13, 1959. Thallus bright blue-green to dark lead colour thick, compact, pencilate or branched tufts, attached at the base, upper portions floating; filaments more or less straight, mostly unconstricted at the cross-walls, or seldom torulose, not attenuated at the ends, not capitate, straight,  $4.5\text{--}12\mu$  broad, dull blue-green; sheath thin, firm or mostly diffluent, not coloured violet by chlor-zinc-iodide; cells shorter or longer than broad,  $4\text{--}9\mu$  long, septa not granulated; end scarcely attenuated, end cells truncated, with a thickened outer membrane, calyptra absent.

***Phormidium corium* var. *capitatum* nom. nov.:** T.V.Desikachary, 271, pl. 43, fig. 11, 1959. Filaments long or short, more or less straight to variously but seemingly regularly spirally coiled,  $9\text{--}12\mu$  broad; sheath thin, colourless, sometimes diffluent, outside uneven;

**Research Paper**

trichome 8-10µ broad, at the ends not or a little attenuated, distinctly constricted at the cross-walls, granulated; cells 1.5-2.7µ long, contents olive to blue-green in colour; end-cell capitate, somewhat flat to broadly conical or rounded.

**Phormidium subfuscum Kütz. ex Gomont.:**

T.V.Desikachary, 273, pl. 44, fig. 23, 1959. Thallus very much expanded, ragged, dark-green or dark olivaceous, thin lamellated; filaments straight, fragile, short, parallel; sheath diffuent in to a lamellose mucuous, not coloured violet by chlor-zinc-iodide; trichome pale blue-green or olive-green, 5.5-11µ broad, not constricted at the cross-walls; cells ½-¼ as long as broad, rarely subquadrate, 2-4µ long, cross-walls often granulated; ends more or less briefly attenuated, capitate; end cells straight, acute-conical.

**Phormidium favosum (Bory) Gomont.:**

T.V.Desikachary, 275, pl. 44, fig. 20, 1959. Thallus dark blue-green, when dried dark steel-blue coloured, generally a little expanded, papery attached to the base; trichomes mostly without sheath in an amorphous mucilage, mucilage not coloured blue with chlor-zinc-iodide; blue-green, elongated, more or less flexuous, not constricted at the cross-walls, (4-) 4.5-9µ broad, ends straight or loosely spirally coiled, gradually attenuated, capitate; cells quadrate up to ½ as long as broad, 3-7µ long, cross-walls granulated, end cell obtuse truncated, calyptra subhemispherical.

**Phormidium uncinatum (Ag.) Gomont.:**

T.V.Desikachary, 276, pl. 43, fig. 1, 1959. Stratum broadly expanded, dark green to brownish black, adherent, thin, firm, or floating attached at the base, thick, torn; filaments straight or slightly bent, sheath mucilaginous, distinct or diffuent in an amorphous mucilage, not coloured blue by chlor-zinc-iodide; trichome blue-green, not constricted at the cross-walls, 6-9µ broad, ends briefly attenuated, capitate, curved or short spirally coiled; cells ½-1/3 as long as broad, rarely sub-quadrate, 2-6µ long, cross-walls frequently granulated; end-cell with a round or depressed conical calyptra.

**Phormidium autumnale (Ag.) Gomont.:**

T.V.Desikachary, 276, pl. 44, fig. 24, 1959. Thallus expanded, dark blue-green or brownish-green, sometimes yellowish or violet, filaments straight, rarely flexuous, variously entangled; sheath firm, mucilaginous, distinct or diffuent in an amorphous mucilaginous matrix, not coloured blue by chlor-zinc-

iodide; trichomes blue-green, not constricted at the cross-walls, 4-7µ broad, ends mostly briefly attenuated, rarely gradually attenuated, straight or scarcely curved, prominently capitate; cells quadrate or ½ as long as broad, 2-5µ long, septa frequently granulated, end cell with a rounded or truncated conical calyptra.

**Lyngbya Ag.:** Trichome single or free in a thin or very massive thick, firm sheath; sheath mostly colourless, seldom coloured yellow to brown or red, blue to purple red; filaments sometimes spirally coiled or attached to the base or in the meddle or the entire filament attached, mostly without such attachment or free-swimming or forming free thallus.

**Key to the species:**

1. Filaments not so attached.....2
2. Filaments attached by the middle with the ends free or by their entire length.....3
2. Filaments not attached by any regular manner, free or epiphytic, or in the mucilage of other algae.....
- 9
3. Filaments not so.....4
4. Trichome narrower.....5
5. Trichome narrower than 5µ.....7
6. Trichome 3-4.5µ broad, marine.....*L. holdenii*
7. Trichome narrower.....8
8. Trichome longer.....9
9. Trichome up to 200µ long, cells ½-⅓ as long as broad.....*L. polysiphoniae*
10. Filaments not spirally coiled.....11
11. Filaments not so.....12
12. Filaments free-floating.....13
12. Filaments among other algae.....16
13. Filaments broader.....14
14. Filaments 20-24µ broad.....*L. birgei*
14. Filaments narrower.....15
15. Filaments 12-14 (-15-20)µ broad.....*L. hieronymusii*
15. Filaments 4-9µ broad.....*L. cryptovaginata*
16. Mature plants with coloured sheaths.....17
16. Mature plants with hyaline sheaths.....26
17. Sheath yellow to brown.....19
17. Sheath red.....18
18. Trichomes 8-12µ broad.....*L. ceylanica*

**Research Paper**

19. broader.....	20	20. Trichomes up to 10µ broad.....	21
21. broader.....	22	22. Cells not longer than broad.....	23
23. Trichomes unstricted.....	24	24. Trichomes 8-24µ broad, often with gas-vacuoles, septa granulated.....	L. aestuarii
24. Trichomes narrower, without gas-vacuoles septa not granulated.....	25	25. Trichomes 12-17µ broad, cells 1/6 as long as broad, cross-walls granulated.....	L. connectens
25. Trichomes 12-14µ broad, cells very short, 3-4µ long, cross-walls not granulated.....	L. truncicola	26. broader.....	28
26. Trichomes 2.8-3.2µ broad, cells 2-6.4µ long, unstricted, septa not granulated.....	L. versicolor	28. In freshwater.....	29
28. Trichomes 3.5-6µ broad.....	30	29. broader.....	31
29. Cells quadratic or longer than broad.....	L. allorgei	30. Cells quadratic or shorter than broad.....	L. aerugineo-coerulea
30. Trichomes narrower.....	32	31. Trichomes broader.....	32
32. Trichomes narrower.....	33	32. Trichomes narrower.....	33
33. Sheath thick, lamellated, trichomes 11-16µ broad.....	L. major		

**Lyngbya holdenii Forti.:** T.V.Desikachary, 286, pl. 49, fig. 6, 1959. Filaments attached to other algae by their middle with ends free, about 8µ broad; sheath thin, delicate; trichome pale green, distinctly constricted at the cross-walls, 3-4.5µ broad; cells subquadrate or up to 1/3 as long as broad (3-13µ long); end cell rounded.

**Lyngbya polysiphoniae Frémy.:** T.V.Desikachary, 287, pl. 53, fig. 5, 1959. Filaments straight or curved, single or in bundle, epiphytic, up to 200µ long; sheath very thin, delicate, papyraceous, colourless, not coloured violet with chlor-zinc-iodide; trichome pale blue-green or violet, constricted at the cross-walls, about 2µ broad, apices not attenuated; cells 1/2-1/3 as long as broad, cross-

walls visible, not granulated; end cells convex, not capitate.

**Lyngbya birgei Smith, G. M.:** T.V.Desikachary, 296, pl. 50, fig. 7, 1959. Filaments straight, seldom coiled, free-floating, 20-24µ broad; sheath firm, colourless, mostly unlamellated, seldom lamellated, 0.5-4µ thick; trichome not constricted at the cross-walls, 18-23µ broad, ends rounded, not attenuated, not capitate; cells shorter than broad, 2-2.5µ long, sometimes with gas-vacuoles.

**Lyngbya hieronymusii Lemm.:** T.V.Desikachary, 297, pl. 48, fig. 4, 1959. Filaments single, free-floating, straight or slightly bent, 12-14 µ broad; sheath firm, homogeneous, colourless, not coloured violet by chlor-zinc-iodide; cells 11-13 µ broad, 2.5-4 µ long, not constricted at the cross-walls, granulated, with gas-vacuoles not attenuated; end cell broadly rounded.

**Lyngbya cryptovaginata Schkorbatow.:** T.V.Desikachary, 297, pl. 50, fig. 6, 1959. Filaments single, free-floating, straight, 4-9µ broad; sheath colourless, delicate, at first often not distinctly visible but later (in cultures) distinct, not coloured blue by chlor-zinc-iodide; trichome slightly constricted at the cross walls, blue-green; cells nearly quadrate, or up to 1/2 as long as broad, with pseudovacuoles; end cells rounded.

**Lyngbya ceylanica Wille.:** T.V.Desikachary, 299, pl. 54, fig. 4, 1959. Thallus olive-green, violet or red; filaments 10-14µ broad, straight; sheath thin, colourless, when older often red, not coloured violet by chlor-zinc-iodide; trichome blue-green or violet, unstricted at the cross-walls, not attenuated at the ends, 8-12µ broad, cross-walls not granulated; cells quadrate to 1/2 or 1/3 as long as broad; end cell round, without calyptra.

**Lyngbya aestuarii Liebm. Ex Gomont.:** T.V.Desikachary, 305, pl. 52, fig. 8, 1959. Filaments single or forming a brown or dull blue-green thallus, sometimes having false branches, nearly straight or coiled, sometimes with calcium incrustations; sheath at first thin, later thick, yellow brown, lamellated, only sometimes brownish on the inside and colourless outside, not coloured violet by chlor-zinc-iodide; cells 8-24µ, ordinarily 10-16µ broad, 1/3-1/6 times as long as broad, 2.7-5.6µ long, not constricted at the cross-walls, cross-walls often granulated, contents sometimes with gas-vacuoles; end cells flat with thickened membrane, slightly attenuated.

**Lyngbya connectens Mont. ex Gomont.:** T.V.Desikachary, 308, pl. 51, fig. 6, 1959. Stratum

**Research Paper**

extensive, about 1 mm thick, when dry shining and dark green; filaments straight or nearly so, lying parallel to each other, the trichome often creeping out of their entire sheath; sheath at first delicate and colourless, but later when old, becomes firm and brownish, 1.5-2µ thick, nearly lamellate with 2-3 lamellae; trichomes 12-17µ broad, not constricted at the cross-walls, slightly thickened at the apex, cells about 1-6µ as long as broad, 2-2.5µ long; dissepiments granulated, contents granular, verdigris-green.

**Lyngbya truncicola Ghose.:** T.V.Desikachary, 308, pl. 51, fig. 4, 1959. Thallus thin, expanded, blue-green; filaments straight, more or less parallel, 14-16µ broad; sheath at first hyaline, and delicate, later firm and yellowish, unlamellated; trichome blue-green, 12-14µ broad, not constricted at the cross-walls, cell-walls not granulated; cells short, 3-4µ long, contents granular; apical cell rotund, not attenuated, calyptra none.

**Lyngbya versicolor (Wartm.) Gom.:** T.V.Desikachary, 311, pl. 53, fig. 6, 1959. Thallus at first adherent, later free-floating, lubricous, somewhat soft, rusty on the outside and inside olive-green; filaments long, tortuous, closely entangled; sheath colourless, somewhat yellowish, slightly mucilaginous, up to 2µ thick, coloured violet by chlor-zinc iodide; trichomes not constricted at the cross-walls, 2.8-3.2µ broad, apices not attenuated, not capitate, cross-walls not granulated; cells blue-green, 2-6.4µ long, end cell rounded, calyptra absent.

**Lyngbya allorgei Frémy.:** T.V.Desikachary, 313, pl. 54, fig. 6, 1959. Filaments solitary or united and caespitose, fasciculate; tortuous, intricate, elongate; sheath very thin, papyraceous, colourless, not coloured violet by chlor-zinc-iodide; trichome pale violet, not constricted at the cross-walls, 3.5-4µ broad, cells nearly quadrate or up to ½ times as long as broad, cross-walls not granulated; end cell round, calyptra absent.

**Lyngbya aeugineo-coerulea (Kütz.) Gom.:** T.V.Desikachary, 315, pl. 48, fig. 9, 1959. Filaments single or more rarely forming a dull blue-green expanded thallus, flexuous, fragile; sheath thin, firm, not lamellated, not coloured violet by chlor-zinc-iodide; trichomes 4-6µ broad, not constricted at the cross-walls, sometimes granulated, apex of trichome occasionally capitate; cells 1-½ as long as broad, 2.3-3µ long, pale blue-green; end cell flattened, conical or rotund, with a slightly thickened outer membrane.

**Lyngbya major Menegh. ex Gomont.:** T.V.Desikachary, 320, pl. 52, fig. 11, 1959. Filaments

long, straight forming dark-green caespitose bundles; sheath thick; colourless, lamellated, not coloured violet by chlor-zinc-iodide; cells 11-16µ broad, ¼-1/8 as long as broad, 2-3.4µ long, dull blue-green, granulated at the septa, slightly or not constricted at the cross-walls; end cell rounded with a slightly thickened membrane.

**Oscillatoria Vaucher.:** Trichome cylindrical, without a sheath or single within a sheath; end sheaths open always. Trichome more or less straight, not regularly spirally coiled. Not in bundles.

**Key to the species:**

1. Cells upto ½ as long as broad.....2
1. Cells longer.....16
2. Trichome distinctly attenuated.....14
2. Trichome otherwise.....3
3. Trichome constricted.....4
3. Trichome unconstricted.....9
4. In freshwater.....5
5. Trichome broader.....6
6. Trichome straight, slightly capitate.....7
6. Trichome spirally coiled, not capitate.....8
7. Trichome constricted, 10-20µ broad.....*O. sancta*
7. Trichome unconstricted, 8-10µ broad.....*O. vizagapatensis*
8. Trichome 13-15µ broad, slightly attenuated.....*O. perornata*
8. Trichome 9-11µ broad, not attenuated.....*O. ornata*
9. Trichome straight.....10
9. Trichome bent or spirally coiled.....12
10. End cell with a thickened outer wall.....*O. limosa*
10. End cell with a thickened outer wall.....11
11. Trichomes 5-6µ broad.....*O. subbrevis*
12. Trichomes broader.....13
13. End cells rounded.....*O. curviceps*
13. End cell slightly capitate.....*O. princeps*
14. Trichomes up to 8µ broad.....16
14. Trichomes broader.....*O. proboscidea*
15. Trichomes 6-8µ broad, capitate.....*O. anguina*
16. Trichomes with a

**Research Paper**

characteristic yellow color.....17 16. Trichome blue-green.....20 17. Trichomes not attenuated.....18 18. Trichomes broader.....19 19. Trichomes with cells 4-8µ long.....*O. chlorina* 20. Apices or portions of trichomes spirally coiled.....21 20. Apices not so coiled, ends only bent or curved.....23 21. Trichome apices not prominent capitate, cells as long as longer than broad, septa granulated.....*O. martini* 21. Trichomes not capited.....22 22. Trichomes 3-6.5µ broad, not constricted at the crosswalls.....*O. terebriformis* 23. Apices distinctly attenuated.....39 23. Apices not distinctly attenuated.....25 24. Cells shorter than long.....25 24. Cells longer than broad.....33 25. Trichomes not constricted.....26 26. Trichomes less broader.....27 27. Trichomes broader than 5µ.....28 28. Trichomes unconstructed.....29 28. Trichomes constricted.....30 29. Without gas vacuoles.....31 30. Trichomes 4-10µ broad, apical cells with a thickened outer membrane.....*O. tenuis* 30. Trichomes 5.2-6µ broad.....*O. raoi* 31. With a thickened outer wall or membrane.....32 32. Cells ½ to as long as broad.....*O. irrigua* 32. Cells shorter.....*O. vizagapatensis* 33. Trichomes not constricted at the cross walls.....34 34. Trichomes broader.....35 35. Trichomes up to 1-2.2µ broad.....36 35. Trichomes broader.....38 36. Cells 2-4 times as long as broad, with two granules one either side of the septa.....*O. quadripunctulata* 36. Cells as long as or somewhat longer than broad...37 37. Septa granulated, 1 or 2 granules.....*O. trichoides* 37. Septa not granulated.....*O. unigranulata* 38. Trichomes 2-3 (-3.5)µ broad, cells 4-8.5µ long, septa granulated.....*O.*

*amphibia* 39. Trichomes constricted at the cross walls.....48 39. Trichomes not constricted at the cross walls.....46 40. End cells capitate.....*O. amoena* 40. End cells not capitate.....41 41. End cells conical, attenuated.....42 42. Cells up to ½ as long as broad.....*O. okeni* 42. Cells longer.....43 43. Cells more or less as long as broad.....44 44. Trichomes broader.....45 45. Trichomes 4-6µ broad.....*O. formosa* 46. End cell capitate.....47 46. End cell not capitate.....49 47. Cells as long as or distinctly shorter than broad...48 47. Cells longer than broad.....*O. splendida* 48. Cells distinctly shorter than broad, 6-8µ broad.....*O. rubescens* 49. Without gas vacuoles.....50 50. Trichomes up to 2.5µ broad.....51 50. Trichome up to 10µ broad.....55 51. Cell up to 2-3 times as long as broad.....52 52. Trichomes up to 2.5µ broad.....53 53. Cross walls granulated.....54 54. With three distinct granules on either sides.....*O. calcuttensis* 55. Apical cell otherwise.....56 56. Cells longer.....57 57. Cells shorter.....*O. acuta*

***Oscillatoria sancta* (Kütz) Gomont:** T.V.Desikachary, 203, pl. 42, fig. 10, 1959. Thallus dark blue, shining, thin, gelatinous; trichomes straight or bent, distinctly constricted at the cross-walls; ends briefly attenuated, 10-20µ broad, dull blue-green or olive-green; cells 1/3-1/6 times as long as broad, 2.5-6µ long, granulated at the cross-walls. End-cell flattened, hemispherical, slightly capitate, with a thickened membrane.

***Oscillatoria vizagapatensis* Rao, C. B.:** T.V.Desikachary, 205, pl. 39, fig. 18, 1959. Thallus blue-green; trichomes straight, or bent, pale blue-green, uniformly broad except at the extreme apex, 8-10µ broad, without constriction at the cross-walls; cells much shorter than broad, 1.6-2µ long, contents granular;



**Research Paper**

end cell broadly rounded forming a cap with a slightly thickened outer wall.

***Oscillatoria martini* Frémy.:** T.V.Desikachary, 216, pl. 38, fig. 6, 1959. Trichome single amidst other algae, sparse, loosely and irregularly spirally coiled throughout its length, uncontracted at the cross-walls, 6 $\mu$  broad, at the ends short and clearly attenuated, ends straight, capitate; cells 1/3 as long as broad, 2-3 (-6) $\mu$  long, not granulated at the cross-walls; end cells with flat convex distinctly thick and broad outer membrane.

***Oscillatoria perornata* Skuja.:** T.V.Desikachary, 205, pl. 41, fig. 8, 1959. Trichomes erect and flexuous, apices briefly attenuated and bent or curved, well constricted at the cross-walls, 13-15 $\mu$  broad, single or aggregated in floccose masses; cells commonly 1/2-1/5 as long as broad, 2.5-6.5 $\mu$  long, contents pallide tenerumgue aeruginus, finely granular, septa more or less granulated, end cell humilis depressed hemispherical, calyptra absent.

***Oscillatoria ornata* Kütz. ex Gomont.:** T.V.Desikachary, 206, pl. 37, fig. 12, 1959. Thallus dark blue-green; trichome spirally coiled at the ends, constricted at the cross-walls, 9-11 $\mu$  broad, dull blue-green, cells 1/2-1/6 as long as broad, 2-5 $\mu$  long, cross-walls granulated; apices slightly attenuated; end-cells rounded, not capitate, without thickened membrane.

***Oscillatoria limosa* Ag. ex Gomont.:** T.V.Desikachary, 206, pl. 42, fig. 11, 1959. Thallus dark blue-green to brown; trichome more or less straight, dull blue-green, brown or olive-green, not constricted at the cross-walls, or only slightly constricted, 11-20 (-22)  $\mu$ , commonly 13-16  $\mu$  broad; cells 1/3-1/6 as long as broad, 2-5  $\mu$  long, cross-walls frequently granulated; end-cell flatly rounded with slightly thickened membrane.

***Oscillatoria subbrevis* Schmidle:** T.V.Desikachary, 207, pl. 37, fig. 2, 1959. Trichomes single, 5-6 $\mu$  broad, nearly straight, not attenuated at the apices; cells 1-2 $\mu$  long, not granulated at the cross-walls; end-cell rounded, calyptra absent.

***Oscillatoria curviceps* Ag. ex Gomont.:** T.V.Desikachary, 209, pl. 38, fig. 2, 1959. Thallus light or dark blue-green; trichomes more or less straight, bent at the end or spirally coiled, not attenuated or very little attenuated, not constricted at the cross-walls, 10-17 $\mu$  broad, cells 1/3-1/6 as long as broad, 2-5 $\mu$  long, cross-walls sometimes granulated; end-cells flat rounded, not capitate.

***Oscillatoria princeps* Vaucher ex Gomont.:** T.V.Desikachary, 210, pl. 37, fig. 1, 1959. Trichomes blue-green, more or less brownish, violet or reddish, mostly forming a thallus, mostly straight, not constricted at the cross-walls, 16-60 $\mu$  broad, commonly 25-50 $\mu$ , blue-green to dirty green, slightly or briefly attenuated at the apices and bent; cells 1/11-1/14 as long as broad, 3.5-7 $\mu$  long; end-cells flatly rounded, slightly capitate without or with slightly thickened membrane.

***Oscillatoria proboscidea* Gomont.:** T.V.Desikachary, 211, pl. 38, fig. 9, 1959. Thallus dull green to dark blue-green; trichome more or less straight, not constricted at the cross-walls, 12-15 $\mu$  broad, at the ends distinctly attenuated, slightly curved or sometimes spirally coiled, brightly blue-green; cells 1/3-1/6 times as long as broad, 2-4 $\mu$  long, not granulated at the cross-walls; end-cells flatly rounded, capitate, with slightly thickened membrane.

***Oscillatoria anguina* (Bory) Gomont.:** T.V.Desikachary, 210, pl. 38, fig. 11, 1959. Thallus dark blue-green; trichome straight, at the ends spirally coiled and distinctly attenuated, not constricted at the cross-walls, 6-8 $\mu$  broad, cross-walls sometimes granulated; cells 1/3-1/6 as long as broad, 1.5-2.5 $\mu$  long; end-cells capitate, with a slightly thickened membrane.

***Oscillatoria chlorina* Kütz. ex Gomont.:** T.V.Desikachary, 215, pl. 40, fig. 4, 1959. Thallus very thin, yellowish green; trichome straight or curved, uncontracted or slightly constricted at the cross-walls; 3.4-4 $\mu$  broad, sometimes up to 6 $\mu$  broad, gas-vacuoles absent; cells somewhat longer or shorter than broad, 3.7-8 $\mu$  long, cross-walls not granulated; calyptra absent.

***Oscillatoria terebriformis* Ag. ex Gomont.:** T.V.Desikachary, 217, pl. 38, fig. 16, 1959. Thallus dull blue; trichomes end bent in a screw-like manner and slightly attenuated, uncontracted at the cross-walls 4-6.5 $\mu$  broad, 2.5-6 $\mu$  long; end cell rounded, not capitate, calyptra absent.

***Oscillatoria tenuis* Ag. ex Gomont.:** T.V.Desikachary, 222, pl. 42, fig. 15, 1959. Thallus thin bluegreen or olive-green, slimy; trichome straight, fragile slightly constricted at the cross-walls, 4-10 $\mu$  broad, blue-green, sometimes bent at the ends, not attenuated at the apices, not capitate; cells up to 1/3 as long as broad, 2.6-5 $\mu$  long, at the septa mostly granulated; end cell more or less hemispherical with thickened outer membrane.

***Oscillatoria raoi* De Toni, J.:** T.V.Desikachary, 223, pl. 42, fig. 17, 1959. Plant mass thin, membranous, firm, pale blue-green to pale bluish violet; trichome straight,

**Research Paper**

usually of uniform thickness, and only rarely slightly tapering at the ends, without constrictions at the joints, 5.2-6 $\mu$  broad, septa indistinct, but with distinct granules closely arranged on either side; cells 2.5-6 $\mu$  (average 5 $\mu$ ) long, with homogeneous contents, end cells rounded rarely conical, sometimes with constriction at the septum, not capitate, without any calyptra.

***Oscillatoria irrigua* (Kütz.) Gomont.:** T.V.Desikachary, 224, pl. 42, fig. 7, 1959. Thallus blackish blue-green, trichome light bluish purple, when dried hyaline or pale blue, straight, flexuous, not torulose, 6-11 $\mu$  broad, apex, slightly attenuated, subcapitate, straight; cells quadrate to  $\frac{1}{2}$  as long as broad, 4-11 $\mu$  long, contents in dried specimen, pellucid, granular; septa ordinarily not granulated; apical cell convex, with an evident thickened outer wall

***Oscillatoria quadripunctulata* Bruhl et Biswas.:** T.V.Desikachary, 227, pl. 37, fig. 5, 1959. Trichomes curved or nearly straight, closely associated into a delicate very pale greenish blue membrane, 1-1.5 $\mu$  in diam., cells 3.5-5 $\mu$  long, 2-4 times as long as wide, not constricted at the joints, contents minutely granular, transverse walls rather obscure marked by a pair of somewhat larger granules on either side.

***Oscillatoria trichoides* Szafer.:** T.V.Desikachary, 228, pl. 41, fig. 13, 1959. Trichome straight, not constricted at the cross-walls, 1-1.5 $\mu$  broad, yellow-green, cells up to 5 $\mu$  long with 1-2 small granules.

***Oscillatoria unigranulata* Biswas.:** T.V.Desikachary, 229, pl. 41, fig. 17, 1959. Trichomes 2-3 $\mu$  diam., tenuous, straight or somewhat curved, not constricted at the cross-walls, not attenuated at the apices, obtusely rounded or truncate, not capitate; calyptra none; cells 2.5-4 $\mu$  in length; cell-wall thick, distinct with one large granule situated at the centre of the partition walls on either side; cell contents finely uniformly granular, blue-green.

***Oscillatoria amphibia* Ag. ex Gomont.:** T.V.Desikachary, 229, pl. 37, fig. 6, 1959. Thallus deep blue-green; trichome straight or coiled, apices not attenuated, not capitate, not constricted at the cross-walls, 2-3 (3.5) $\mu$  broad, pale blue-green; cells 2-3 times longer than broad, 4-8.5 $\mu$  long, with two granules at the septa, end cell not capitate, rounded, calyptra absent.

***Oscillatoria amoena* (Kütz.) Gomont.:** T.V.Desikachary, 230, pl. 40, fig. 12, 1959. Thallus more or less blue-green; trichomes straight, slightly constricted at the cross-walls, ends gradually attenuated, 2.5-5 $\mu$  broad, dull blue-green; cells nearly as long as

broad, 2.5-4.2 $\mu$  long, septa granulated, end cells capitate, broadly conical with calyptra.

***Oscillatoria okeni* Ag. ex Gomont.:** T.V.Desikachary, 231, pl. 38, fig. 17, 1959. Thallus dull blue-green; trichome straight, fragile distinctly constricted at the cross-walls, 5.5-9 $\mu$  broad, at the ends gradually attenuated, undulating, slightly bent; cells  $\frac{1}{3}$  as long as broad, 2.7-4.5 $\mu$  long, at the ends up to 8 $\mu$  long; end cells obtuse or subconical not capitate, without calyptra.

***Oscillatoria formosa* f. *loktakensis* Biswas.:** T.V.Desikachary, 233, pl. 39, fig. 4, 1959. Thallus dull-green to very; trichome straight or bent, distinctly constricted at the cross-walls gradually attenuated at the apices, straight or bent like a sickle, 2.6 $\mu$  broad, pale blue-green; cells nearly barrel-shaped as long as broad or somewhat longer seldom somewhat shorter than broad, 1.5-4 $\mu$  long, granulated at the cross-walls; end cell conical.

***Oscillatoria splendida* Grev. ex Gomont.:** T.V.Desikachary, 234, pl. 37, fig. 8, 1959. Thallus brilliant blue-green or olive-green; trichome straight or curved, not constricted at the cross-walls, at the ends gradually attenuated, 2-3 $\mu$  broad; cells 2-4 times longer than broad rarely quadrate, 3-9 $\mu$  long, septa often granulated: ends more or less bent, sometimes screw-like or a sickle; end cells capitate, nearly rounded, mostly without calyptra.

***Oscillatoria rubescens* DC ex Gomont.:** T.V.Desikachary, 235, pl. 42, fig. 12, 1959. Trichome straight, at the ends gradually attenuated, 6-7 $\mu$  broad, not constricted at the cross-walls, sometimes forming a purple red, or violet, free-swimming bundles; cells  $\frac{1}{2}$ - $\frac{1}{2}$  as long as broad, 2-4 $\mu$  long, often granulated at the septa, with gas-vacuoles; end cell capitate, with convex calyptra.

***Oscillatoria calcuttensis* Biswas.:** T.V.Desikachary, 237, pl. 42, fig. 21, 1959. Thallus leathery brown; trichomes parallel straight, not constricted at the cross-walls, 2 $\mu$  broad, at the ends briefly attenuated, curved or bent; cells 2-5 times as long as broad, 6-10 $\mu$  long, cross-walls with 3 granules, blue-green, end cell conical, pointed, not capitate.

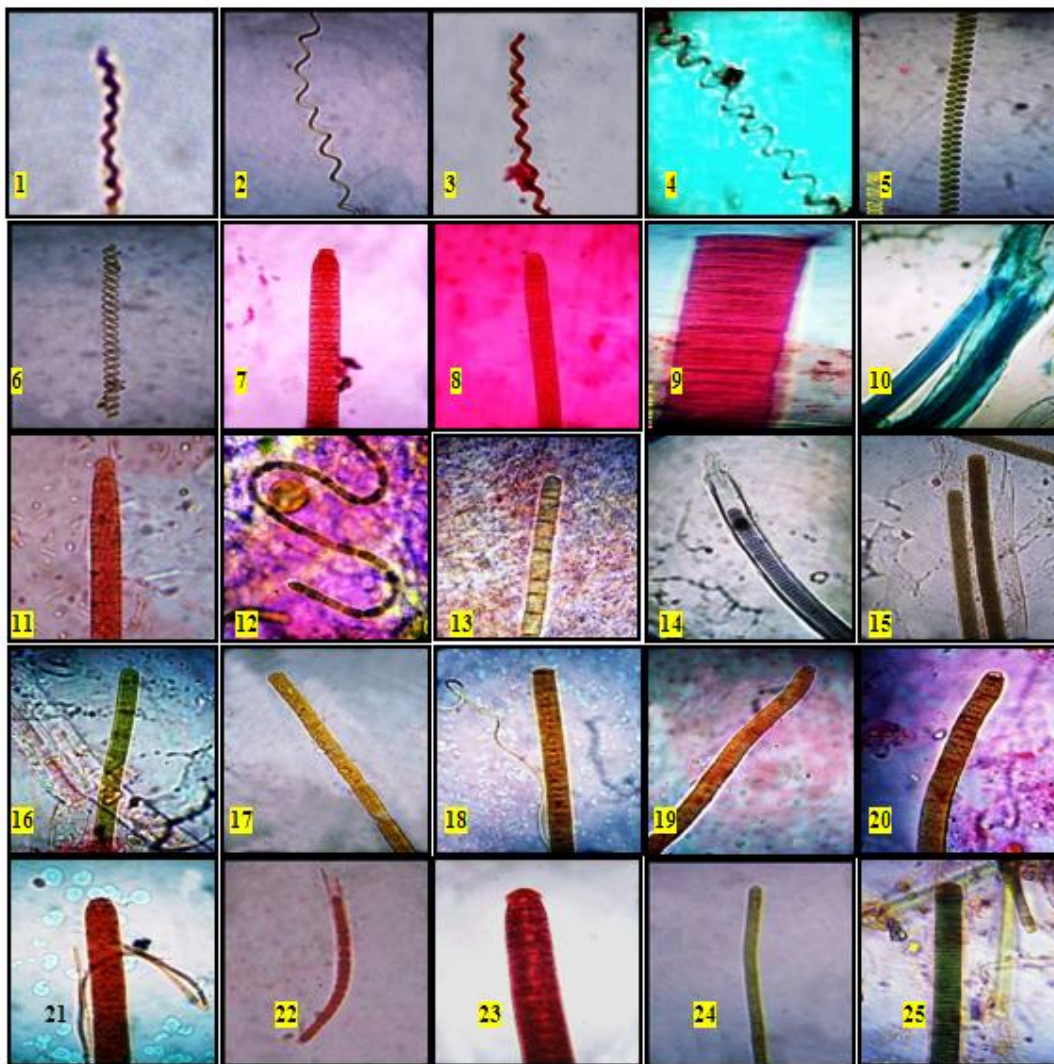
***Oscillatoria acuta* Bruhl et Biswas, orth. mut. Geitler.:** T.V.Desikachary, 240, pl. 39, fig. 5, 1959. Trichomes either solitary or a number of them parallel to each other aggregated into bundles of moderate size, hardy, brittle, not constricted at the cross-walls, 4-6 $\mu$  thick, 70-400 $\mu$  long, usually quite straight, narrow or

**Research Paper**

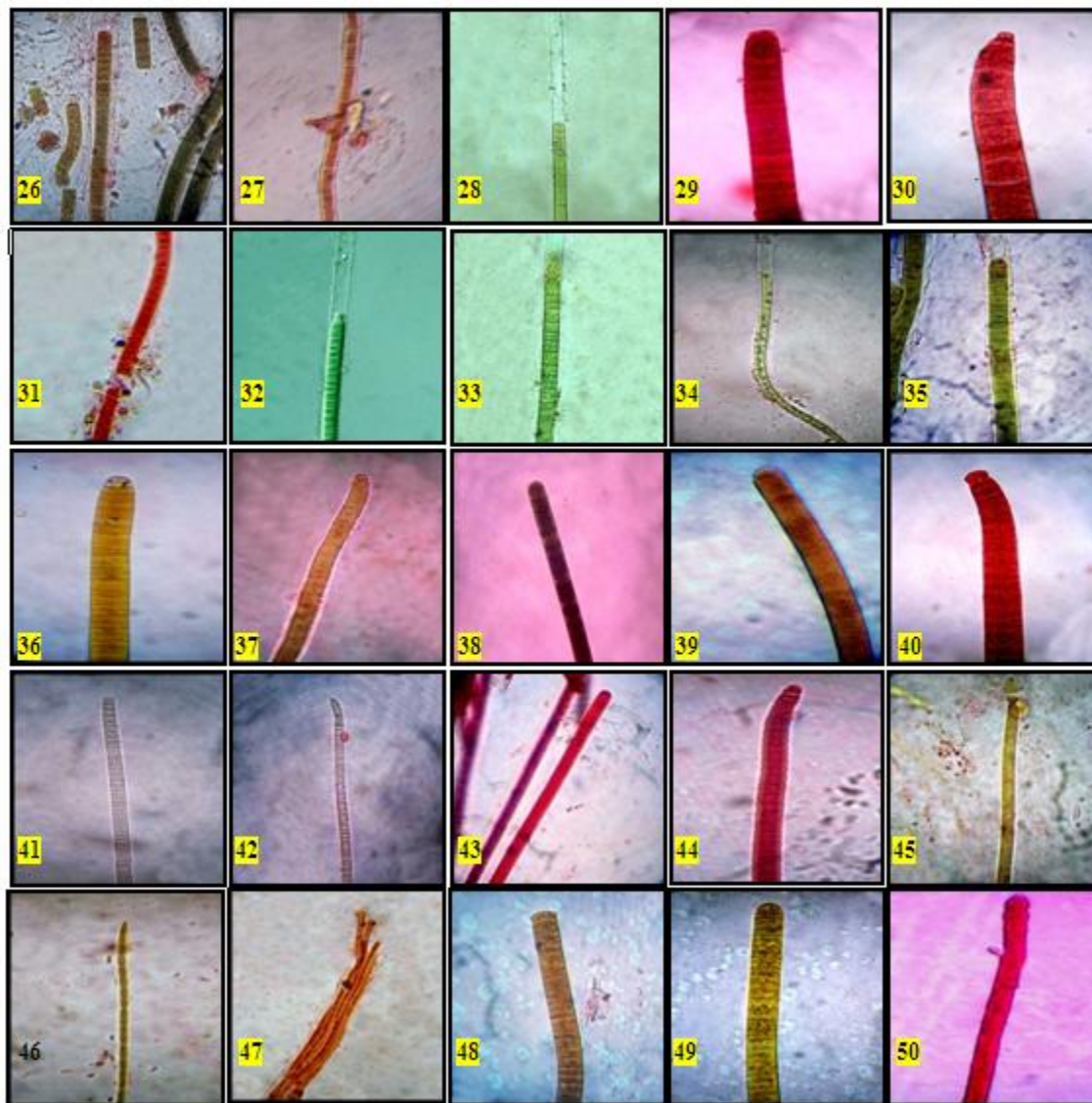
accuminate towards the subobtues, non-capitate, non-calystrate apex, which may be straight but is more often rather abruptly bent; cells 3-4 $\mu$  long contents bluish green, finely granular, sometimes with some larger granules close to the surface.

filaments at first prostrate, later mostly forming erect bundles, partly false branched; sheath firm or later gelatinising; trichome straight, sometimes slightly attenuated; end cell not capitate, sometimes with a thickened outer membrane.

**Symploca Kützing:** Trichome single in a thin sheath;



**Plate A (Figs. 1-25):** 1. *Spirulina meneghiniana* Zanard. Ex Gomont, 2. *Spirulina laxissima* forma major f. n., 3. *Spirulina princeps* West & West, 4. *Spirulina subtilissima* Kütz., 5. *Spirulina gigantea* Schmidle., 6. *Spirulina major* Kütz., 7. *Oscillatoria martini* Frémy., 8. *Katagnymene pelagic* Lemm., 9. *Porphyrosiphon notarissii* (Menegh.) Kütz. ex Gomont., 10. *Polychlamydom insigne* West ex West., 11. *Phormidium microtomum* Skuja., 12. *Phormidium tenue* (Menegh.) Gomont., 13. *Phormidium purpurascens* (Kütz.) Gomont., 14. *Phormidium stagnina* Rao, C. B., 15. *Phormidium anomala* Rao, C. B., 16. *Phormidium ambiguum* Gomont., 17. *Phormidium retzii* (Ag.) Gomont., 18. *Phormidium capitatum* nom. nov., 19. *Phormidium favosum* (Bory) Gomont., 20. *Phormidium uncinatum* (Ag.) Gomont., 21. *Phormidium autumnale* (Ag.) Gomont., 22. *Lyngbya holdenii* Forti., 23. *Phormidium subfuscum* Kütz. ex Gomont., 24. *Lyngbya polysiphoniae* Frémy., 25. *Lyngbya birgei* Smith, G. M.



**Plate B (Figs. 26-50):** 26. *Lyngbya hieronymusii* Lemm., 27. *Lyngbya cryptovaginata* Schkorbatow., 28. *Lyngbya ceylanica* Wille., 29. *Lyngbya aestuarii* Liebm. Ex Gomont., 30. *Lyngbya connectens* Mont. ex Gomont., 31. *Lyngbya truncicola* Ghose., 32. *Lyngbya versicolor* (Wartm.) Gom., 33. *Lyngbya allorgei* Frémy., 34. *Lyngbya aeugineo-coerulea* (Kütz.) Gom., 35. *Lyngbya major* Menegh. ex Gomont., 36. *Oscillatoria vizagapatensis* Rao, C. B., 37. *Oscillatoria rubescens* DC ex Gomont., 38. *Oscillatoria limosa* Ag. ex Gomont., 39. *Oscillatoria curviceps* Ag. ex Gomont., 40. *Oscillatoria princeps* Vaucher ex Gomont., 41. *Oscillatoria tenuis* Ag. ex Gomont., 42. *Oscillatoria terebriformis* Ag. ex Gomont., 43. *Oscillatoria raoi* De Toni, J., 44. *Oscillatoria sancta* (Kütz) Gomont., 45. *Oscillatoria amoena* (Kütz.) Gomont., 46. *Microcoleus lacustris* Rabenh., 47. *Symploca hydroides* Kütz., 48. *Hydrocoleum heterotrichum* Kütz. em. Gomont., 49. *Oscillatoria subbrevis* Schmidle., 50. *Oscillatoria perornata* Skuja.

**Research Paper**

**Key to the species:**

1. Plants  
halophilous.....2 2.  
Trichomes 6-8 $\mu$  broad.....*S. hydroides*

***Symploca hydroides* Kützing ex Gomont:** T.V. Desikachary, 335, pl. 60, fig. 6, 1959. Thallus bundles or tufts; dirty to dark violet, bundles up to 3 cm long, erect, pointed at the base; filaments very densely aggregated, slightly united, partly branched irregularly bent; sheath thin, coloured indistinctly violet by chlor-zinc-iodide; trichome blue-green, 6-11 $\mu$  broad, often constricted at the cross-walls in the apical portion; cells as long as or twice as broad, 5-14 $\mu$  long; end cell slightly swollen, without calyptra.

***Microcoleus Desmazieres:*** Filaments unbranched or sparsely branched; sheath mostly colourless, more or less regularly cylindrical, not lamellated, sometimes when old, gelatinizing; trichomes very many in each sheath, densely aggregated, often coiled or contorted like a rope; ends straight, mostly attenuated; end cell more or less conical seldom capitate.

**Key to the species:**

1. In fresh water.....2  
2. In freshwater, trichomes not capitate, without calyptra.....  
3 3. Trichomes broader.....4 4.  
Trichomes constricted.....5  
5. Trichomes 6-10 $\mu$  broad, not coloured blue by chlor-zinc-iodide.....*M. lacustris*

***Microcoleus lacustris* (Rabenh.) Farlow.:** T.V. Desikachary, 345, pl. 60, fig. 4, 1959. Thallus blackish blue-green, filaments contorted, seldom branched; sheath colourless, slimy, not coloured violet by chlor-zinc-iodide, sometimes gelatinising, many trichomes in each; trichomes distinctly constricted at the cross walls, 4-5 $\mu$  broad; cells cylindrical, 1-3 times as long as broad, 6-12 $\mu$  long, bright blue-green; end cells more or less rounded, conical, not capitate.

***Hydrocoleum* Kütz. :** Few trichomes in gelatinous, mostly colourless sheath, sheath in older ones diffluent; filaments more or less branched, forming a tuft or membranaceous thallus; ends of trichome straight, more or less attenuated and capitate; end cells often with calyptra.

**Key to the species:**

1. Freshwater.....  
2 2. Trichome 16-19 $\mu$  broad.....*H. heterotrichum*

***Hydrocoleum heterotrichum* Kütz. em Gomont.:** T.V. Desikachary, 348, pl. 46, fig. 3, 1959. Filaments blackish, up to 5mm high, arranged in tufts, with repeated erect false branches, sometimes with calcium in crustation; sheath somewhat slimy, uneven, often transversely plicate, at the ends pointed; trichomes mostly straight or somewhat spirally contorted, not constricted at the cross-walls, 16-19 $\mu$  broad; cells 1/3-1/5 times as long as broad, 3.4-4.5 $\mu$  long, brownish-green; end cells capitate, round truncated.

**DISCUSSION**

From the total sixty five (65) species of phytoplanktonic blue green algae identified belonged to order *Nostocales*, family *Oscillatoriaceae* among the identified ten genera *Katagnymene* 1.54%, *Porphyrosiphon* 1.54%, *Polychlamydom* 1.54%, *Symploca* 1.54%, *Microcoleus* 1.54%, *Hydrocoleum* 1.54%, were represented by single species, *Spirulina* 9.23% by six, *Phormidium* 20% and *Lyngbya* 20% by thirteen and *Oscillatoria* 41.53% exhibited the largest diversity with twenty seven species. The temperature is considered to an important factor in the periodicity of *Oscillatoriaceae*. *Oscillatoriaceae* were found to be abundant during the last part of summer and winter. In aquatic habitat of the study area *Oscillatoria princeps*, one of the most dominant specie was found throughout the study period. The enumerated bluegreen algal species are showing plate no. A & B.

**ACKNOWLEDGEMENT**

Authors are thankful to Prof. Dr. S. P. Borah and Dr. B. Tanty, Deptt. of Botany, Gauhati University and S. P. Deka, Department of Geography, Goalpara College for the guidance provided while writing this manuscript.

**REFERENCES**

- Anand N (1998).** Indian Freshwater Microalgae. Bishen Singh Mahendra Pal Singh, Dehradun, India. 94.  
**Bhuiyan J R and Gupta S (2007).** A comparative hydrobiological study of a few ponds of Barak Valley, Assam and their role as sustainable water resources. *Journal of Environmental Biology* **28** 799-802.

**Research Paper**

- Desai P V, S. J. Godsae and S. G. Halker (1995).** Physicochemical characteristics of Khanderpur river Goa, India. *Pollution Research* **14** 447-454.
- Desikachary T V (1959).** Cyanophyta. Indian Council of Agricultural Research, New Delhi. 686.
- Desikachary T V (1987).** Atlas of diatoms. Monographs fascicle II, III and IV. Madras Science Foundation, Madras. 80.
- Ghose S L (1927b).** The Myxophyceae of Rangoon, III. *Ibid.*, **17** (3) 237-243.
- Kaushik B D (1987).** Laboratory methods of blue-green algae. Publ. Associated Publishing Company, New Delhi, 1<sup>st</sup> Edition. 28.
- Kemdirim E C (2001).** Checklist of phytoplankton of shedam reservoir in Plateau State, Nigeria. *Journal of Aquatic Sciences* **16** 61-63.
- Laskar H S and Gupta S (2009).** Phytoplankton diversity and dynamics of chatla floodplain lake, Barak Valley, Assam, North East India- A seasonal study. *Journal of Environmental Biology* **30** (6) 1007-1012.
- Prescott G W (1964).** *The Freshwater Algae*, W.M.C. Brown Comp. Pub. 135, South Locust Street. Dubuque, Iowa. 52003-272.
- Rai A N, Soderback E and Bergman B (2000).** Tansley Review: cyanobacterium-plant symbioses. *New Phytologist* **147** 449-81.
- Sant' Anna C L, de Paiva Azevedo M T, Branco L H Z and Komarek J (2007).** New aerophytic morphospecies of *Nostoc* (Cyanobacteria) from Sao Paulo State, Brazil. *Hoehnea* **34** (1) 95-101.
- Saravanakumar A, Rajkumar M, Thivakaran GA and Serebiah JS (2008).** Abundance and seasonal variations of phytoplankton in the creek waters of western mangrove of Kachchh-Gujarat. *Journal of Environmental Biology* **29** 271-274.
- Senthilkumar R and Sivakumar K (2008).** Studies on phytoplankton diversity in response to abiotic factors in Veeranam lake in the Cuddalore district of Tamil Nadu. *Journal of Environmental Biology* **29** 747-752.
- Shekhar TRS, Kiran BR and Puttiah ET (2008).** Phytoplankton as index of water quality with reference to industrial pollution. *Journal of Environmental Biology* **29** 233-236.
- Sing PK (1985).** Nitrogen fixation by the Blue-green algae in paddy fields. In Rice Research in India, ICAR, New Delhi. 344-362.
- Sridhar R, Thangaradjou T, Senthil Kumar S and Kannan L (2006).** Water quality and phytoplankton characteristics in the Palk Bay, southeast coast of India. *Journal of Environmental Biology* **27** 561-566.
- Talukdar R (1997).** Ph.D. Thesis, G.U., Taxo and Eco. Sur. Of BGA of Kamrup District, Assam.
- Tas B and Gonulol A (2007).** An ecologic and taxonomic study on phytoplankton of a shallow lake, Turkey. *Journal of Environmental Biology* **28** 439-445.
- Tiwari A and Chauhan SVS (2006).** Seasonal phytoplankton diversity of Kitham lake, Agra. *Journal of Environmental Biology* **27** 35-38.