

Algal diversity in foot hills of Eastern Himalayas-II (Cyanoprokaryota: Oscillatoriales)

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ABSTRACT

Eastern Himalayas have been declared as a biodiversity hotspot by Conservation International. Koch Bihar is one such district of West Bengal which situated at the foot hills of eastern Himalayas at 26°22' N 89°29'E. This area is also rich in different types of Flora and Funna not explored properly. Algal flora of this area is more or less untouched. So it's time to explore this area. On the basis of algal flora exploration work authors encountered 24 taxa of Oscillatoriales under Cyanoprokaryotes represented in this paper. These are *Geitlerinema* (Anagnostidis et Komárek) Anagnostidis (2), *Glaucospira* Lagerheim (1), *Hormoscilla* Anagnostidis et Komárek (1), *Komvophoron* Anagnostidis et Komárek (1), *Leibleinia* (Gomont) L. Hoffmann (1), *Leptolyngbya* Anagnostidis et Komárek (1), *Lyngbya* C. Agardh ex Gomont (2), *Oscillatoria* Vaucher ex Gomont (9), *Phormidium* Kützing ex Gomont (3), *Planktothrix* Anagnostidis et Komárek (2) and *Spirulina* Turpin (1). *Geitlerinema sandbergii* (Skuja) Anagnostidis, *Hormoscilla feldmannii* Anagnostidis, *Oscillatoria leonardii* Compère, *Phormidium cf. variabile* (Wille) Anagnostidis et Komárek are new report from India; *Komvophoron schmidlei* (Jaag) Anagnostidis et Komárek, *Oscillatoria jenensis* Schmid are new report from Eastern India and *Oscillatoria pseudoanguina* Keshri et Das sp. nov. is introduced as new to science. One new combination *Glaucospira laxissima* (G. S. West) Keshri et Das has been proposed.

Key Words: Eastern Himalaya, Cyanoprokaryotes, Oscillatoriales, new species, new combination.

INTRODUCTION:

Cyanoprokaryotes are one of the most primitive groups of organisms. Komárek and Anagnostidis (2005) on the basis of morphological characters recognized Oscillatoriales as a new order. The members of this order are filamentous lacking heterocyst. This order is one of the most important orders among the other members of Cyanoprokaryotes. Many workers have done excellent floristic works throughout the world in this group.

Works have been done on the algal flora including BGA of West Bengal from nineteenth century onwards. While considering Oscillatoriales, however work is insignificant. Biswas (1925a, 1925b, 1926) described two new taxa of *Oscillatoria* (*O. calcuttensis* Biswas & *O. salina* Biswas), one of *Cylindrospermum* (*C. bengalense* Biswas) along with other blue-greens and greens from different parts of Calcutta. Apart from describing a new variety: *Lyngbya ceylanica* Wille var. *bankurensis*, Bengal Sinha J. P. and Mukherjee D. (1975a, 1975b, 1984a, b) made new records of 19 taxa for India and 72 for the state from paddy-fields of Bankura district of West Bengal. Sen and Gupta (1987) enlisted 16 species of *Oscillatoria* from Greater Calcutta. Rare cyanobacterial genus *Borzia* Cohn ex Gomont was investigated by Chatterjee and Keshri (2005). In this paper two rare species of *Borzia* viz. *B. trilocularis* Cohn ex Gomont, *B. susedana* Ercegovic were recorded and a new species *B. indica* Chatterjee and Keshri was introduced. Two cyanoprokaryotes viz. *O. obscura* Brühl et Biswas and *Nostoc punctiforme* (Kützing) Hariot ex Bornet et Flahault were recorded growing endophytic within a semiaquatic angiosperm *Alternanthera sessilis* R. Br. by Keshri and Chatterjee (2010). Sikdar and Keshri (2014) investigated *Oscillatoria* Vaucher from Hoogly District of West Bengal and total reported 16 taxa, out of 16 taxa 1 is new report to Indian flora.

MATERIAL AND METHODS:

Samples were collected from all the blocks of Koch Bihar District throughout the year (Map-1). Main target for sampling were rice fields, damp soil, sewage, ditches and ponds. Samples were preserved in FAA/5 % formalin. Ecological notes like pH, Temperature, habitat, habit were also recorded at the time of collection. In the laboratory slides have been prepared using GWF as mountant (Bando 1988). Camera Lucida drawings were made for each taxa. Simultaneously photomicrographs were also taken from permanent slides using Carl Zeiss Axiostar Plus microscope with Nikon SLR model (D60) camera. All the samples have been kept in the Algal Herbarium of the department of Botany, The University of Burdwan (BURD).

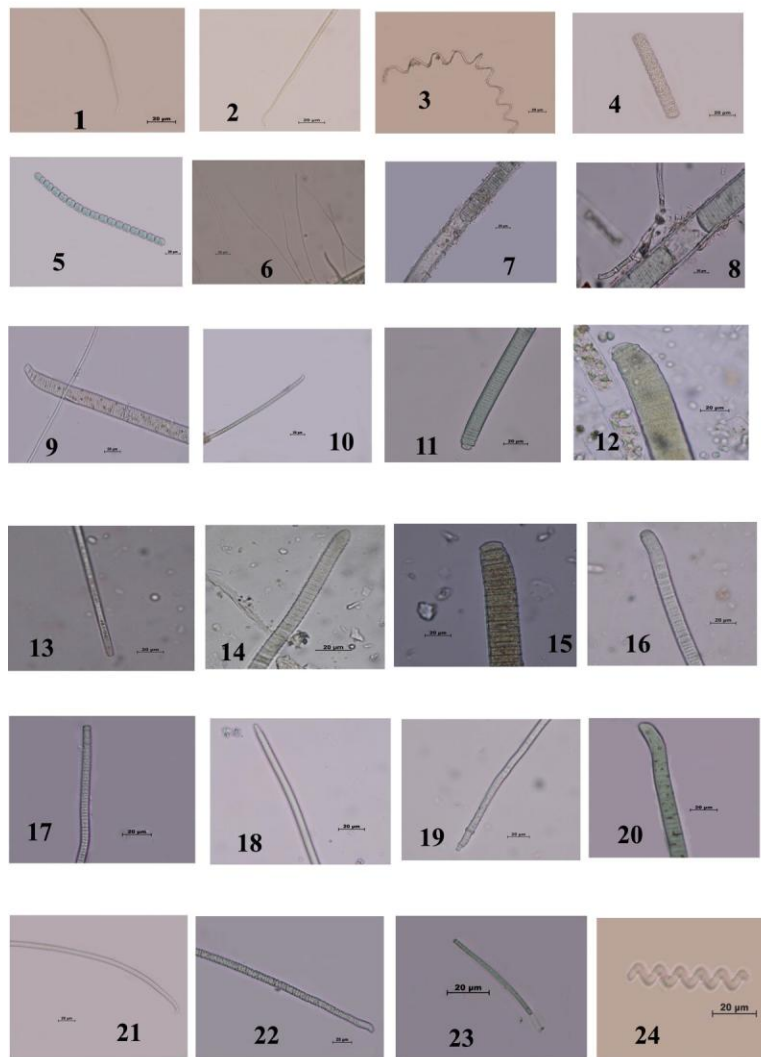


PLATE-1

1. *Geitlerinema acutissimum* (Kufferath) Anagnostidis. 2. *Geitlerinema sandbergii* (Skuja) Anagnostidis
3. *Glaucospira laxissima* (G. S. West) Keshri & Das Comb. nov. 4. *Hormoscilla feldmannii* Anagnostidis
5. *Komvophoron schmidlei* (Jaag) Anagnostidies et Komárek 6. *Leiblieinia epiphytica* (Hieronymus) Compère
7. *Lyngbya major* Meneghii ex Gomont 8. *Lyngbya majuscula* Harvey ex Gomont 9. *Oscillatoria pseudoanguina* Keshri & Das sp. nov.
10. *Oscillatoria jenensis* Schmid 11. *Oscillatoria limosa* Agardh ex Gomont 12. *Oscillatoria leonardii* Compère 13. *Oscillatoria nitida* Škorbatov
14. *Oscillatoria perornata* Skuja 15. *Oscillatoria princeps* Vaucher ex Gomont 16. *Oscillatoria sancta* Kützing ex Gomont
17. *Oscillatoria* cf. *proboscidea* Gomont 18. *Phormidium breve* (Kützing ex Gomont) Anagnostidis et Komárek 19. *Phormidium* cf. *variable* (Wille) Anagnostidis et Komárek
20. *Phormidium chalybeum* (Mertens ex Gomont) Anagnostidis et Komárek 21. *Planktothrix agardhii* (Gomont) Anagnostidis et Komárek
22. *Planktothrix isothrix* (Skuja) Komárek et Komárková 23. *Leptolyngbya subtilis* (W. West) Anagnostidis 24. *Spirulina meneghiniana* Zanardini ex Gomont

2. *Geitlerinema sandbergii* (Skuja) Anagnostidis

[Komárek and Anagnostidis 2005, p. 131, f. 142]

(Pl. 1, Fig. 2; Pl. 2, Fig. 2)

Apical portion of trichome hook like, swollen and gradually attenuated with capitate end; cross wall minutely constricted; small fine granules are observed throughout the cell.

Length of the cell: 2.93 μm – 7.82 μm ; Breadth of the cell: 5.86 μm .

Collection No. & Ecological notes: MD- 098, 01. 07. 2012, Dewanhat, Koch Bihar; found in a small water body, full with monsoon water (pH- 5.5, Temp. 28 $^{\circ}\text{C}$).

Distribution in India: This is probably the first report of the taxon from India.

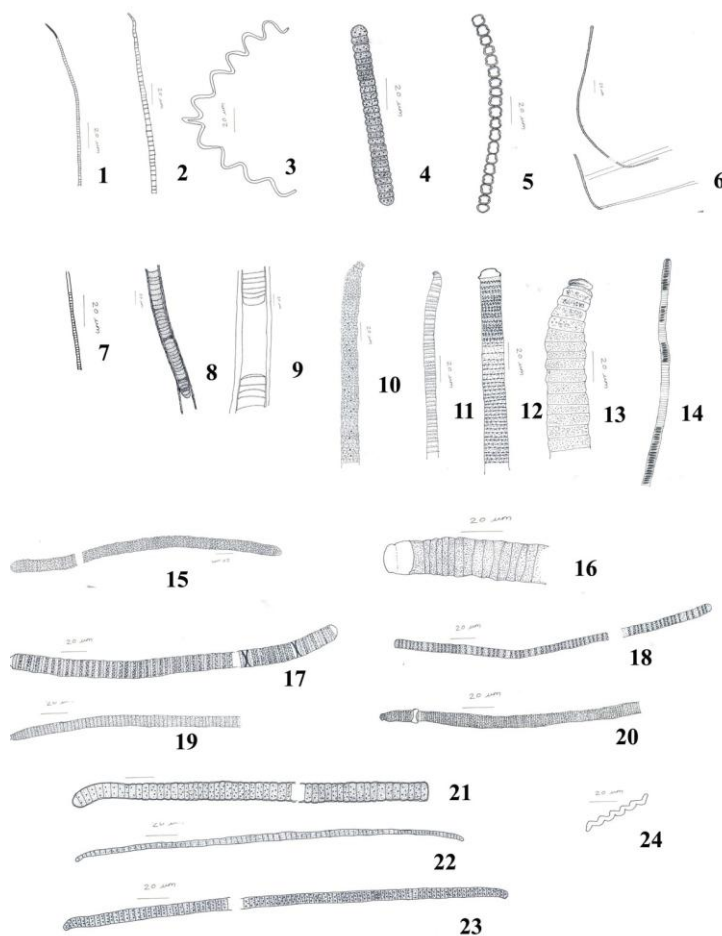


PLATE-2

1. *Geitlerinema acutissimum* (Kufferath) Anagnostidis 2. *Geitlerinema sandbergii* (Skuja) Anagnostidis 3. *Glaucospira laxissima* (G. S. West) Keshri & Das Comb. nov. 4. *Hormoscilla feldmannii* Anagnostidis 5. *Komvophoron schmidlei* (Jaag) Anagnostidis et Komárek 6. *Leibleinia epiphytica* (Hieronymus) Compère 7. *Leptolyngbya subtilis* (W. West) Anagnostidis 8. *Lyngbya major* Meneghii ex Gomont 9. *Lyngbya majuscula* Harvey ex Gomont 10. *Oscillatoria pseudoanguina* Keshri & Das sp. nov. 11. *Oscillatoria jenensis* Schmid 12. *Oscillatoria limosa* Agardh ex Gomont 13. *Oscillatoria leonardii* Compère 14. *Oscillatoria nitida* Škorbatov 15. *Oscillatoria perornata* Skuja 16. *Oscillatoria princeps* Vaucher ex Gomont 17. *Oscillatoria sancta* Kützing ex Gomont 18. *Oscillatoria* cf. *proboscidea* Gomont 19. *Phormidium breve* (Kützing ex Gomont) Anagnostidis et Komárek 20. *Phormidium* cf. *variabile* (Wille) Anagnostidis et Komárek 21. *Phormidium chalybeum* (Mertens ex Gomont) Anagnostidis et Komárek 22. *Planktothrix agardhii* (Gomont) Anagnostidis et Komárek 23. *Planktothrix isothrix* (Skuja) Komárek et Komárková 24. *Spirulina meneghiniana* Zanardini ex Gomont

3. *Glaucospira laxissima* (G. S. West) Keshri et Das Comb. nov.

[Desikachary 1959, p.196, pl. 36, f. 5 as *Spirulina laxissima* G. S. West; Komárek and Anagnostidis 2005, p. 140, f. 160] (Pl. 1, Fig. 3; Pl. 2, Fig. 3)

Trichomes loosely coiled in right handed rotation; lacking cross wall.

Distance between two spirals: 9.09 μm – 18.18 μm ; Trichome: 0.75 μm – 1.5 μm broad.

Collection No. & Ecological notes: MD- 313, 09. 02. 2014, Vatkuar par, Koch Bihar; aquatic, lodged on aquatic plant (pH- 6, Temp. 18 $^{\circ}\text{C}$).

Distribution in India: Andhra Pradesh (Kumaraswamy *et al.*, 2013); Jammu & Kashmir (Anand V. K., 1979; Ara *et al.*, 2002, Ara and Rather, 2005); Karnataka (Airsang and Lakshman, 2015); Kerala (Jeyachitra *et al.*, 2013; Vijayan and Roy, 2015); Maharashtra (Suryavanshi *et al.*, 2010); Tamil Nadu (Desikachary, 1959; Ramasamy and Chandran, 2015); Uttarakhand (Kumar P. *et al.*, 2012); West Bengal (Singha Roy and Pal, 2015) [all as *S. laxissima* G. S. West].

Comment: Such specimens are listed under unrevised species of *Glaucospira* Lagerheim by Komárek & Anagnostidis 2005. It was previous considered as a species of *Spirulina* Turpin ex Gomont 1892 but from the circumscription of the taxa & material observed it is placed under *Glaucospira* as *Glaucospira laxissima* (G. S. West) Keshri et Das comb. nov. subscribing the opinion of Komárek & Anagnostidis (2005).

4. *Hormoscilla feldmannii* Anagnostidis

[Komárek & Anagnostidis 2005, p. 563, f. 840]

(Pl.1, Fig.4; Pl.2, Fig.4)

Cells in filament barrel shaped, constricted at the cross – walls; apical cell rounded, hemispherical.

Length: 6 µm – 8 µm; Breadth: 11 µm – 12 µm.

Collection No. & Ecological notes: MD- 313, 09. 02. 2014, Vatkuar par, Koch Bihar; aquatic, lodged on aquatic plants (pH- 6, Temp. 18°C).

Distribution in India: This is probably the first report of the taxon from India.

Comment: The dimension of the taxon tallies with the type species but it is a marine species. However, we have observed it in fresh water.

5. *Komvophoron schmidlei* (Jaag) Anagnostidies et Komárek

[Komárek & Anagnostidis 2005, p. 336, f. 463]

(Pl.1, Fig. 5; Pl. 2, Fig. 5)

Filaments up to 19 cells, slightly curved without sheath; cell cylindrical with rounded end, cross-wall deeply constricted; apical cells obtuse-conical in shape, cells finely granulated.

Length: 10 µm – 12 µm; Breadth: 9 µm – 11 µm.

Collection No. & Ecological notes: MD- 166, 10. 02. 2013, Pundibari, Koch Bihar; aquatic, lodged on aquatic plants (pH- 6, Temp. 28°C); MD- 260, 20. 10. 2013, Mahisbathan, Koch Bihar; aquatic, lodged on aquatic plants (pH- 6, Temp. 34°C).

Distribution in India: Himachal Pradesh (Dwivedi *et al.*, 2008 as *Pseudoanabaena schmidlei* Skuja).

This is the first report of the taxon from Eastern India.

6. *Leibleinia epiphytica* (Hieronymus) Compère

[Desikachary 1959, p. 284, pl. 53, f. 7 as *Lyngbya epiphytica* Hieronymus in Kirchner 1898; Komárek & Anagnostidis 2005, p. 170, f. 210]

(Pl. 1, Fig. 6; Pl. 2, Fig. 6)

Filaments attached to *Cladophora* and *Pithophora* along their length and sometimes coiled with the host filaments; sheath thin and colourless; cells broader than their long; apical cell rounded.

Length of the cell: 0.75 µm – 3 µm; Breadth of the cell: 2 µm – 3.5 µm.

Collection No. & Ecological notes: MD- 096, 01. 07. 2012, Dewanhat, Koch Bihar; found in small waterbody, surface of a snail body (pH- 5.5, Temp. 28°C); MD-130, 27. 10. 2012, Rajbari Park, Cooch Behar; aquatic, attached with *Cladophora* and *Pithophora* (pH- 6, Temp. 28°C).

Distribution in India: Maharashtra (Patil V. P. *et al.*, 2011); Rajasthan (Pandey J. *et al.*, 1998 as *Lyngbya epiphytica* Hieronymus in Kirchner).

This is probably first report of the taxon from Eastern India.

7. *Leptolyngbya subtilis* (W. West) Anagnostidis

[Komárek & Anagnostidis 2005, p. 186, f. 227]

(Pl. 1, Fig. 23; Pl. 2, Fig. 7)

Filament attached to the substrate; 1.8 µm broad; sheath thin, hyaline; cell broader than long; apical cell rounded.

Length of the cell: 0.68 µm; Breadth of the cell: 1.8 µm.

Collection No. & Ecological notes: MD- 001, 24. 10. 2010, Dewanhat, Koch Bihar; aquatic, found in rice field attached with some aquatic plants (pH- 5.5, Tem. 17°C).

Distribution in India: Karnataka (Kamat, 1972); Kerala (Anand N. and ShantaKumar Hopper, 1995); Uttar Pradesh (Bendre and Kumar, 1975; Pal, 1975); West Bengal (Brühl and Biswas, 1923) [all as *Lyngbya subtilis* W. West].

8. *Lyngbya major* Meneghiin ex Gomont

[Desikachary 1959, p. 320, p. 52, f. 11, Komárek and Anagnostidis 2005, p. 619, f. 941]

(Pl. 1, Fig. 7; Pl. 2; Fig. 8)

Trichomes not constricted at the cross wall; sheath thick, colourless, lamellated; apical cell rounded with thick membrane; cells with iron granules.

Length of the cell: 3 – 8 µm; Breadth of the cell with sheath: 19 – 28 µm; Breadth of the cell without sheath: 11 – 20 µm.

Collection No. & Ecological notes: MD- 113, 06. 08. 2012, Dewanhat, Koch Bihar; terrestrial, growing on damp soil (Temp. 29°C); MD- 208, 04. 05. 2013, Purbo Barochoki, Cooch Behar; aquatic, lodged on aquatic plants (pH- 6, Temp. 27°C).

Distribution in India: Arunachal Pradesh (Singh N. I. *et al.*, 1997); Himachal Pradesh (Dwivedi *et al.*, 2008); Jammu & Kashmir (Ara and Rather, 2005); Karnataka (Somasekar, 1983); Punjab (Sharma *et al.*, 1979); Rajasthan (Srivastava and Nigam, 1980); Uttar Pradesh (Rao C. B., 1937; Pal and Yadav, 1974; Pal, 1975; Bendre and Kumar, 1975; Prasad and Mahrotra, 1980); West Bengal (Banerji, 1938; Sinha J. P. and Mukherjee D., 1975b; Mukhopadhyay and Chatterjee, 1981; Mazumdar and Chandra, 1987; Sen, 2000; Roy and Keshri, 2014).

9. *Lyngbya majuscula* Harvey ex Gomont

[Desikachary 1959, p. 313, pl. 48, f. 7, pl. 49, f. 12, pl. 52, f. 10, Komárek and Anagnostidis 2005, p. 623, f. 950]
(Pl. 1, Fig. 8; Pl. 2 Fig. 9)

Trichome not constricted at the cross walls; long, sheath thick, lamellated: apical cell rounded.

Length: 6 – 8 µm; Breath: 32 – 34 µm; Sheath: 10 – 12 µm.

Collection No. & Ecological notes: MD- 068, 27. 11. 2011, Garopara Mansai river, Koch Bihar, free floating (pH- 6, Temp. 22°C).

Distribution in India: Andhra Pradesh (Laloraya and Mitra, 1973; Sarojini, 1996; Ghosh and Keshri, 2011); Arunachal Pradesh (Singh N. I. *et al.*, 1997); Assam (Adhikary and Jena, 2012); Bihar (Vasishtha, 1968; Kumar S. and Saha, 1993); Delhi (Rao C. B., 1940); Gujarat (Vasishtha, 1968); Karnataka (Tiwari G. L., 1972, 1975; Somasekar, 1983, 1984); Kashmir (Ara *et al.*, 2002); Madhya Pradesh (Bendre and Agarkar, 1965; Dikshit and Agarkar, 1974); Maharashtra (Dixit, 1936, Kamat, 1963a, 1968a; Tarar and Kelkar, 1979; Barhate and Tarar, 1981; Tarar and Shewale, 1984; Bhoge and Ragothaman, 1986); Manipur (Indrama Devi and Tiwari, 2011); North India (Prasad and Mehrotra, 1979), Odisha (Rao C. B., 1939a); Rajasthan (Pandey U. C., 2002); Tamil Nadu (Rao C. B., 1938b; Tiwari G. L., 1975; Venkataraman and Srinivasan, 1980; Anand N. and Revathi, 1987; Anand N., 1989; Ramakrishnan and Kannan, 1992; Anand N. and Subramanian, 1994; Christi *et al.*, 2014); Uttar Pradesh (Gupta A. B., 1956; Saxena, 1960; Singh K. P. and Chaturvedi, 1970; Khan and Kumari, 1972; Pal and Yadav, 1974; Bendre and Kumar, 1975; Darbal *et al.*, 1978; Pandey U. C. and Chaturvedi, 1979; Prasad and Mehrotra, 1980; Pandey U. C. and Pandey D. C., 1982); West Bengal (Banerji, 1938; Biswas, 1949; Vasishtha, 1968; Chatterjee *et al.*, 1980; Maity and Santra, 1985; Santra *et al.*, 1988, Santra and Pal, 1989; Santra, 1993; Bhattacharya *et al.*, 2014; Ghosh *et al.*, 2015).

This is a more or less common taxon.

10. *Oscillatoria pseudoanguina* Keshri et Das sp. nov.

(Pl. 1, Fig. 9; Pl. 2, Fig. 10)

Trichomes constricted at the cross wall; cells gradually attenuated towards the end, apical cell bit twisted & curved, thickened and rounded; granules present at the cross wall.

Length of the cell: 2.27 µm – 5.30 µm; Breath of the cell: 8.33 µm - 13.63 µm.

Holotype No.: MD- 039, 23. 02. 2011, Dewanhat, Koch Bihar found in water tank (pH- 6, Temp. 20°C); deposited in algae herbarium, Department of Botany, The University of Burdwan (BURD).

Comment: Morphologically the specimen tallies with *O. anguina* Bory ex Gomont but as also pointed out by Komárek & Anagnostidis (2005) (p. 592) such tropical population may belong to different genotype. Accordingly it has been placed in a new taxon.

11. *Oscillatoria jenensis* Schmid

[Komárek and Anagnostidis 2005, p. 590, f. 882]

(Pl. 1, Fig. 10; Pl. 2, Fig. 11)

Trichomes not constricted at cell wall; a row of fine granules present on each side of the cross-wall; cell attenuated at the ends and hook like bent; apical cell hyaline rounded, not capitate.

Length of the cell: 2.27 µm – 4.5 µm; Breadth of the cell: 7.82 µm.

Collection No. & Ecological notes: MD- 094, 01. 07. 2012, Dewanhat, Koch Bihar; found in a small water body (pH- 5.5, Temp. 28°C)

Distribution in India: Kerala (Prasad A. and Panikkar, 2008).

This is probably the 2nd report of the taxon from India.

12. *Oscillatoria limosa* Agardh ex Gomont

[Desikachary 1959, p. 206, pl. 42, f. 11; Komárek and Anagnostidis 2005, p. 593, f. 886]

(Pl. 1, Fig. 11; Pl. 2, Fig. 12)

Trichomes straight without constricted cross-walls; granules present throughout the cross-wall; apical cell not capitate but thick, flat rounded.

Length of the cell: 1.96 μm – 3.78 μm ; Breadth of the cell: 12 μm – 14 μm .

Collection No. & Ecological notes: MD- 068, 27. 11. 2011, Garopara Mansai River, Koch Bihar, free floating (pH- 6, Temp. 22 $^{\circ}\text{C}$); MD- 313, 09. 02. 2014, Vatkuar par, Koch Bihar, aquatic, lodged on aquatic plants (pH- 6, Temp. 18 $^{\circ}\text{C}$).

Distribution in India: Andaman & Nicobar Islands (Prasad and Srivastava, 1992); Andhra Pradesh (Ghousuddin, 1937; Munawar, 1974; Rao V. S., 1977); Assam (Hazarika *et al.*, 2001, Hazarika *et al.*, 2002; Deka and Sarma, 2011); Bihar (Vasishta, 1968); Gujarat (Kamat, 1962-63; Gupta, 1964); Himachal Pradesh (Vasishta, 1968; Kumar P. *et al.*, 2012); Uttarakhand (Gupta R. K., 2005); Jammu and Kashmir (Anand V. K., 1979); Karnataka (Bharati and Bongale, 1975a, 1975b; Bongale and Bharati, 1980a); Kerala (Shaji and Panikkar, 1994; Prasad A. and Panikkar M. V. N., 2008); Madhya Pradesh (Jain, 2015); Maharashtra (Vasishta, 1968; Kamat, 1968b; Tiwari, 1972, 1975; Ashtekar and Kamat, 1980; Kumawat and Jawale, 2006); Odisha (Rao C. B., 1939a; Mohanty, 1982; Dash *et al.*, 2011), Panjab (Vasishta, 1961; Prasad and Srivastava, 1965; Sharma and Kanta, 1978); Tamil Nadu (Ganapati, 1940; Ramkrishnan and Kannan, 1992; Subramaniam *et al.*, 2012; Ramanathan *et al.*, 2013); Uttar Pradesh (Ahmad, 1967, 1972; Kumar H., 1970; Singh K. P. and Chaturvedi U. K., 1970; Khan and Kumari, 1972; Khan and Rawat, 1972; Pal and Yadav, 1974; Bendre and Kumar, 1975; Darbal *et al.*, 1978; Rai and Kumar, 1979; Prasad and Mehrotra, 1980; Pandey U. C., 1982; Pandey U. C. and Pandey D. C., 1982; Misra and Srivastava, 2005; Tiwari A. and Chauhan S. V. S., 2006; Misra *et al.*, 2008); West Bengal (Martens, 1870, 1871; Prain, 1905; Biswas, 1942; Kachroo, 1959; Chatterjee *et al.*, 1980, Sen and Gupta, 1998; Sen, 2006; Naskar *et al.*, 2008; Chakraborty *et al.*, 2010; Gupta P., 2010; Sen Sarkar *et al.*, 2013).

This is more or less a common taxon.

13. *Oscillatoria leonardii* Compère

[Komárek and Anagnostidis 2005, p. 599, f. 899]

(Pl. 1, Fig. 12; Pl. 2, Fig. 13)

Trichomes attenuated towards the ends; apical part wavy; cross wall not constricted; apical cell capitate.

Length of the cell: 4.5 μm – 7.6 μm ; Breadth of the cell: 16 μm – 27.5 μm .

Collection No. & Ecological notes: MD- 084, 20. 02. 2012, Gouranga Bazar, Koch Bihar, found in small river likewater body (pH- 5.5, Temp. 28 $^{\circ}\text{C}$).

Distribution in India: This is probably the first report of the taxon from India.

14. *Oscillatoria nitida* Schorbatov [Škorbatov]

[Komárek and Anagnostidis 2005, p. 586, f. 875]

(Pl. 1, Fig. 13; Pl. 2, Fig. 14)

Trichomes more or less straight, cross-wall not constricted & apical cell not attenuated, rounded.

Length of the cell: 2.27 μm ; Breadth of the cell: 5.77 μm .

Collection No. & Ecological notes: MD-130, 27. 10. 2012, Rajbari Park, aquatic, attached with aquatic plants (pH- 6, Temp. 28 $^{\circ}\text{C}$).

Distribution in India: This is the first report of the taxon from India.

15. *Oscillatoria perornata* Skuja

[Desikachary 1959, p. 205, pl. 41, f. 8, 9, 14; Komárek and Anagnostidis 2005, p. 586, f. 873]

(Pl. 1, Fig. 14; Pl. 2, Fig. 15)

Trichomes slightly bent with constricted cross-walls; apical cell conical in shape and rounded; granules present throughout the cell.

Length of the cell: 1.5 μm – 4.5 μm ; Breadth of the cell: 10 μm – 11 μm .

Collection No. & Ecological notes: MD- 113, 06. 08. 2012, Dewanhat, Koch Bihar; terrestrial, growing on damp soil (Temp. 29 $^{\circ}\text{C}$).

Distribution in Indian: Andaman & Nicobar Islands (Prasad and Srivastava, 1992); Jammu & Kashmir (Anand V. K., 1979; Ara *et al.*, 2002); Himachal Pradesh (Dwivedi *et al.*, 2008); Kerala (Shaji and Panikkar, 1994; Maya *et al.*, 2000; Prasad A. and Panikkar M. V. N., 2008); Maharashtra (Patil K. J. *et al.*, 2011); Odisha (Mohanty and Adhikary, 2013); Punjab (Vasishta, 1968); Tamil Nadu (Sivakamasundari and Rajendran, 2015); Uttar Pradesh (Pal, 1975; Tiwari A. and Chauhan S. V. S., 2006, Misra *et al.*, 2008); West Bengal (Gupta P., 2010).

16. *Oscillatoria princeps* Vaucher ex Gomont

[Desikachary 1959, p. 210, pl. 37, f. 1, 10, 11, 13, 14; Komárek and Anagnostidis 2005, p. 590, f. 883]
(Pl. 1, Fig. 15; Pl. 2, Fig. 16)

Trichomes straight, sometimes slightly curved and very long; margin wavy in some places.

Length of the cells: 2 μm – 4.5 μm ; Breadth of the cells: 22 μm – 24 μm ; Length of tip portion: 5.3 μm – 14.3 μm ; Breadth of the tip portion: 16.6 μm – 19.7 μm .

Collection No. & Ecological notes: MD- 004, 24. 10. 2010, Dewanhat, Koch Bihar; aquatic, found attached with root of trees (pH- 6. Temp. 21^oC).

Distribution in India: Andaman & Nicobar Islands (Prasad and Srivastava, 1992); Andhra Pradesh (Ghousuddin, 1937; Venkateswarlu, 1976; Mohan and Reddy, 1986; Sarojini, 1996); Assam (Biswas, 1934; Deka and Sarma, 2011); Delhi (Rao C. B., 1940); Gujarat (Gupta, 1964; Patel *et al.*, 1974); Himachal Pradesh (Kumar P. *et al.*, 2012); Jammu & Kashmir (Subba Raju, 1963; Mir and Suri, 1975; Anand V. K., 1976, 1979); Karnataka (Srinivasan, 1963; Kamat, 1972; Tiwari G. L., 1972, 1975; Bongale and Bharati, 1980a, 1980b); Kerala (Suxena *et al.*, 1973; Shaji and Panikkar, 1994); Madhya Pradesh (Bendre and Agarkar, 1965; Agarkar, 1967; Tiwari G. L., 1972, 1975; Dikshit and Agarkar, 1974); Maharashtra (Dixit, 1936; Kamat, 1963b, 1974; Kumawat & Jawale, 2006; Patil and Neelima, 2013); Odisha (Rao C. B., 1939a; Mohanty, 1982; Dash *et al.*, 2011; Das and Adhikary, 2012); Punjab (Vasishta, 1963; Grover and Pandhol, 1975; Pandhol and Grover, 1976); Rajasthan (Goyal, 1964); Tamil Nadu (Rao C. B., 1938b; Tiwari G. L., 1972, 1975; Ramkrishnan and Kannan, 1992; Anand N. and Subramanian, 1994; Subramaniyan *et al.*, 2012; Madhumathi and Vijayakumar, 2013); Uttar Pradesh (Rao C. B., 1936; Mitra, 1961; Gupta A. B., 1957; Singh K. P., 1959b; Saxena, 1960; Gupta A. B. and Nair G. U., 1962; Prasad, 1964-65; Das *et al.*, 1965; Gupta and Srivastava, 1965; Gupta A. B., 1966; Shukla, 1966; Kumar H., 1970; Singh K. P. and Chaturvedi U. K., 1970; Pal and Yadav, 1974; Bendre and Kumar S., 1975; Chaturvedi and Pandey, 1976; Rai L. C. and Kumar H. D., 1976, 1979; Darbal *et al.*, 1978; Prasad and Saxena, 1980; Pandey U. C., 1982; Misra and Srivastava, 2005; Tiwari and Chauhan, 2006; Misra *et al.*, 2008); Uttarakhand (Gupta, 2005); West Bengal (Biswas, 1925, 1949; Banerji, 1938; Kachroo, 1959; Sinha and Mukherjee, 1975; Sen and Gupta, 1998; Chakraborty *et al.*, 2010; Roy and Keshri, 2014, Roy *et al.*, 2014).

Comment: Such specimens are also close to *O. leonardii* Compère but it is rather difficult to distinguish between them and variations are not so pronounced that they could be treated as separate species. Rather *O. leonardii* Compère may be considered as synonym of *O. princeps* Vaucher ex Gomont.

17. *Oscillatoria sancta* Kützing ex Gomont

[Desikachary 1959, p. 203, pl. 42, f. 10; Komárek and Anagnostidis 2005, p. 594, f. 890]
(Pl. 1, Fig. 16; Pl. 2, Fig. 17)

Trichomes bent with constricted cross-walls; apical cell attenuated, rounded with thick membrane; granules are present at the cross-walls.

Length of the cells: 2 μm – 4 μm ; Breadth of the cells: 12 μm - 14 μm .

Collection No. & Ecological notes: MD- 336, 16.02. 2014, Tufangange, Koch Bihar; aquatic, attached with aquatic plants (pH- 7, Temp. 27^oC).

Distribution in India: Andaman & Nicobar Islands (Prasad and Srivastava, 1992); Assam (Hazarika *et al.*, 2001; Hazarika *et al.*, 2002; Deka and Sarma, 2011); Bihar (Rao C. B., 1939; Vasishta, 1968; Sinha and Srivastava, 1980); Delhi (Rao C. B., 1940); Himachal Pradesh (Vasishta, 1968; Dwivedi *et al.*, 2008); Jammu & Kashmir (Kant and Kachroo, 1975); Karnataka (Gonzalves and Joshi, 1946; Vasishta, 1968); Kerala (Prasad A. and Panikkar M. V. N., 2008); Odisha (Rao C. B., 1939a, Rao S. D. and Pattnaik H., 1975; Mohanty, 1982); Punjab (Vasishta, 1961; Grover & Pandhol, 1975; Pandhol and Grover, 1976; Sharma and Kanta, 1978); Maharashtra (Karande *et al.*, 2012; Patil and Neelima, 2013); Uttar Pradesh (Rao C. B., 1937; Gupta A. B., 1956; Singh K. P., 1959b; Bendre and Kumar, 1975; Pal, 1975; Prasad and Mehrotra, 1980; Prasad and Saxena, 1980; Pandey U. C. and Pandey D. C., 1982; Tiwari *et al.*, 2001); West Bengal (Banerji, 1938; Kachroo, 1959; Sen and Gupta, 1998).

18. *Oscillatoria cf proboscidea* Gomont

[Komárek and Anagnostidis 2005, p. 596, f. 891]
(Pl. 1, Fig 17; Pl. 2, Fig. 18)

Trichomes slightly bent; apical cell rounded with thick membrane; granules are present at the cross-walls.

Length of the cells: 1.5 μm – 3 μm ; Breadth of the cells: 7 μm – 8 μm .

Collection No. & Ecological notes: MD- 267, 09. 02. 2014, Pokhihaga bill, Koch Bihar; aquatic, lodged on aquatic plants (pH- 6, Temp. 34^oC).

Distribution in India: Andaman & Nicobar Islands (Prasad and Srivastava, 1992); Bihar (Vasishta, 1968; Sinha B. D. and Srivastava N. K., 1980); Delhi (Rao C. B., 1940); Gujarat (Vasishta, 1968); Himachal Pradesh (Vasishta, 1968); Karnataka (Bongale and Bharati, 1980a); Madhya Pradesh (Tiwari G. L., 1972, 1975); Maharashtra (Gonzalves, 1947; Vasishta, 1968; Tiwari G. L., 1972, 1975; Kamat, 1975); Tamil Nadu (Tiwari G. L., 1972, 1975); Uttarakhand (Khan, 1970); Uttar Pradesh (Singh R. N., 1939; Venkataraman, 1958; Pandey D. C., 1965a, 65b; Ahmad, 1967; Kumar H., 1970; Bendre and Kumar, 1975; Pal, 1975; Chaturvedi U. K. and Pandey U. C., 1976; Darbal *et al.*, 1978); West Bengal (Vasishta, 1968; Sinha and Mukherjee, 1975) [all as *O. proboscidea* Gomont].

19. *Phormidium breve* (Kützing ex Gomont) Anagnostidis et Komárek

[Desikachary 1959, p. 241, as *Oscillatoria brevis* Kützing ex Gomont, Komárek and Anagnostidis 2005, p. 421, f. 599] (Pl. 1, Fig. 18; Pl. 2, Fig. 19)

Trichomes straight; not constricted at cross walls; cell attenuated towards the end; apical cell rounded, conical in shape.

Length of the cell: 1.51 μm – 3.03 μm ; Breadth of the cell: 6.84 μm .

Collection No. & Ecological notes: MD- 040, 23. 02. 2011, Dewanhat, Koch Bihar; found in wet place (Temp. 20^oC).

Distribution in India: Bihar (Rao C. B., 1939b); Kerala (Anand N. and Shanthakumar Hopper, 1995; Madhusoodanan and Dominic, 1995); Delhi (Rao C. B., 1940); Maharashtra (Venkataraman, 1957; Kamat, 1975; Barhate and Tarar, 1983; Kumawat and Jawale, 2006; Patil K. J. *et al.*, 2011); Punjab (Dhingra and Ahluwalia, 2007); Tamil Nadu (Anand N. and Subramanian, 1994; Muthukumar *et al.*, 2007; Ramasamy and Chandran, 2015); Uttar Pradesh (Singh K. P. and Chaturvedi U. K., 1970; Prasad and Mehrotra, 1979; Pandey U. C. and Chaturvedi U. K. 1979, Tiwari A. and Chauhan S. V. S., 2006); West Bengal (Martens, 1871; Banerji, 1938; Sinha and Mukherjee, 1975) [all as *O. brevis* Kützing ex Gomont].

20. *Phormidium chalybeum* (Mertens ex Gomont) Anagnostidis et Komárek

[Desikachary 1959, p. 218, pl. 38, f. 3 as *Oscillatoria chalybea* Mertens ex Gomont; Komárek & Anagnostidis 2005, p. 422, f. 604]

(Pl. 1, Fig. 20; Pl. 2, Fig. 21)

Filaments with constricted cross-walls; apical cell rounded and hook like; whole filaments look like hockey stick; cells with aerotypes, granulated.

Length: 5 μm – 7 μm ; Breadth: 13 μm – 17 μm .

Collection No. & Ecological notes: MD- 083, 20. 02. 2012, GourangaBazar, Koch Bihar; found in small, river like water body (pH- 5.5, Temp. 28^oC).

Distribution in India: Andara Pradesh (Rao C. B., 1938a; Sarojini, 1996; Jahnsen, 2006); Assam (Hazarika *et al.*, 2001; Adhikary and Jena, 2012); Delhi (Rao C. B., 1940); Jammu & Kashmir (Ara *et al.*, 2002); Karnataka (Parukutty, 1940; Kamat, 1972); Kerala (Shaji and Panikkar, 1994); Maharashtra (Gonzalves and Joshi, 1946; Kamat, 1975; Kumawat and Jawale, 2005; Patil K. J. *et al.*, 2011); Odisha (Rao C. B., 1938a; Bhakta *et al.*, 2011); Uttarakhand (Patralekh, 1990); Uttar Pradesh (Singh K. P. and Chaturvedi U. K., 1970; Pal, 1975; Pandey U. C. and Chaturvedi U. K., 1979; Misra and Srivastava, 2005; Tiwari A. and Chauhan S. V. S., 2006); West Bengal (Biswas, 1926; Sinha and Mukherjee, 1975; Mukhopadhyay and Chatterjee, 1981; Sen 2006) [all as *Oscillatoria chalybea* Mertens ex Gomont].

21. *Phormidium cf. variabile* (Wille) Anagnostidis et Komárek

[Komárek & Anagnostidis 2005, p. 406, f. 570 as *Oscillatoria variabilis* (Wille)]

(Pl. 1, Fig. 19; Pl. 2, Fig. 20)

Filament attached with other green algae; cell attenuated towards end; apical cell rounded with cap.

Length: 0.75-2.3 μm ; Breadth: 3.8-6 μm .

Collection No. & Ecological notes: MD- 254, 20. 10. 2013, Maranadir Kuthi, Koch Bihar, aquatic, growing attached with *Cladophora* (pH- 6, Temp. 22^oC).

Distribution in India: This is probably the first report of the taxon from India.

22. *Planktothrix agardhii* (Gomont) Anagnostidis et Komárek

[Desikachary 1959, p. 235 as *Oscillatoria agardhii* Gomont; Komárek and Anagnostidis 2005, p. 359, f. 500]

(Pl. 1, Fig. 21; Pl. 2, Fig. 22)

Trichomes not constricted, with both end are free; gradually attenuated towards the apices; apical cells slightly curved and rounded without cap and calyptras; granules present at the cross wall.

Length of the cell: 1.5 μm – 3.03 μm ; Breadth of the cell: 2.27 μm – 4.54 μm .

Collection No. & Ecological notes: MD- 096, 01. 07. 2012, Dewanhat, Koch Bihar, found in a small water body, surface of a snail body (pH- 5.5, Temp. 28⁰C).

Distribution in India: Andhra Pradesh (Sarojini, 1996); Jammu & Kashmir (Ara and Rather, 2005); Karnataka (Somashekar, 1983); Kerala (Prasad A. and Panikkar M. V. N., 2008); Maharashtra (Kamat, 1975; Patil K. J. *et al.*, 2011); Manipur (Indrama Devi and Tiwari, 2011); Punjab (Singh R. N., 1941); Tamil Nadu (Ganapati, 1940; Desikachary, 1959); Uttarakhand (Patralekh, 1990); Uttar Pradesh (Rao C. B., 1936; Pal and Yadav, 1974); West Bengal (Biswas, 1942; Roy, 1955; Sen 2006) all as *Oscillatoria agardhii* Gomont.

23. *Planktothrix isothrix* (Skuja) Komárek et Komárková

[Komárek and Anagnostidis 2005, p. 356, f. 495]

(Pl. 1, Fig. 22; Pl.2, Fig. 23)

Trichomes slightly curved at the end portion; a row of granules present on each side of the cross walls; cell rounded and slightly curved at the apices.

Length of the cell: 3.03 µm; Breadth of the cell: 6.06 µm.

Collection No. & Ecological notes: MD- 208, 04. 05. 2013, Purbo Barochoki, Koch Bihar, aquatic, lodged on aquatic plants (pH- 6, Temp. 27⁰C).

Distribution in India: Karnataka (Kamat, 1972), Sikkim (Das and Adhikary, 2014), Uttar Pradesh (Pal and Yadav, 1974; Bendre and Kumar, 1975) all as *Oscillatoria mougeotii* Bory ex Gomont; West Bengal (Roy *et al.* 2014).

24. *Spirulina meneghiniana* Zanardini ex Gomont

[Desikachary 1959, p. 195, pl. 36, f. 8, Komárek & Anagnostidis 2005, p. 147, f. 172]

(Pl. 1, Fig. 24; Pl. 2, Fig. 24)

Trichomes screw like coiled with right handed rotation; cross wall absent.

Breadth of the trichomes: 2.27 µm; Breadth of the coil: 3.03 µm – 4.55 µm; Distance between two coils: 7.57 µm – 10.60 µm.

Collection No. & Ecological notes: MD- 053, 19. 10. 11, Panisala, Koch Bihar; aquatic, lodged on aquatic plants (pH- 5.5, Temp. 30⁰C).

Distribution in India: Andaman & Nicobar Islands (Prasad and Srivastava, 1992); Bihar (Sinha B. D. and Srivastava N. K., 1980; Kumar B. N. and Choudhary S. K., 2009); Gujarat (Kamat, 1962-63; Parikh *et al.*, 2006); Karnataka (Kamat, 1972; Bharati and Bongale, 1975); Manipur (Bharadwaja, 1963); Maharashtra (Vasishta, 1968; Kamat, 1968a, 1975; Nandan and Ahuja, 2010; Patil and Nandan, 2011); Karnataka (Somashekar, 1983, 1984); Tamil Nadu (Anand N. and Revathi, 1987; Anand N. and Subramanian, 1994; Muthukumar *et al.*, 2007); Uttar Pradesh (Pal, 1975; Rai *et al.*, 2008); West Bengal (Choudhury and Pal, 2011; Banerji, 1938; Naskar *et al.*, 2008; Roy and Keshri, 2014).

DISCUSSION:

In this district nitrogen level of soil is very low. Soil and water are acidic in nature that's why algal diversity is low in number in spite of their volume. *Oscillatoria* has been found as a dominant genus. Its occurrence is almost ubiquitous. Several *Oscillatoria* species are pollution indicator. It shows the trend towards increasing pollution. Some *Oscillatoria* species have been found to fix atmospheric nitrogen in microaerobic environment. Its potential can be explored. Since a new species of *Oscillatoria* has been introduced in this work it appears that investigation could be more intensified. *Lyngbya majuscula* Harvey ex Gomont has been reported in this work known for its medicinal properties. It produces aurilides B and C, which are active against human tumor and mouse neuroblastoma cell lines (Han *et al.* 2006). This also explains the possibility of the use of local biodiversity in various fields of application including in medicine and indicating pollution level for biomonitoring studies.

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BIBLIOGRAPHY:

Adhikary, S. P. and M. Jena, 2012. Algal diversity of Kazirenga National Park and Majuli river island hot spots in Assam. *Nelumbo* **54**: 218-238.

Agarkar, D. S. 1967. Myxophyceae of Gwalior, Madhya Pradesh. *Phykos* **6 (1 & 2)**: 1-6

- Ahmad, M. R. 1967. Algal flora of some ponds of Kanpur. *Phykos* **29(1&2)**: 156-164
- Ahmad, M. R. 1972. Algae of Allen forest lake Kanpur, India. *Nova Hedwigia* **23(1)**: 125-129
- Airsang, R. V. and H. C. Lakshman, 2015. Periodical Assessment of Phytoplankton Diversity in Navalgund Lentic Water body of Dharwad District in Karnataka, India. *Int. J. R. Eng. and Appl. Sci.* **5(5)**: 1-15
- Anand, N. 1989. Hand Book of Blue-Green Algae. Bishen Singh Mahendra Singh, Dehradun, India, pp. 1-79
- Anand, N. and G. Revathi, 1987. Blue green algae from rice fields of Tamil Nadu. *Phykos* **26**: 17 - 21
- Anand, N. and R. S. Shanthakumar Hopper, 1995. Distribution of blue green algae in rice fields of Kerala state, India. *Phykos* **34**: 55-64
- Anand, N. and T. D. Subramanian, 1994. Distribution of natural populations of blue green algae in a rice field. *Phykos* **33(1 & 2)**: 163-169
- Anand, V. K. 1976. A preliminary list of Cyanophyceae of Saruinsar Lake (Jammu). *Geobios* **3**: 132-133
- Anand, V. K. 1979. Blue-green algae of Gadigarh stream (Miran Sahib, Jammu)-I. *Phykos* **18(1&2)**: 21-24
- Ara, S. and Rather, 2005. Cyanobacterial flora of Dal Lake – A taxonomic consideration. *J. Econ. Taxon. Bot.* **29(1)**: 38-40
- Ara, S., M. Y. Zargar and M. A. Khan, 2002. Cyanobacterial diversity in agro-ecosystems of Kashmir. *Phykos* **41 (1 & 2)**: 1-5
- Asthekar, P. V. and N. D. Kamat, 1980. Nostocales of Marathwada, Maharashtra. *Phykos* **19(1)**: 89-93
- Bando, T. 1988. A revision of the genera *Docidium*, *Haplotaenium* and *Pleurotaenium* (Desmidiaceae, Chlorophyta) of Japan. *J. Sci. Hiroshima University series B, Div. 2 (Botany)* **22 (1)**: 1-63
- Banerji, J. C. 1938. Studies on the Myxophyceae of Lower Bengal II, A few hormogoniales. *J. Dept. Sci. Cal. Univ.* **1(2)**: 95-109
- Barhate, V. P. and J. L. Tarar, 1981. The Algal flora of Tapti Rivar, Bhusawal, Maharashtra. *Phykos* **20 (1 & 2)**: 75-78
- Barhate, V. P. and J. L. Tarar, 1983. Algae of Maharashtra: I Additions to Cyanophyceae of Khandesh. *Phykos* **22 (1 & 2)**: 67-72
- Bendre, A. M. and M. S. Agarkar, 1965. Myxophyceae of Bhopal and its environs. *Phykos* **4(2)**: 76-82
- Bendre, A. M. and S. Kumar, 1975. Cyanophyceae of Merut. *Phykos* **14(1 & 2)**: 1-7
- Bhakta, S., S. K. Das, M. Nayek, P. K. Panda and L. B. Sukla 2011. Phyco-diversity assessment of Bahuda river mouth areas of east coast of Odisha, India. *Rec. Res. Sci. Tech.* **2(4)**: 80-89
- Bharadwaja, Y. 1963. The freshwater algae of Manipur, India –I. Proc. Indian Nat. Acad. Sc. *Plant Sciences B.* **57(4)**: 239-258
- Bharati, S. G. and U. D. Bongale, 1975a. Studies on the soils and soil algae of Raichur, Karnataka State, India. *Karnatak Univ. J. Sci.* **20**: 130-141
- Bharati, S. G. and U. D. Bongale, 1975b. Systematic account of fresh water algae of Karnataka State Part I soils and soil algae of Dharwar, India. *Karnatak Univ. J. Sci.* **21**: 203-207

- Bharati, S. G. and Bongale U. D. 1975c. Studies on the soils and soil algae of Karnataka State. Part-I, soils and soil algae of Dharwar. *Karnatak Univ. J. Sci.* 20: 142-149.
- Bhattacharya, S., Rath J. and Ray S. 2013. Cyanobacteria of soil crust from forest soils of Birbhum district, West Bengal-distribution of speies in relation to soil parameters. *Phykos* 43(2): 1-8.
- Bhattacharya, S., Rath J. and Ray S. 2014. Species composition of soil-crust cyanobacteria in red soil zone of the district Birbhum, West Bengal: a comparison with the alluvial zone. *Indian Hydrobiol.* 16 (2): 87-98.
- Bhoge, O. N. and Ragothaman G. 1986. Studies on the Cyanophyceae from Jalgaon region, Maharashtra. *Phykos* 25: 129-131.
- Biswas, K. P. 1925a. The algal flora of maiden Tanks, Calcutta. *Calcutta Rev.* : 449-455.
- Biswas, K. P. 1925b. Road Slimes of Calcutta. *J. Dept. Sci. Cal. Univ.* 7: 1-11.
- Biswas, K. P. 1926. Flora of Salt Lakes, Calcutta (West Bengal). *J. Dept. Sci. Cal. Univ.* 8: 1-47.
- Biswas, K. P. 1934. Observation on algal collections from Khasia and Jainta Hills, Assam, India. *Hedwigia* 74: 1-28.
- Biswas, K. P. 1942. The role of common algal communities of the river Hooghly on the drinking water, Calcutta. 150th Ann. Vol. Roy. Bot. Gdn. 189-206.
- Biswas, K. 1949. Common fresh and brakish water algal flora of India and Burma. II. *Rec. Bot. Surv. India* 15: 1-169.
- Bongale, U. D. and Bharati S. G. 1980a. On the algal flora of cultivated soils of of Karnataka State, India. *Phykos* 19(1): 95-109.
- Bongale U. D. and S. G Bharati, 1980b. Fresh water algae of Devanagere and Rachur of Karnataka State, India. *J. Bombay Nat. Hist. Soc.* 77: 6-11.
- Brühl, P. and K. P. Biswas, 1923. Algae epiphyticae epiphloiae Indicae or Indian Bark algae. *J. Dept. Sci. Cal. Univ.* 5: 1-22
- Chakraborty, T., A. Mukhopadhyay and R. Pal, 2010. Micro algal diversity of Kolkata, West Bengal, India. *Indian Hydrobiol.* 12(2): 204-224
- Chatterjee, M. and A. Choudhury and S. P. Chatterjee, 1980. Algal flora of the Water Reserviors of Golapbag, Burdwan, West Bengal. *Phykos* 19 (1 & 2): 67-69
- Chatterjee, S. and J. P. Keshri, 2005. *Brozia* (Cyanophyta) in West Bengal, India with the description of *B. indica* sp. nov. *Cyptogamie Algol.* 26(4): 331-336
- Chaturvedi, U. K. and U. C. Pandey, 1976. A list of blue-green algae and green algae from Rohilkhand division, U.P., India- IV. *Phykos* 15(1 & 2): 127-131
- Choudhury, A. K. and R. Pal, 2011. Variations in seasonal phytoplankton assemblages as a response to environmental changes in the surface waters of a hyposaline coastal station along the Bhagirathi – Hooghly estuary. *Environ. Monit. Assess.* 179(1-4): 531-553
- Christi, R. M., H. J. Alexander, N. Renukabei and T. Christy Kala, 2014. Water quality of two sub-urban ponds at Kanyakumari district in relation to Phytoplankton diversity. *Indian Hydrobiol.* 16 (2): 137 – 144
- Darbal, P. K., A. M. Bendre and L. Singh, 1978. Cyanophyceae of Rishikesh and its adjacent foot-hills. *Botanical Progress* 1: 41-44

- Das, A. K., A. C. Shukla and A. B Gupta, 1965. The Utilization of hydrophytes as a source of subsidiary protein food. *Ichthyologica* **4(1 & 2)**: 50-52
- Das S. K. and Adhikary S. P. 2012. Algal diversity in the reservoir of Odisha state, India. *Indian Hydrobiol.* 15(1): 17-41
- Das, S. K. and Adhikary S. P. 2014. Freshwater algae of eastern India. Daya publication, New Delhi. pp. 1- 453.
- Dash, P. K., Mohapatra P. K. and Kar M, 2011. Diversity of cyanobacteria from freshwater bodies of Simlipal biosphere reserve, Orissa, India. *E-planet* 9(1): 1–14.
- Deka, S. J. and Sarma G. C. 2011. Taxonomical studies of Oscillatoriaceae (Cyanophyta) of Goalpara District, Assm, India. *I. J. Fundl. Appl. Life Sci.* 1(3): 22-35.
- Desikachary, T. V. 1959. Cyanophyta. ICAR. New Delhi. pp. 1- 686.
- Dhingra, R. and Ahluwalia A. S. 2007. Genus *Phormidium* Kutzing ex Gomont (Cyanoprokarote) from diverse habitats of Punjab. *J. Indian. Bot. Soc.* 86(3 & 4): 86-94.
- Dikshit, R. and Agarkar M. S. 1974. Algae of Bandhavgarh. *Vibha* 2(1): 159-163.
- Dixit, S. C. 1936. The Myxophyceae of the Bombay Presidency, India – I. Proceedings of Indian Acad. Sci. Sect. B: Plant Sci. 3(1): 93–106.
- Dwivedi, R. K., Shukla S. K., Shukla C. P., Misra P. K. and Seth M. 2008. Cyanophycean flora of Southern Himachal Pradesh, India. *Ecoprint*15: 29-36.
- Ganapati, S. V. 1940. Studies on the chemistry and biology of the slow sand filters of the Madras Water Works. *Proc. Nat. Inst. Sci. India* 6: 237-300.
- Ghose, S. and J. P. Keshri, 2011. Some Cyanophycean algae from the costal region of Visakhapatnam, India. *J. Indian Bot. Soc.* **90 (1 & 2)**: 165-167
- Ghosh, S., Ghosh S. P. and Keshri J. P. 2015. Diversity and Community composition of Phytoplankton in a Lentic Waterbody of Burdwan, West Bengal, India. *European J. Biomedical and Pharmaceutical Sciences.* 2(1): 267-274.
- Ghousuddin, M. 1937. A preliminary survey of the algal flora of Hyderabad (Deccan). *J. Bombay Nat. Hist. Soc.* **39(1 & 2)**: 149-150
- Gonzalves, E. A. 1947. The algal-flora of the hot springs of Vajreshwari near Bombay. *J. Univ. Bombay* **16**: 22-27
- Gonzalves, E. A. and D. B. Joshi, 1946. Freshwater algae near Bombay. 1. The seasonal succession of the algae in a tank at Bandra. *J. Bombay Nat. Hist. Soc.* **46 (1)**: 154 – 176
- Goyal, S. K. 1964. Algal flora of Jodhpur and its environs.III. Oedogoniales. *J. Univ. Bombay. Nat. His. Soc.* **61 (2)**: 385-95
- Grover, I S and R K, Pandhol, 1975. Algal-flora of paddy fields of Ludhiana & its adjacent areas. *Phykos* **14(1&2)**: 89-97
- Gupta, A. B. 1956. A contribution to the algal flora of the Allahabad district. *J. Res.* **3(1)**: 76-81
- Gupta, A. B. 1957. The algal flora of some paddy fields and its importance in soil economy. *J. Res.* **4(1)**: 1-24
- Gupta, A. B. 1964. Role of subterranean Myxophyceae in rice field. *Labdev J. Sci. Tech.* **2(1)**: 1-2
- Gupta, A. B. 1966. Algal flora and its importance in the economy of rice fields. *Hydrobiol.* **28(2)**: 213-222

- Gupta, A. B. and G. U. Nair 1962. A Contribution to the algal flora of Garhwal. *J. Agra. Univ. Res. Sci.* **11(3)**: 227-240
- Gupta, P. 2010. Algal diversity on and around *Lodoicea maldivica* (J. E. Gmel.) Pres. (Double coconut) In AJC Bose Indian Botanic garden, Howrah. *Nelumbo* **52**: 53-62
- Gupta, R. K. 2005. Algal flora of Dehradun District, Uttaranchal. Botanical Survey of India, CGO complex. pp. 1-298
- Han, B., H. Gross, D. E. Goeger, S. L. Mooberry and W. H. Gerwick, 2006. Aurilides B and C, cancer cell taxins from a Papua New Guinea collection of the marine cyanobacterium *Lyngbya majuscula*. *Journal of Natural Products* **69**: 572-575
- Hazarika, B., P. Devi and C. L. Boissya, 2001. Cyanobacteria of rice fields of lakhimpur. *Phykos* **40 (1 & 2)**: 95-102
- Hazarika, B., P. Devi and C. L. Boissya, 2002. Genus *Oscillatoria* Vaucher from Ranga Nandi and its adjoining areas of Lakhimpur district, Assam. *Phykos* **41**: 13-15
- Indrama Devi, T. and O. N. Tiwari, 2011. Exploration of oscillatoriacean cyanobacteria of Manipur, India, Falling under Indo-Burma Biodiversity Hotspots. *J. Indian Bot. Soc.* **90 (1 & 2)**: 33-34
- Jain, N. 2015. Diversity of blue-green algae and study on related physico-chemical parameters of paddy fields of Chhatarpur district of Madhya Pradesh. *Int. J. Res. Dev. Pharma. Life Sci.* **4 (2)**: 1456-1462
- Jeyachitra, K., A. Panneerselvam, R. Rajendran, M. Mahalakshmi and S. Karthik Sundaram, 2013. Physico-chemical and biological factors in the distribution of Cyanobacteria population in three different sampling sites of South India. *African J. Microbiol. Res.* **7 (25)**: 3240-3247
- Johnson, M. E. C. 2006. Algal flora of Banjara and Nadimi Lakes. *J. Indian Bot. Soc.* **85**: 103-106
- Kachroo, F. 1959. Aquatic vegetation of Damodar Valley. *J. Asiatic Soc.* **1(4)**: 271-298
- Kamat, N. D. 1962-63. The Oscillatoriaceae of Ahmadabad, India. *J. Univ. Bombay* **31 (3 & 5)**: 20-27
- Kamat, N. D. 1963a. The algae of Mahabaleshwar. *J. Univ. Bombay* **31(3 & 4)**: 28-41
- Kamat, N. D. 1963b. The algae of Kolhapur, India. *Hydrobiol.* **22(3 & 4)**: 209-305
- Kamat, N. D. 1968a. Algae of Alibag, Maharashtra. *J. Bombay Nat. Hist. Soc.* **65**: 88 – 104
- Kamat, N. D. 1968b. Algae of Simla. *J. Bombay Nat. Hist. Soc.* **65**: 271-277
- Kamat, N. D. 1972. Oscillatoriaceae of Mysore state. *Phykos* **11(1 & 2)**: 59-63
- Kamat, N. D. 1974. Algae of Marathawada, Maharashtra. *Phykos* **13(1)**: 22-32
- Kamat, N. D. 1975. Algae of Vidarbh Maharashtra. *J. Bombay Nat. Hist. Soc.* **72(2)**: 450-476
- Kant, S. and P. Kachroo, 1975. Limnological studies in Kashmir Lakes-II. Diurnal movements of phytoplankton. *J. Indian Bot. Soc.* **54**: 9-12
- Karande , V. C., G. V. Uttekar, P. Kamble and C. T. Karande, 2012. Diversity of cyanobacteria in biofilms on building facades of Western Maharastra. *Phykos* **42(2)**: 54-58
- Keshri, J. P. and S. Chatterjee, 2010. First record of two cyanoprokaryotas, *Oscillatoria* (Oscillatoriales) and *Nostoc* (Nostocales), endophytic within the angiosperm *Alternanthera sessilis* R. Br (Amaranthaceae) from India. *Alogological Studies* **135**: 83-88

- Khan, M. 1970. Algal-flora of Dehradun-I, Myxophyceae. *Phykos* **9(2)**: 126-131
- Khan, M. and S. Kumari, 1972. Some addition to the algal flora of Dehradun-III, Cyanophyta. *J. Ranchi Univ.* **8**: 298-300
- Khan, M. and Rawat R. S. 1972. Studies on the algal flora of Golatappar swamp (A preliminary report). *Phykos* **11(1 & 2)**: 67-70
- Komárek, J. and K. Anagnostidis, 2005. Süßwasserflora von Mitteleuropa 19/2, Cyanoprokaryota 2. Teil/Part 2: Oscillatoriales- In Büdel, B., Gärtner G., Krientz, L. & Schagest, M. (eds.). Spektrum Akademischer Verlag. pp. 1-759
- Kumar, B. N. and S. K. Choudhary, 2009. Algal flora of Jagatpur wetland in the middle Ganga flood plain near Bhagalpur, Bihar (India). *J. Ind. Bot. Soc.* **88(3 & 4)**: 8–11
- Kumar, H. 1970. Cyanophyceae of Sardhana. *Phykos* **9 (2)**: 79-85
- Kumar, S. and L. C. Saha, 1993. Freshwater algae of drinking water reservoirs at Bhagalpur. *Phykos* **32 (1 & 2)**: 131-146
- Kumar, P., A. Wanganeo, F. Sonaulah and F. Wanganeo, 2012. Limnological study on two high altitude Himalayan Ponds, Badrinath, Uttarakhand. *Int. J. Ecosystem.* **2 (5)**: 103-111
- Kumaraswamy, B., L. Dupsingh., M. Ramesh Babu and B. Digamber Rao 2013. Study of Algae from Freshwater Reservoirs of Warangal (A. P.), India. *Nature Environment & Pollution Technology* **12(4)**: 577-584.
- Kumawat, D. A. and A. K. Jawale, 2006. The genus *Oscillatoria* Vaucher from fish ponds of Jalagaon district, Maharashtra (India). *J. Ind. Bot. Soc.* **85**: 97–102
- Laloraya, V. K. and A. K. Mitra, 1973. Studies on the blue-green algae of the paddy fields of India. Part I. Cultural Studies, general considerations and distribution pattern of the blue green algae in the paddy fields of India. *Nova Hedwigia* **47**: 227- 262
- Madhumathi, V. and S. Vijayakumar 2013. Survey of Cyanobacterial flora from Samuthiram Lake of Thanjavur, Tamil Nadu, India. *J. Algal Biomass Utiln.* **4(1)**: 70–79
- Madhusoodanan, P. V. and T. K. Dominic, 1995. Variation in the diversity of blue green algae in rice fields of Kerala. *Phykos* **34**: 55-69
- Maity, H. and S. C. Santra, 1985. Blue green algal flora of 24-parganas, W.B. (India). *Phykos* **24**: 46-51
- Martens, G. V. 1870. A third list of Bengal algae, communicated by Mrs. S. Kurz. *Proc. Asiatic Soc. Beng.* **39**: 9-12
- Martens, G. V. 1871. A fifth list of Bengal algae, determined by G.V. Martens, communicated by Mrs. S. Kurz. *Proc. Asiatic Soc. Beng.* **40**: 170-173
- Maya, S., S. K. Premeela and V. Sarojini Menon, 2000. A preliminary study on the algal flora of temple tanks of Southern Kerala. *Phykos* **39 (1 & 2)**: 77-83
- Mazumdar, P. K. and A. K. Chandra, 1987. Studies on the Cyanophyta of certain district of West Bengal correlated with Physico-chemical properties of the soil. *Geophytol.* **17(2)**: 231-236
- Mir, A. M. and B. L. Suri, 1975. Phytoplankton of Ladakh. *Geobios* **2(6)**: 199-200
- Misra, P. K., R. K. Mehrotra, M. Shukla and J. Prakash, 2008. Genus – *Oscillatoria* Vaucher from district Gorakhpur, Uttar Pradesh. *J. Indian Bot. Soc.* **87(1&2)**: 57–60

- Misra, P. K. and K. A. Srivastava, 2005. Fresh water Cyanophycean algae from North- Eastern Uttar Pradesh, India. *J. Ind. Bot. Soc.* **84**: 67-75
- Mitra, G. P. 1961. Some aspects of fixation of elementary nitrogen blue-green algae in the soil. *Proc. Nat. Acad. Sci. India* **31(1)**: 98-99
- Mohan, K. S. and K. Reddy, 1986. Cyanophyceae of two lakes of Hyderabad. *Proc. Indian Natn. Sci. Acad B52*, No. 5, pp. 649 – 659
- Mohanty, R. C. 1982. Blue-green algae of Bhubaneswar and its adjoining regions-II. *Phykos* **21**: 96-98
- Mohanty, D. and S. P. Adhikary, 2013. Assessment of Changes in the Algal Diversity of Chilka Lagoon after opening of New Mouth of Bay of Bengal. *J. Water Resource and Protection* **5**: 611-623
- Mukhopadhyay, A. and P. Chatterjee, 1981. A check of blue-green algae from the paddy fields of 24-Parganas and Hooghly districts of West Bengal-I. *Phykos* **20(1 & 2)**: 81–84
- Munawar, C. 1974. Limnological studies on fresh water ponds of Hyderabad, India. *Hydrobiol.* **44 (1)**: 13-27
- Muthukumar, C., G. Muralitharan, R. Vijayakumar, A. Panneerselvam and N. Thajuddin, 2007. Cyanobacterial biodiversity from different freshwater ponds of Thanjavur, Tamilnadu (India). *Acta Botanica Malacitana* **32**: 17-25
- Nandan, S. N. and S. R. Ahuja, 2010. Study of blue green algal biodiversity of lentic hydrosphere of Haranbari dam of Maharashtra (India). *Asian J. Exp. Biol. Sci.* **1(Spl)**: 140-143
- Naskar, N., K. R. Naskar and C. R. Sen, 2008. Brakish water Oscillatoriaceae from North 24–Parganas, West Bengal, India. *Bangladesh J. Plant Taxon.* **15(1)**: 31–38
- Pal, S. 1975. A check list of algae from Ghaziabad. *Phykos* **14(1&2)**: 67-76
- Pal, S. and A. K. Yadav, 1974. Some Cyanophyceae from Saharanpur district. A taxonomic enumeration. *Phykos* **13(1)**: 38-47
- Pandey, D. C. 1965a. A study of the algae from paddy field soils of Ballia and Ghazipur districts of Uttar Pradesh, India. *Nova Hedwigia* **10(1/2)**: 177-207
- Pandey, D. C. 1965b. A study of the algae from paddy field soils of Ballia and Ghazipur districts of Uttar Pradesh, India-I. *Nova Hedwigia* **9(1-4)**: 299-334
- Pandey, J., Pandey U., Tyagi H. R. and Rai N. 1998. Algal flora and physicochemical environment of Fateh Sagar Lake. *Phykos* **37 (1 & 2)**: 29 – 39
- Pandey, U. C. 2002. Soil cyanobacteria from arable lands of southern Rajasthan. *Phykos* **41 (1 & 2)**: 7-11
- Pandey, U. C. 1982. Additions to algal flora of Rohilkhand division-VI, Cyanophyceae. *Phykos* **21**: 137-140
- Pandey, U. C. and Chaturvedi U. K., 1979. Algae of Rohilkhand division, U.P., India- V. *Phykos* **18(1 & 2)**: 37-43
- Pandey, U. C., U. K. Chaturvedi, I. Habib, H. M. Shukla and A. K. Agnihotri, 1988. Some desmids new to Bareilly. *J. Indian Bot. Soc.* **67**: 71-73
- Pandey, U. C. and D. C. Pandey, 1982. Additions to the algal flora of Allahabad-VIII, Cyanophyceae. *Phykos* **21**: 76-79
- Pandhol, H. K. and I. S. Grover, 1976. Algal flora of Ludhiana and its adjacent areas. *Phykos* **15(1 & 2)**: 81-87

- Pariikh A., Shah and Madahwar, 2006. Cyanobacterial flora from polluted Industrial effluents. *Environmental monitoring and Assesment* **116 (1-3)**: 91-102
- Parukutty, P. R. 1940. The Myxophyceae of Travancore state, India. *Proc. Indian Acad. Sci.-Sect. B* **11(3)**: 117-124
- Patel, R. J., M. J. Soni and J. K. Vaghela, 1974. A preliminary survey of Cyanophyceae of Anand (Gujarat, India). *Bangladesh J. Bot.* **3(1)**:23-33
- Patil, K. J., R. T. Mahajan and S. R. Mahajan, 2011. Phytonic diversity of Jalgaon District, Maharashtra (India). *J. Algal. Biomass. Utiln.* **3(2)**: 71-102
- Patil, and Neelima 2013. Cyanophycean flora of Toranmal, district Nandurbar, Maharashtra. *Indian Hydrobiol.* **16(1)**: 32-41
- Patil, V. P. and S. N. Nandan, 2011. Biodiversity of Cyanophyceae from Amarabati Dam of Dhule district, (Maharashtra). *J. Experimental Science* **2(3)**: 33-36
- Patralekh, L. N. 1990. Thermophilic blue-green algae of Rishikund. *J. Econ. Taxon. Bot.* **14(3)**: 735-737
- Prain, D. 1905. The vegetation of the districts of Hooghly-Howrah and the 24-Pergunnahs. *Rec. Bot. Surv. India* **3(2)**: 143-339
- Prasad, A. and M. V. N. Panikkar, 2008. Species of *Oscillatoria* Vaucher from Kerala, India. *J. Econ. Taxon. Bot.* **32 (4)**: 909-921
- Prasad, B. N. 1964-65. On the algal flora of river Varnua in Varanasi district. *J. Sci. Res. BHU* **15(1)**: 142-151
- Prasad, B. N. and R. K. Mehrotra, 1978. Some new additions to Cyanophycean flora of India. *J. Indian Bot. Soc.* **57(1)**: 98-101
- Prasad, B. N. and R. K. Mehrotra, 1979. Cyanophycean flora of some North Indian crop fields. *Geophytol.* **8(2)**: 147-157
- Prasad, B. N. and R. K. Mehrotra, 1980. Blue-green algae of paddy fields of Uttar Pradesh. *Phykos* **19(1)**: 121-129
- Prasad, B. N. and M. Saxena, 1980. Ecological study of Blue-gren-algae in river Gomati. *Indian J. Environ. Hlth.* **22(2)**: 151-168
- Prasad, B. N. and P. N. Srivastava, 1965. Thermal algae from Himalayan hot springs. *Proc. Nat. Inst. Sci.* **31(1 & 2)**: 45-53
- Prasad, B. N. and M. N. Srivastava. 1992. Fresh water algal flora of Andaman and Nicobar Island, Vol. I. Bishen Singh and Mahendra Pal Singh, Dehradun, India, pp. 1-369
- Rai, L. C. and H. D. Kumar, 1976. Systematic and Ecological studies on algae of some habitats polluted with fertilizer factory effluent. *Nova Hedwigia* **27**: 805-811
- Rai L. C. and H. D. Kumar, 1979. Studies on some algae of polluted habitats. *Recent Researchers in plant Sciences*. Ed S S Bir, Kalyani Publishers, New Delhi, India. pp. 12-18
- Rai, U. N., S. Dubey, O. P. Shukla, S. Dwivedi and R. D. Tripathi, 2008. Screening and identification of early warning algal species for metal contamination in freshwater bodies polluted from point and non-point sources. *Environ. Monit. Assess.* **114**: 469-481
- Ramakrishnan, N. and L. Kannan 1992. Blue green algal flora of Muthupet, Tamil Nadu. *Phykos* **31**: 169-171

- Ramanathan, G., R. Sugumar, A. Jeeverathinam and K. Rajarathinam, 2013. Studies of Cyanobacterial distribution in estuary region of Southeastern Coast of Tamil Nadu, India. *J. Algal Biomass Utiln.* **4(3)**: 26-34
- Ramasamy, S. and P. Chandran, 2015. Evaluation of Cyanobacterial Distribution in Estuary Region of Southeastern India and its Phycoremedian studies in Industrial Effluent. *Int. J. of Adv. Res.* **3(4)**: 1085-1093
- Rao, C. B. 1936. The Myxophyceae of the United Provinces, India–II. *Proc. Indian Acad. Sci.* **3(2)**: 165-174
- Rao, C. B. 1937. The Myxophyceae of the United Provinces, India–III. *Proc. Indian Acad. Sci.* **6**: 339–375
- Rao, C. B. 1938a. The Myxophyceae of the Orissa Province, India–I. *Proc. Indian Acad. Sci.-Section B* **8(3)**: 157-170
- Rao, C. B. 1938b. The Myxophyceae of the Madras presidency, India-I. *J. Indian Bot. Soc.* **17**: 81-96
- Rao, C. B. 1939a. The Myxophyceae of the Orissa provinces, India-I. *J. India Acad. Sci.* **8(B)**: 157-170
- Rao, C. B. 1939b. The Myxophyceae of the Bihar province, India-I. *India Acad. Sci.* **9(3) B**: 142-150
- Rao, C. B. 1940. The Myxophyceae of the Delhi province, India-I. *India Acad. Sci.* **11(3B)**: 125-131
- Rao, S. D. and H. Pattnaik, 1975. Studies on some blue-green algae growing at high temperature. *Phykos* **14(1 & 2)**: 27-28
- Rao, V. S. 1977. An ecological study of three fresh-water ponds of Hyderabad-India-IV (Diatom, Euglenineae, & Myxophyceae). *Hydrobiol.* **53(1)**: 13-32
- Roy, H. K. 1955. Plankton ecology of the river Hooghly at Palta, West Bengal. *Ecology* **36(2)**: 169-175
- Roy, S., S. Bhattacharya, M. Debnath and S. Ray, 2014. Diversity of cyanobacterial flora of Bakreswar geothermal spring, West Bengal, India-II. *Algological Studies* **147 (2015)**: 29–44
- Roy, S. and J. P. Keshri, 2014. On the occurrences of the members of Nostocales (Cyanophyta) from Burdwan, West Bengal, India with a note on their ecology. *International Journal of Life Sciences Biotechnology and Pharma Research* **3(3)**: 126-149
- Sahu, J. K. 2000. Distribution and monthly succession of blue-green algae in the rice fields of Puri District of Orissa. *J. Econ. Taxon. Bot.* **24(1)**: 191-196
- Santra, S. C. 1993. Biology of Rice fields Blue green algae. Daya publishing house. New Delhi pp. 1-184
- Santra, S. C. and U. C. Pal, 1989. Phytoplanktons of Bhagirathi-Hooghly estuary: An illustrative account. *Indian Biologist* **21(1)**: 1-27
- Santra, S. C., U. C. Pal, H. Maity and G. Bandyopadhyay, 1988. Blue green algae in saline habitats of West Bengal, A systematic account. *Biol. Mem.* **14(1)**: 81–108
- Sarojini, Y. 1996. Seasonal changes in phytoplankton of sewage and receiving harbor waters at Vishakhapatnam. *Phykos* **35(1 & 2)**: 171-182
- Saxena, P. N. 1960. Algal flora of "Usar" lands in Uttar Pradesh. *Sci. & Cult.* **25(9)**: 542-543
- Sen, C. R. 2000. The genus *Lyngbya* Ag. From Gangetic plains of West Bengal. *Phykos* **39 (1 & 2)**: 61-64

- Sen, C. R. 2006. Some Cyanophyceae from greater Calcutta-I. A taxonomic emmeration. *J. Econ. Taxon. Bot.* **30(4)**: 885-890
- Sen, C. R. and D. Gupta, 1987. The genus *Oscillatoria* from Greater Calcutta. *Bull. Botan. Soc. Bengal* **41**: 4-45
- Sen, C. R. and D. Gupta, 1998. The genus *Oscillatoria* Voucher from lower gangetic plains of West Bengal. *Phykos* **37 (1 & 2)**: 89-93
- Sen Sarkar, N., T. Bandyopadhyaya, S. Datta and S. Das, 2013. Algae in the assessment of industrial effluents: Case study in Southern Bengal, India. *J. Environ. Pathol. Toxicol. Oncol.* **32(2)**: 101-114
- Shaji, C. and M. V. N. Panikkar, 1994. Cyanophyceae of Kerala, India. *Phykos* **33 (1 & 2)**: 105-112
- Sharma, T. A. and S. Kanta, 1978. Algal flora of Patiala and its environs- I. *Phykos* **17(1&2)**: 105-111
- Sharma, T. A., S. Kanta and Sunita, 1979. Algal flora of Patiala and its environ- Cyanophyceae II. *Phykos* **18(1 & 2)**: 13-19
- Shukla, P. 1966. Behaviour of catalase in some members of Chlorophyceae and Cyanophyceae. *Hydrobiol.* **27(3-4)**: 460-464.
- Sikdar, J. and Keshri J. P. 2014. The Genus *Oscillatoria* Vaucher (Oscillatoriales: Cyanoprokaryota) In West Bengal, India. *Indian J. Curr. Res. Rev.* **6(21)**: 47-59
- Singha Roy, A. and R. Pal, 2015. Planktonic Cyanoprokaryota and Bacillariophyta of East Kolkata wetlands Ecosystem, a Ramsar site of India with reference to diversity and taxonomic study. *J. of Algal Biomass Utiln.* **6(3)**: 47-59
- Singh, A., V. Tiwari and J. Mohan, 2014. Chroococcales in river Ganga at Jajmau Ghat, Kanpur. *Tropical Plant Res.* **1(1)**: 28-30
- Singh, K. P. 1959a. The Myxophyceae of the Kumaon hills, U.P., India-I. *Proceedings: Plant Sciences* **49(3)**: 161-166
- Singh, K. P. 1959b. The algal flora of Vindhyan formations of the Mirzapur district, U.P. *Proceedings: Plant Sciences* **49(1)**: 66-73
- Singh, K. P. and U. K. Chaturvedi, 1970. Myxophyceae of the Rohilkhand division, U.P. India-II. *Phykos* **9(1)**: 36-40
- Singh, N. I., N. S. Singh, G. A. Devi and S. M. Singh, 1997. Blue green algae from rice growing areas of Arunachal Pradesh. *Phykos* **36(1 & 2)**: 21-26
- Singh, R. N. 1939. An investigation into the algal flora of paddy field soils of the United Provinces. *J. Indian Jour. Agri. Sci.* **9(1)**: 55-77
- Singh, V. P. 1941. On a Collection of Algae from the Chamba state, Punjab-I. *Proc. Indian Aca. Sci.* **14 (3)**: 250-255
- Sinha B. D. and N. K. Srivastava, 1980. Algal flora of Balmikinagar, Bihar. *Phykos* **19(2)**: 171-174
- Sinha, J. P. and D. Mukherjee, 1975a. On Blue-green algae from the paddy fields of Bankura district of W.B. I. *Phykos* **14(1 & 2)**: 117-118
- Sinha, J. P. and D. Mukherjee 1975b. On Blue-green algae from the paddy fields of Bankura district of W.B. II. *Phykos* **14(1 & 2)**: 119-120

- Sinha, J. P. and D. Mukherjee, 1984a. Blue-green algae from the paddy fields of Bankura district of West Bengal – III. *Phykos* **23**: 142–143.
- Sinha, J. P. and D. Mukherjee, 1984b. New variety of *Lyngbya ceylanica* Wille var. *bankurensis* var. nov. *Phykos* **23(1 & 2)**: 148-151
- Sivakamasundari, K. and R. Rajendran 2015. Cyanobacterial Biodiversity in Natural Mangrove vegetation of Paravandar Estuary of Poondiyankuppam, Cuddalore coast, South East coast of India. *Int. J. Curr. Res. Life Sci.* **4(2)**: 130-132
- Somasekhar, R. K. 1983. Algal flora of river Cauvery, Karnataka I. Cyanophyceae and Chlorophyceae. *Phykos* **22**: 73-80
- Somashekar, R. K. 1984. Contribution to the algal flora of river Kapila, Karnataka I. Cyanophyceae & Chlorophyceae. *Phykos* **23(1 & 2)**: 116-124
- Srinivasan, M. V. 1963. Some Myxophyceae from the Mysore state. *Phykos* **2(1 & 2)**: 45-48
- Srivastava, P. N. and C. Nigam, 1980. Soil Algae from semi-arid regions. *Geophytol.* **10 (2)**: 129-136
- Subba Raju, N. 1963. The algal flora of Kashmir-I. *J. Osmania Univ. Sci.* **1**: 9-16
- Subramaniyan, V., J. Savarimuthu, and M. Chocckaya, 2012. Studies on Cyanobacterial population in industrial effluents. *J. Algal Biomass Utiln.* **3(1)**: 39-45
- Suryavanshi, S. S., S. D. Pingle and V. B. Gaikwad, 2010. Diversity of Cyanophyceae members in and around Ahmednagar region (M. S.). *J. Indian Bot. Soc.* **89(1 & 2)**: 189-196
- Suxena, M. R., V. Venkateswarlu, N. S. Raju and V. S. Rao, 1973. The algae Testaceae of Cragnore, Kerala State, India. *J. Indian Bot. Soc.* **52**: 316 – 341
- Tarar, J. L. and D. B. Kelkar, 1979. Effects of some selected antibodies on soil algae. *Curr. Sci.* **48(3)**: 352-354
- Tarar, J. L. and T. H. Shewale, 1984. Studies on the effects of some fungicides on soil algae of paddy field. *Phykos* **23**: 191-201
- Tiwari, A. and S. V. S. Chauhan, 2006. Seasonal variation in some *Oscillatoria* species from polluted ponds of Agra. *J. Indian Bot. Soc.* **85**: 110–117
- Tiwari, D., S. Singh and P. Kaur, 2001. Algal periphyton of the river Pandu. *Phykos* **40 (1 & 2)**: 39-43
- Tiwari, G. L. 1972. Study of blue-green algae from paddy fields soils of India. *Hydrobiol.* **29**: 335–350
- Tiwari, G. L. 1975. A study of the Blue green algae from paddy field soils of India-II. Taxonomic considerations of Non-heterocystous blue-green algae. *Nova Hedwigia* **26**: 765-797
- Vasishta, P C. 1961. More Cyanophyceae of Hoshiarpur. *J. Bombay Nat. Hist. Soc.* **58(1)**: 135-146
- Vasishta, P. C. 1963. More Cyanophyceae of Hoshiarpur II. *J. B. N. H. S.* **60(3)**: 671-678
- Vasishta, P. C. 1968. Thermal Cyanophyceae of India-I. *Phykos* **7 (1 & 2)**: 198-341
- Venkataraman, G. S. 1957. The algal flora of the ponds and puddles inside the Banaras Hindu University grounds, India. *J. Bombay Nat. Hist. Soc.* **54**: 908-991

Venkataraman, G. S. 1958 b. Observation on some Myxophyceae from high altitudes. *J. Bombay Nat. Hist. Soc.* **55**: 318-321

Venkataraman, R. and S. Srinivasan, 1980. Blue green algae. A renewable resource in rice cultivation. Proc. Nat. Work. Algal. Systems. Indian Soc. Biotech. I.I.T./ New Delhi pp. 45-53

Venkateswarlu, V. 1976. Taxonomy and ecology of algae in the river Moosi, Hyderabad, India. *Nova Hedwigia* **27**: 661 – 688

Vijayan, D. and J. G. Roy, 2015. Ecology and Diversity of Cyanobacteria in Kuttanadu Paddy Wetlands, Kerala, India. *American Journal of Plant Sciences* **6**: 2924-2938