

## CYANOPHYCEAN FLORA OF SOUTHERN HIMANCHAL PRADESH, INDIA

**R.K. Dwivedi, S.K. Shukla, C.P. Shukla, P.K. Misra and M.K. Seth\***

Phycology Research Laboratory, Department of Botany  
University of Lucknow, Lucknow 226007, India

\*Department of Bio-sciences  
Himanchal Pradesh University, Shimla 171003, India  
Email: misrapkm@yahoo.com

### ABSTRACT

The present paper deals with 37 taxa, 18 genera, 32 species, 4 varieties and 1 forma explored from southern Himanchal Pradesh of India. These taxa are represented by *Microcystis*, *Chroococcus*, *Aphanocapsa*, *Aphanothece*, *Merismopedia*, *Coelosphaerium*, *Gomphosphaeria*, *Stichosiphon*, *Oscillatoria*, *Lyngbya*, *Pseudanabaena*, *Cylindrospermum*, *Anabaena*, *Nostoc*, *Nodularia*, *Fortiea*, *Calothrix*, *Anabaenopsis*. Out of 37 taxa, 27 are first report from the study area.

**Key words:** Fresh-water, blue-green algae, systematics, southern Himanchal Pradesh, India.

### INTRODUCTION

Earlier works of Singh (1959, 1961), Talpasayi (1962), Kamat (1968, 1973), Gupta and Nair (1962), Darbal *et al.* (1978), Khan (1970), Habib (1999), and Seth *et al.* (2006), on fresh-water algae of western Himalaya of India, reveal that a large part of this region is still unexplored. Habib *et al.* (1998) have reported chlorococcales from Kotdwar. Habib and Chaturvedi (1999, 2000, 2001) have described chlorococcales and chaetophorales from Ramnagar, Ranikhet and Kumaon region, respectively. Shukla and Misra (2006), and Shukla *et al.* (2007) have worked on fresh-water algae from foothills of western Himalayas. Misra *et al.* (2006) have reported some desmids from Himanchal Pradesh (western Himalayas).

### MATERIALS AND METHODS

Random sampling technique has been applied in the algal collection procedure. Sample collections were made between November 2003 to November 2006 from lotic and lentic habitats of southern Himanchal Pradesh, India, by using planktonic mesh net. The algal samples were preserved in 3-4% formalin and slides were prepared by staining cyanophycean algae with methylene blue and mounted in glycerine. Detailed studies were made by examining specimens under a Nikon Labophot microscope E-400 with H-III photomicrographic attachment. All measuring scales given for algal photographs are equal to 10  $\mu\text{m}$  except some which are equal to 50  $\mu\text{m}$  and are mentioned above the scale.

Species identifications have been done after Desikachary (1959), Prescott (1951) and Prasad and Srivastava (1992).

## RESULTS AND DISCUSSION

A Total of 37 taxa, 18 genera, 32 species, 4 varieties and 1 forma belonging to class Cyanophyceae have been recorded. *Aphanocapsa* and *Fortiea* have been reported only from Una district, while genus *Stichosiphon*, *Anabaenopsis* from Hamirpur district, *Fortiea* and *Pseudanabaena* from Mandi district and *Cylindrocapsa* from Sirmaur district only. Genus *Oscillatoria* Vaucher has been present at every region. Twenty seven taxa are being reported for the first time from this study area that are represented with an asterisk mark (\*) in explanation of figures (Plates 1 and 2)

**Order:** Chroococcales

**Family:** Chroococcaceae

**Genus:** *Microcystis* Kütz.

1. *Microcystis aeruginosa* Kutz. (Pl. 1, Fig. 1) Desikachary, T.V. (1959) (Pl. 17, Figs. 1, 2, 6, PP. 93)

**Collection Number and Date:** HP/MAN/6b, 21/5/2004

**Locality:** Rewalsar Lake, Mandi.

2. *M. flos-aquae* (Wittr.) Kirchner (Pl. 1, Fig. 2) Desikachary, T.V. (1959) (Pl. 17, Fig. 11, PP. 94)

**Collection Number and Date:** HP/MAN/6b, 21/5/2004

**Locality:** Rewalsar Lake, Mandi.

**Description:** Cells 3-4 µm in diameter.

3. *M. lamelliformis* Holsinger (Pl. 1, Fig. 4) Desikachary, T.V. (1959) (Pl. 19, Figs. 1, 2, PP. 91)

**Collection Number and Date:** HP/HAM/5c, 2/6/2005

**Locality:** Taal Pond, Hamirpur.

**Description:** Cells 3-4 µm in diameter.

4. *M. robusta* (Clark) Nygaard (Pl. 1, Fig. 3) Desikachary, T.V. (1959) (Pl. 17, Fig. 7-10, PP. 85)

**Collection Number and Date:** HP/HAM/Sc, 2/6/2005

**Locality:** Taal Pond, Hamirpur.

**Description:** Cells 6-8 µm in diameter.

**Genus:** *Chroococcus* Nag.

1. *Chroococcus limneticus* Lemm. (Pl. 1, Fig. 5) Desikachary, T.V. (1959) (Pl. 26, Fig. 4-6, PP. 107)

**Collection Number and Date:** HP/UNA/4c, 1/6/2005

**Locality:** Swan River Una.

**Description:** Cells without sheath 10 µm in diameter with sheath 14 µm in diameter.

2. *C. minutus* (Kutz.) Nag. (Pl. 1, Fig. 7) Desikachary, T.V. (1959) (Pl. 24, Fig. 4, PP. 103)

**Collection Number and Date:** HP/MAN/4b, 20/5/2004

**Locality:** Nalsar Pond, Mandi.

**Description:** Cells without sheath 8 µm in diameter with sheath 10 µm in diameter.

3. *C. tenax* (Kirchn.) Hieron (Pl. 1, Fig. 6) Desikachary, T.V. (1959) (Pl. 26, Fig. 7, 16, PP. 103)

**Collection Number and Date:** HP/UNA/4c, 4/4/2006

**Locality:** Saloh Ghaluwal Pond, Una.

**Description:** Cells without sheath 19 µm in diameter with sheath 29 µm in diameter.

**Genus:** *Aphanocapsa* Nag.

1. *Aphanocapsa pulchra* (Kutz.) Rabenh (Pl. 1, Fig. 8) Desikachary, T.V. (1959) (Pl. 21, Fig. 2, PP. 132)

**Collection Number and Date:** HP/UNA/4c, 4/4/2006

**Locality:** Saloh Ghaluwal Pond, Una.

**Description:** Cells 3.5 µm in diameter.

**Genus:** *Aphanothece* Nageli

1. *Aphanothece castagnei* (Breb.) Rabenh (Pl. 1, Fig. 9) Desikachary, T.V. (1959) (Pl. 21, Fig. 8, PP. 140)

**Collection Number and Date:** HP/UNA/4c, 4/4/2006

**Locality:** Saloh Ghaluwal Pond, Una.

**Description:** Cells 6 µm in length; 3.5 µm in width

**Genus:** *Merismopedia* Meyen

1. *Merismopedia glauca* (Ehr.) Nag. (Pl. 1, Fig. 10) Desikachary, T.V. (1959) (Pl. 29, Fig. 5; PP. 155) Prasad, B.N. and Srivastava, M.N. (1992) (Pl. 6 Fig. 5, PP. 44)

**Collection Number and Date:** HP/MAN/2b, 19/5/2004

**Locality:** Jarol Khad, Mandi.

**Description:** Diameter of cell 3-4 µm, diameter of colony 10 µm.

**Genus:** *Coelosphaerium* Nag.

1. *Coelosphaerium kützingianum* Nag. (Pl. 1, Fig. 11) Desikachary, T.V. (1959) (Pl. 28, Fig. 7, 8, PP. 148)

**Collection Number and Date:** HP/UNA/4c, 4/4/2006

**Locality:** Saloh Ghaluwal Pond, Una.

**Description:** Cells 2.5-6 µm in diameter, colony 110 µm in diameter.

**Genus:** *Gomphosphaeria* Kütz.

1. *Gomphosphaeria aponina* Kütz. (Pl. 1, Fig. 12) Desikachary, T.V. (1959) (Pl. 28, Figs. 1-3, PP. 150)

**Collection Number and Date:** HP/SIM/I 5b, 25/5/2004

**Locality:** Kufri Pond, Shimla.

**Description:** Cells 6 µm in length; 4 µm in width.

**Order -** Chamaesiphonales

**Family:** Dermocarpaceae

**Genus:** *Stichosiphon* Geitler

1. *Stichosiphon sansibaricus* (Hieron.) Drouet et Daily (Pl. 1, Fig. 13) Desikachary, T.V. (1959) (Pl. 32, Fig. 9-13, PP. 176)

**Collection Number and Date:** HP/HAM/12c, 4/6/2005

**Locality:** Kunah Khad Dindwi, Hamirpur.

**Description:** Cells 4-5 µm in width.

**Order -** Nostocales

**Family:** Oscillatoriaceae

**Genus:** *Oscillatoria* Vaucher

1. *Oscillatoria perornata* Skuja (Pl. 2, Fig. 15) Desikachary, T.V. (1959) (Pl. 41, Fig. 14, PP. 205)

**Collection Number and Date:** HP/HAM/I Ic, 4/6/2005

**Locality:** Jhanyari Khad Bhota, Hamirpur.

**Description:** Trichome 10 µm broad, 3-4 µm long.

2. *O. princeps* Vaucher ex Gomont (Pl. 2, Fig. 17) Desikachary, T.V. (1959) (Pl. 37, Fig. 11, PP. 210)

**Collection Number and Date:** HP/MAN/4b, 20/5/2004

**Locality:** Nalsar Pond, Mandi.

**Description:** Trichome 45 µm broad, 5 µm long.

3. *O. sancta* (Kütz.) Gomont (Pl. 1, Fig. 14) Desikachary, T.V. (1959) (Pl. 42, Fig. 10, PP. 203).

**Collection Number and Date:** HP/MAN/4b, 20/5/2004

**Locality:** Nalsar Pond, Mandi.

**Description:** Trichome 2.5 µm long, 11 µm broad

4. *O. terebriformis* Ag. ex Gomont (Pl. 1, Fig. 16) Desikachary, T.V. (1959) (Pl. 38, Fig. 16, PP. 217)

**Collection Number and Date:** HP/UNA/4c, 4/4/2006

**Locality:** Saloh Ghaluwal Pond, Una.

**Description:** Trichome 3 µm long, 6 µm broad.

**Genus:** *Lyngbya* Agardh

1. *Lyngbya hirgei* Smith, G.M. (Pl. 1, Fig. 20) Desikachary, T.V. (1959) (Pl. 50, Fig. 7, PP. 296)

**Collection Number and Date:** HP/MAN/4b, 20/5/2004

**Locality:** Nalsar Pond, Mandi.

2. *L. martensiana* Menegh. ex Gomont (Pl. 2, Fig. 1) Desikachary, T.V. (1959) (Pl. 52 Fig. 6, PP. 318)

**Collection Number and Date:** HP/MAN/4b, 20/5/2004

**Locality:** Nalsar Pond, Mandi.

**Description:** Trichome 11  $\mu\text{m}$  in width; 1.5  $\mu\text{m}$  in length.

3. *L. major* Menegh. ex Gomont (Pl. 1, Fig. 19) Desikachary, T.V. (1959) (Pl. 52, Fig. 11, PP. 320)

**Collection Number and Date:** HP/MAN/4b, 20/5/2004

**Locality:** Nalsar Pond, Mandi.

4. *L. putealis* Mont. ex Gomont (Pl. 1, Fig. 18) Desikachary, T.V. (1959) (Pl. 52, Fig. 12, PP. 317)

**Collection Number and Date:** HP/MAN/4b, 20/5/2004

**Locality:** Nalsar Pond, Mandi.

**Description:** Filament 16  $\mu\text{m}$  in width, trichome 12-13  $\mu\text{m}$  in width and 4-5  $\mu\text{m}$  in length.

**Family:** Nostocaceae

**Genus:** *Anabaenopsis* (Wolosz.) Miller sensu strict

1. *Anabaenopsis circularis* (G.S. West) Wolosz. et Miller var. *javanica* Wolosz. (Pl. 2, Fig. 2) Desikachary, T.V. (1959), (Pl. 63, Fig. 3 and 5, PP. 354)

**Collection Number and Date:** HP/HAM/5c, 2/6/2005

**Locality:** Taal Pond, Hamirpur.

**Description:** Cells 4-5  $\mu\text{m}$  broad; heterocyst  $\mu\text{m}$  broad

**Genus:** *Cylindrospermum* Kutzing

1. *Cylindrospermum stagnate* (Kutz.) Born et Flah. (Pl. 2, Fig. 3) Desikachary, T.V. (1959), (Pl. 65, Fig. 9, PP. 363)

**Collection Number and Date:** HP/SIR/11a, 8/11/2003

**Locality:** Giri river Yashawantnagar, Sirmaur.

**Description:** Cells 3-4  $\mu\text{m}$  broad; heterocyst 5  $\mu\text{m}$  broad, akinete 8  $\mu\text{m}$  broad.

**Genus:** *Nostoc* Vaucher

1. *Nostoc carneum* Ag. ex Born. et Flah. (Pl. 2, Fig. 5) Desikachary, T.V. (1959), (Pl. 69, Fig. 6, PP. 381)

**Collection Number and Date:** HP/MAN/6c, 6/4/2006

**Locality:** Suketi Khad Ner Chowk, Mandi.

**Description:** Cells 3  $\mu\text{m}$  broad; heterocyst 4  $\mu\text{m}$  broad.

2. *N. muscorum* Ag. ex Born. et Flah. (Pl. 2, Fig. 4) Desikachary, T.V. (1959) (Pl. 70, Fig. 2, PP. 385)

**Collection Number and Date:** HP/MAN/6c, 6/4/2006

**Locality:** Suketi Khad Ner Chowk, Mandi.

3. *N. passerifianum* (De. Not.) Bornet ex Born. et Flah. (Pl. 2, Fig. 6) Desikachary, T.V. (1959), (Pl. 69, Fig. 4, PP. 385)

**Collection Number and Date:** HP/MAN/4b, 20/5/2004

**Locality:** Nalsar Pond, Mandi.

**Description:** Cells 3-4  $\mu\text{m}$  broad; heterocyst 5  $\mu\text{m}$  broad.

**Genus:** *Anabaena* Bory

1. *Anabaena circmalis* Rabenhorst ex Born. et Flah. var. *crassa* Ghose (Pl. 2, Fig. 8) Desikachary, T.V. (1959), (Pl. 77, Fig. 5, PP. 414)

**Collection Number and Date:** HP/HAM/5c, 2/6/2005

**Locality:** Taal Pond, Hamirpur.

**Description:** Cells 3-4 µm broad; heterocyst 5 µm broad.

2. *A. macrospora* Klebahm (Pl. 2, Fig. 11) Prescott, G. W. (1951) (Figs. 4-6, Pl. 117, PP. 517)

**Collection Number and Date:** HP/MAN/Sc, 6/4/2006

**Locality:** Nalsar Pond, Mandi.

**Description:** Cells 7 µm in width, heterocyst 7 µm in width.

3. *A. fertilissima* Rao, C. B. (Pl. 2, Fig. 9) Desikachary, T.V. (1959), (Pl. 74, Fig. 1, PP. 398)

**Collection Number and Date:** HP/UNA/4c, 4/4/2006

**Locality:** Saloh Ghaluwal Pond, Una.

**Description:** Cells 5-6 µm broad; heterocyst 9 µm broad.

4. *A. laxa* (Rabehn.) (Pl. 2, Fig. 10) Desikachary, T.V. (1959), (, PP. 413)

**Collection Number and Date:** HP/UNA/4c, 4/4/2006

**Locality:** Saloh Ghaluwal Pond, Una.

**Description:** Cells 4 µm broad; heterocyst 5 µm broad and 7 µm long.

5. *A. helicoidea* Bernard (Pl. 2, Fig. 12) Prescott, G. W. (1951) (Fig. 8, Pl. 116, PP. 515)

**Collection Number and Date:** HP/HAM/5c, 2/6/2005

**Locality:** Taal Pond, Hamirpur.

**Description:** Cells 5 µm broad.

6. *A. torulosa* (Carm.) Lagerh. (Pl. 2, Fig. 7) Desikachary, T.V. (1959), (Pl. 71, Fig. 6, PP. 415)

**Collection Number and Date:** HP/MAN/5c, 6/4/2006

**Locality:** Nalsar Pond, Mandi.

**Genus:** *Pseudanabaena* Lauterborn

1. *Pseudanabaena schmidlei* Jaag. O. (Pl. 2, Fig. 13) Desikachary, T.V. (1959), (Pl. 75, Fig. 4, PP. 419)

**Collection Number and Date:** HP/SOL/10a, 8/11/2003

**Locality:** Mohan Baodi Dharmapur, Solan.

**Description:** Cells 10 µm broad 9 µm long.

**Sub Family:** Aulosirae

**Genus:** *Nodularia* Mertens

1. *Nodularia spumigena* Mertens ex Born. et Flah. (Pl. 2, Fig. 14) Desikachary, T.V. (1959), (Pl. 80, Figs. 13, 14, PP. 423)

**Collection Number and Date:** HP/UNA/4c, 4/4/2006

**Locality:** Saloh Ghaluwal Pond, Una.

**Description:** Cells 7 µm broad; heterocyst 10 µm broad.

**Family:** Microchaetaceae

**Genus:** *Fortiea* De Toni, J.

1. *Fortiea bossei* (Freymy) comb. nov. (Pl. 2, Fig. 15) Desikachary, T.V. (1959), (Pl. 82, Fig. 13-15, PP. 516)

**Collection Number and Date:** HP/MAN/5c, 6/4/2006

**Locality:** Nalsar Pond, Mandi.

**Family:** Rivulariaceae

**Genus:** *Calothrix* Ag.

1. *Calothrix braunii* (A. Br.) Bornet et Flahault (Pl. 2, Fig. 16) Desikachary, T.V. (1959), (Pl. 114, Fig. 3, PP. 535)

**Collection Number and Date:** HP/UNA/4c, 4/4/2006

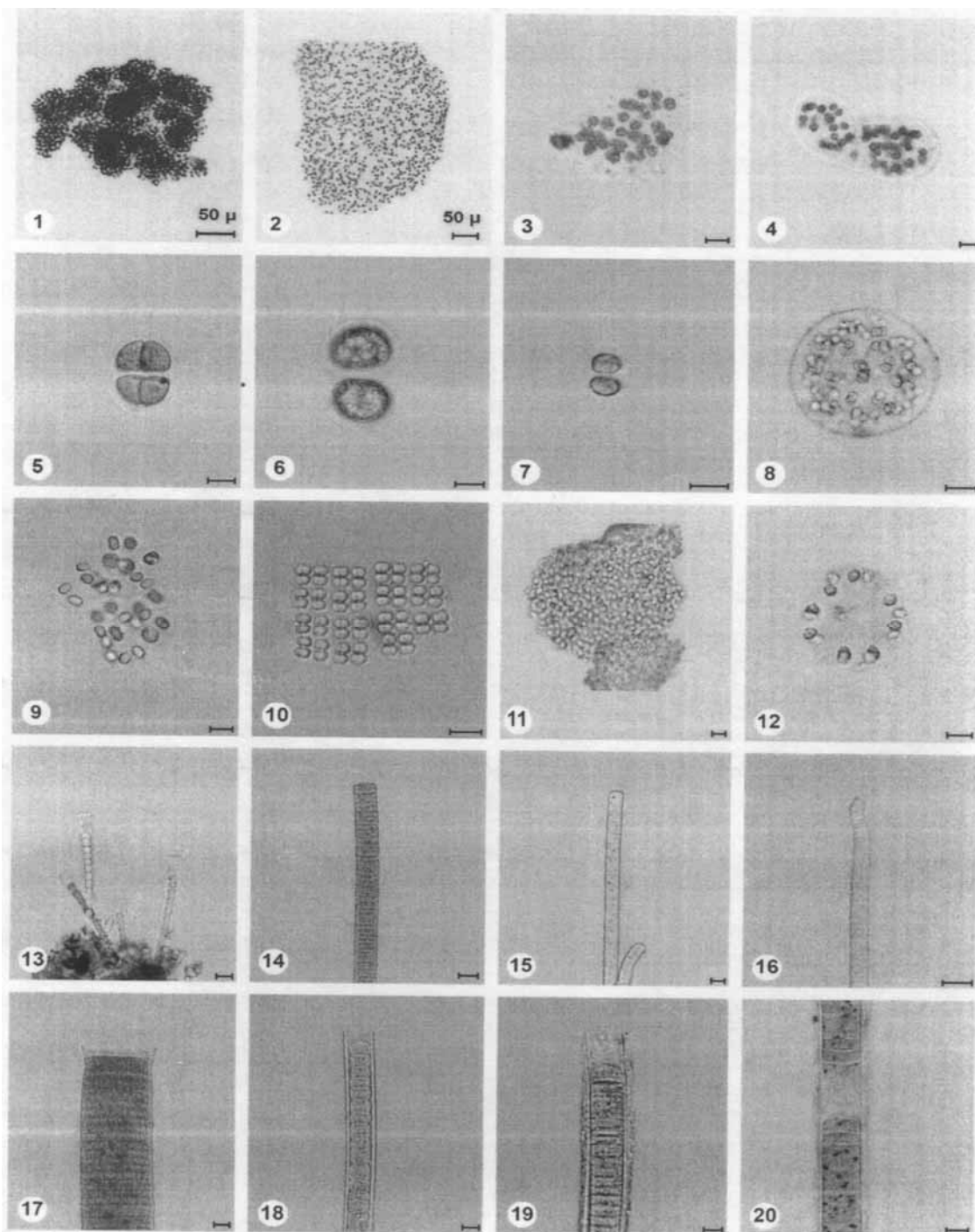
**Locality:** Saloh Ghaluwal Pond, Una.

2. *C. brevissima* West G.S. var. *moniliforme* Ghose (Pl. 2, Fig. 17) Desikachary, T.V. (1959) (Pl. 112, Fig. 8, PP. 533)

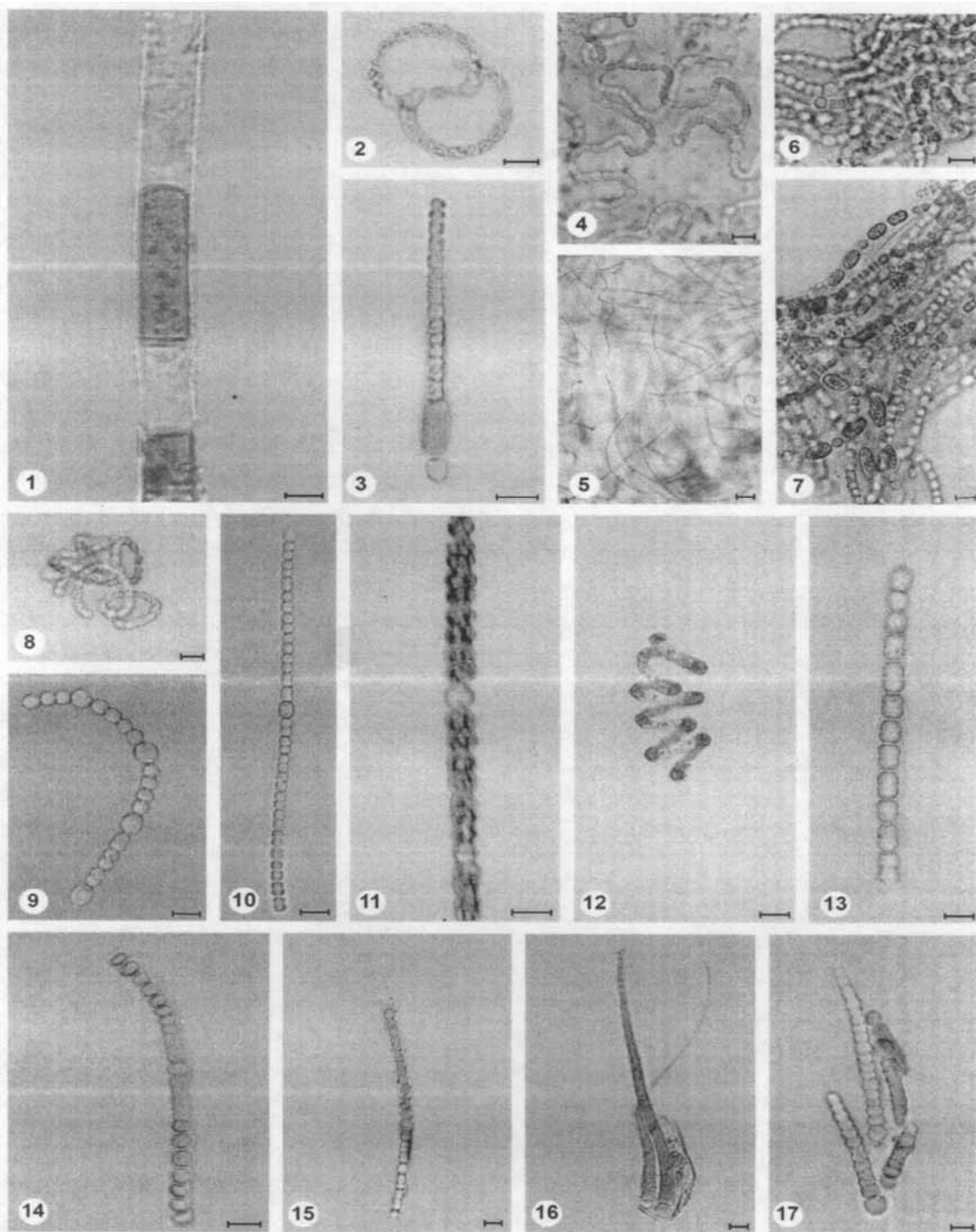
**Collection Number and Date:** HP/UNA/4c, 4/4/2006

**Locality:** Saloh Ghaluwal Pond, Una.

**Description:** Cells 4-8 µm broad; heterocyst 9 µm broad.



**Plate 1.** Fig. 1. *Microcystis aeruginosa* Kutzing, Fig. 2. *M. flos-aquae* (Wittr.) Kirchner, Fig. 3. *\*M. robusta* (dark) Nygaard, Fig. 4. *M. lamelliiformis* Holsinger, Fig. 5. *Chroococcus limnelicus* Lemmermann, Fig. 6. *\*C. tenax* (Kirchn.) Hieron, Fig. 7. *C. minutus* (Kutz.) Nageli, Fig. 8. *\*Aphanocapsa pulchra* (Kutz.) Rabenhorst, Fig. 9. *Aphanothece castagnei* (Breb.) Rabenhorst, Fig. 10. *Merismopedia glauca* (Ehr.) Nageli, Fig. 11. *Coelosphaerium Kützingianum* Nageli, Fig. 12. *Gomphosphaeria aponina* Kützing, Fig. 13. *\*Stichosiphon sansibaricus* (Hieron.) Drouet and Daily, Fig. 14. *Oscillatoria sancta* (Kütz.) Gomont, Fig. 15. *\*O. peronata* Skuja f. *attenuata* Skuja, Fig. 16. *O. terebriformis* Ag. ex Gomont, Fig. 17. *\*O. princeps* Vaucher ex Gomont var. *crassa* Rao, Fig. 18. *\*Lyngbya putealis* Mont. ex Gomont, Fig. 19. *L. major* Menenghini ex Gomont, Fig. 20. *L. birgei* Smith



**Plate 2 .** , Fig. 1. *Lyngbya martensiana* Menegh. ex Gomont, Fig. 2. *Anabaenopsis circularis* (G.S. West) Wolosz. and Miller var. *javanica* Wolosz., Fig. 3. *Cylindrospermum stagnate* (Kutz.) Bornet and Flahault, Fig. 4. *Nostoc muscorum* Ag. ex Born. and Flah., Fig. 5. *N. carneum* Ag. ex Born. and Flah., Fig. 6. *N. passerinianum* (De. Not.) Bornet ex Born. and Flah., Fig. 7. *Anabaena torulosa* (Carm.) Lagerheim, Fig. 8. *A. circinalis* Rabenhorst ex Born. and Flah var. *crassa* Ghose, Fig. 9. *\*A. fertilissima* Rao, Fig. 10. *\*A. laxa* (Rabehn.) Brown, Fig. 11. *A. macrospora* Klebahn., Fig. 12. *\*A. helicoidea* Bernard, Fig. 13. *Pseudanabaena schmidtei* Jaag, Fig. 14. *Nodularia spumigena* Mertens ex Born. and Flah., Fig. 15. *Fortiea bossei* (Fremy) comb. Desikachary, Fig. 16. *Calothrix braunii* (Br.) Bornet and Flahault, Fig. 17. *C. brevissima* West var. *momliiforme* Ghose.

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