



## DIVERSITY OF FRESHWATER ALGAE IN ARUNACHAL PRADESH AND THEIR DISTRIBUTION IN DIFFERENT ALTITUDES

**S.K. DAS AND S.P. ADHIKARY \***

*Centre for Biotechnology, Institute of Science  
Visva-Bharati, Shantiniketan, West Bengal-731235*

\* Corresponding author email: [adhikarysp@visva-bharati.ac.in](mailto:adhikarysp@visva-bharati.ac.in)

Eighty six freshwater algal species were documented from different locations of Arunachal Pradesh. These include 8 Cyanophyta (Cyanoprokaryota/Cyanobacteria), 30 Chlorophyta, 8 Euglenophyta, 40 Heterokontophyta (39 Bacillariophyceae and 1 Xanthophyceae). Among all these taxa, 12 species were reported for the first time in India. Distributional pattern of these species in different altitudinal ranges of the region has been described.

**Key words:** Algae, Altitudinal gradient, Arunachal Pradesh, Freshwater, Systematic enumeration

The terrain of Arunachal Pradesh consists of mountain ranges of the Himalayas on eastern side and sloping down to the plains of Assam towards the west. Though the region lies in the Indo-Burma hotspots, the diversity of algae in its freshwater habitats is still not fully known. There are only four published records which are confined to the Cyanophyta (Cyanobacteria/Cyanoprokaryota) diversity in rice fields and other subaerophytic habitats. Reddy *et al.* (1986) reported 10 species of Cyanophyta belonging to 7 genera. Singh *et al.* (1997) made a study on the blue green algae in the rice fields and documented 83 species under 25 genera. Recently, Devi *et al.* (2010) and Oinam *et al.* (2010) recored one species each from the moist soil surface in Itanagar, Arunachal Pradesh. The present work was carried out to survey the freshwater algal flora from different locations of Arunachal Pradesh, at different altitudes ranging from 436 to 13792 ft a.s.l. and their distributional pattern in different altitudinal ranges is presented.

### MATERIALS AND METHODS

A total of 48 samples were collected from different freshwater habitats like ponds, lakes, streams and rivers of Arunachal Pradesh covering Sangey, Tawang, Jaswant garh,

Itanagar, Ziro, Doimukh and Pasighat during October November, 2010. Samples were collected using plankton net (45  $\mu\text{m}$  pore size) and fixed with Lugol's iodine on the spot. GPS data of the habitat along with pH, conductivity, temperature and transparency of the water bodies were recorded (Table - 1). Each sample was assigned with a voucher number with date of collection, preserved in formaldehyde (4 %, v/v) and deposited at the Centre for Biotechnology, Visva Bharati, Santiniketan. Microphotograph of each specimen was taken using a Olympus epifluorescence microscope BX - 41 fitted with Nikon Coolpix 4500 digital camera. The organisms were identified by following different monographs (Kützing 1865, Huber-Pestalozzi 1942, 1955, Desikachary 1959, 1989, Randhawa 1959, Philipose 1967, Hindák 1988, Komárek and Fott 1983, Ettl and Gärtner 1995, Komárek and Anagnostidis 1998, 2005, Wołowski and Hindák 2005, Ramanathan 1964, West *et al.* 1923, Gonzalves 1981) and research publications (Cho 2000, Prescott 1961, Prasad and Mishra 1992, Prasad and Srivastava 1992, Pal and Santra 1992, Kant and Gupta 1998, Komárek and Jankovská 2001, Gonzalves and Gandhi 1952, Gandhi 1958, 1959, 1970, Sreenivasa and Duthie 1973, Misra and

Srivastava 2003, Rott and Lenzenweger 1994, Srivastava and Odhwani 1990). The Cyanophyta/Cyanoprokaryota taxa were presented in the text as per the classification of Komárek and Anagnostidis (1989, 1998, 2005). For algal taxa belonging to Chlorophyta, Euglenophyta and Heterokontophyta (Xanthophyceae and Bacillariophyceae) the classification of Lee (1999) was followed.

## RESULTS

Systematic Enumeration

Prokaryotic algae

Division Cyanophyta

(Cyanoprokaryota/Cyanobacteria)

Order Chroococcales

Family Merismopediaceae

**Genus *Aphanocapsa* Nägeli**

**1. *Aphanocapsa conferta* (W. et G.S. West)**

Komárková Legnerová et Cornberg (Plate 1, Fig. 1)

(Basionym *Aphanocapsa elachista* f. *conferta* West and G.S. West)

Komárek and Anagnostidis 1998, p. 155, fig. 180, 183

Free floating colonies with spherical, small, blue green cells, mucilage delicate, indistinct, colorless, cells 2-3.3  $\mu\text{m}$  in diameter, without aerotopes.

Place of collection Ganga lake, Itanagar; Habitat planktonic; Voucher number 2751; Date of collection 02.11.2010 (reported first time in India)

**Genus *Merismopedia* Meyen**

**2. *Merismopedia glauca* (Ehrenberg) Nägeli** (Plate 1, Fig. 2)

(Synonym - *Gonium glaucum* Ehrenberg, *Merismopedia aeruginea* Brébisson, *Merismopedia nova* Wood)

Desikachary 1959, p. 155, pl. 29, fig. 5

Colonies light blue green, almost rectangular

with slightly sinuate margin; hemispherical cells, 1 - 2.2  $\mu\text{m}$  in diameter, colony is 64 celled, 14 - 15  $\mu\text{m}$  long and 16 - 17  $\mu\text{m}$  broad.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2764; Date of collection 03.11.2010

Family Microcystaceae

**Genus *Microcystis* Kützing ex Lemmermann**

**3. *Microcystis wesenbergii* (Komárek)** Komárek in Kondrateva (Plate 1, Fig. 3)

(Synonym - *Diplocystis wesenbergii* Komárek) Komárek and Anagnostidis 1998, p. 232, fig. 305

Colonies spherical when young, cells arranged randomly, rarely densely, in young colonies cells occur near the colonial surface, mucilage colorless, structureless, cell spherical, with distinct aerotopes, 4.5-5  $\mu\text{m}$  in diameter.

Place of collection Ganga lake, Itanagar; Habitat planktonic; Voucher number 2749; Date of collection 02.11.2010

Order Oscillatoriales

Family Borziaceae

**Genus *Komvophoron* Anagnostidis et Komárek**

**4. *Komvophoron crassum* (Vozen)** Anagnostidis et Komárek (Plate 1, Fig. 4)

(Synonym *Pseudanabaena crassa* Vozen) Komárek and Anagnostidis 2005, p. 333, fig. 460

Filaments solitary, slightly bent, cells almost barrel shaped, 5 - 7  $\mu\text{m}$  long and 5  $\mu\text{m}$  broad, deeply constricted at the cross walls, apical cell rounded.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2757; Date of collection 03.11.2010 (reported first time in India)

Family Phormidiaceae

**Table 1:** GPS data and certain physico chemical characteristics of the water of the collection sites in Arunachal Pradesh

Locations	GPS	Temperature (°C)	Transparency(ft)	pH	Conductivity (iS)
Stream, Sangey	27°26'53.3"N 92°07'04.4"E Alt. 9223 ft	12	-	5.5 – 6	011
Paradise/Sela lake, Sela pass, Tawang	27°30'16.1"N 92°06'17.2"E Alt. 13792 ft	7	4.5	4.5 – 5	003
Stream on way to Jaswant garh	27°30'56.5"N 92°04'58.4"E Alt. 13036 ft	9	-	6	008
Gayker Sinyi / Ganga lake, Itanagar	27°03'23.8"N 93°33'13.6"E Alt. 4678 ft	26	2.5	6.5 – 7	027
Tarin fish farm, Ziro, Lower Subansiri	27°31'03.1"N 93°49'37.7"E Alt. 5087 ft	21 – 22	2 – 2.5	6.5	029-037
Stream, Doimukh	27°18'20.6"N 93°48'22.7"E Alt. 2297 ft	17	-	6	035
Siang river, Pasighat	28°04'37.3"N 95°18'12.2"E Alt. 436 ft	18	-	6	106
Siang river, Rani ghat, Pasighat	28°05'46.8"N 95°18'12.2"E Alt. 451 ft	21	-	6	117

### Genus - *Planktothrix Anagnostidis et Komárek*

#### 5. *Planktothrix cryptovaginata* (Škorbatov) Anagnostidis et Komárek (Plate 1, Fig. 5)

(Synonym - *Lyngbya cryptovaginata* Škorbatov)

Komárek and Anagnostidis 2005, p. 355, fig. 493

Filaments solitary, almost straight, trichomes 5.5 - 6  $\mu\text{m}$  wide, slightly constricted at the cross walls, not attenuated at the end, sheath delicate, not visible distinctly, cells 3.3 - 5  $\mu\text{m}$  long, cell contents with aerotopes (mainly in the cell centre), apical cell widely rounded.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2760; Date of collection 03.11.2010

### Genus *Phormidium* Kützing ex Gomont

#### 6. *Phormidium chlorinum* (Kützing ex Gomont) Anagnostidis (Plate 1, Fig. 6)

(Synonym *Oscillatoria chlorina* Kützing ex Gomont)

Komárek and Anagnostidis 2005, p. 436, fig. 634

Filament straight, yellowish green, 5.8  $\mu\text{m}$  in diameter, cross walls slightly constricted and granulated, cells almost isodiametric, 2.5-5  $\mu\text{m}$  long, apical cell rounded.

Place of collection Sangey; Habitat stream, epilithic; Voucher number 2686; Date of collection 29.10.2010

#### 7. *Phormidium numidicum* (Gomont sensu Welsh) Anagnostidis (Plate 1, Fig. 7)

(Basionym *Oscillatoria numidica* Gomont)

Komárek and Anagnostidis 2005, p. 436, fig. 632

Blue green trichome, 4 - 5  $\mu\text{m}$  broad, slightly constricted at the cross walls, not attenuated towards the tip, cells 3.7 - 4  $\mu\text{m}$  long, apical cell rounded.

Place of collection Jaswant garh; Habitat

**Table 2:** Distribution of algal taxa in different altitudinal ranges of Arunachal Pradesh. Cyanophyta/Cyanoprokaryota taxa were arranged as per Anagnostidis and Komarek (1989, 1998, 2005) and for the taxa belonging to Chlorophyta, Euglenophyta and Heterokontophyta the classification of Lee (1999) was followed.

Organisms	Altitudes (in ft.)			
	13036 - 13792	9223	2297 – 5087	436 - 451
<b>Cyanophyta</b>				
<i>Aphanocapsa conferta</i>			+	
<i>Merismopedia glauca</i>			+	
<i>Microcystis wesenbergii</i>			+	
<i>Komvophoron crassum</i>			+	
<i>Planktothrix cryptovaginata</i>			+	
<i>Phormidium chlorinum</i>		+		
<i>Phormidium numidicum</i>	+			
<i>Oscillatoria yamadae</i>			+	
<b>Chlorophyta</b>				
<i>Spirogyra acanthophora</i>			+	
<i>Spirogyra parvula</i>	+			
<i>Closterium moniliferum</i>	+			
<i>Staurastrum bicorne</i>			+	
<i>Staurastrum bieneanum</i> var. <i>ellipticum</i>	+	+		
<i>Staurastrum gracile</i>			+	
<i>Cosmarium awadhense</i>		+		
<i>Cosmarium miscellum</i>			+	
<i>Cosmarium radiosum</i>	+			
<i>Desmidium pseudostreptonema</i>	+		+	
<i>Coleochaete scutata</i>		+		
<i>Radiofilum transversalis</i>		+		
<i>Characium ambiguum</i>			+	
<i>Pediastrum tetras</i>			+	
<i>Dictyosphaerium pulchellum</i>			+	
<i>Botryococcus braunii</i>			+	
<i>Coelastrum reticulatum</i> var. <i>cubanum</i>			+	
<i>Scenedesmus bijugatus</i>		+		
<i>Scenedesmus bijugatus</i> var. <i>bicellularis</i>			+	
<i>Scenedesmus bijugatus</i> f. <i>parvus</i>			+	
<i>Scenedesmus ecornis</i> var. <i>ecornis</i>	+			
<i>Scenedesmus pseudopoliensis</i>				+
<i>Scenedesmus quadricauda</i> var. <i>quadrispina</i>			+	
<i>Dimorphococcus lunatus</i>			+	
<i>Monoraphidium fontinale</i>	+			
<i>Kirchneriella irregularis</i> var. <i>irregularis</i>			+	
<i>Kirchneriella lunaris</i>			+	
<i>Ankistrodesmus densus</i>			+	
<i>Microspora amoena</i>		+		
<i>Oedogonium platygynum</i> var. <i>osilia</i>	+			
<b>Euglenophyta</b>				
<i>Euglena oxyuris</i>			+	
<i>Euglena sanguinea</i>			+	

<i>Phacus caudatus</i>			+	
<i>Trachelomonas abrupta</i> var. <i>minor</i>			+	
<i>Trachelomonas armata</i> f. <i>punctata</i>			+	
<i>Trachelomonas hispida</i> var. <i>granulata</i>			+	
<i>Trachelomonas volvocina</i>	+		+	
<i>Trachelomonas volvocina</i> var. <i>punctata</i>			+	
<b>Heterokontophyta</b>				
<i>Melosira granulata</i>	+		+	
<i>Melosira granulata</i> var. <i>muzzanensis</i>			+	
<i>Melosira islandica</i> subspecies <i>helvetica</i>			+	
<i>Cyclotella stelligera</i>			+	
<i>Tabellaria fenestrata</i>	+	+		
<i>Fragilaria arcus</i>			+	
<i>Fragilaria capucina</i>			+	
<i>Fragilaria construens</i> f. <i>venter</i>	+	+		
<i>Fragilaria leptostauron</i>			+	
<i>Fragilaria virescens</i>			+	
<i>Synedra crystallina</i>			+	
<i>Synedra delicatissima</i>				+
<i>Synedra tenera</i>				+
<i>Synedra ulna</i> var. <i>amphirhynchus</i>		+		+
<i>Synedra ulna</i> var. <i>oxyrhynchus</i>	+	+		
<i>Achnanthes coarctata</i> var. <i>elliptica</i>		+	+	
<i>Achnanthes convergens</i>	+			+
<i>Diadesmis confervacea</i>	+	+	+	
<i>Pinnularia interrupta</i>	+		+	
<i>Pinnularia nodosa</i>			+	
<i>Pinnularia subsimilis</i>			+	
<i>Navicula amphirhynchus</i>			+	
<i>Navicula cryptocephaloides</i>			+	
<i>Navicula dicephala</i> var. <i>sphaerophora</i>	+		+	
<i>Navicula pupula</i>			+	
<i>Navicula sphaerophora</i>			+	
<i>Navicula viridis</i>	+		+	
<i>Anomoeoneis vitrea</i>				+
<i>Gomphonema montanum</i> var. <i>genuina</i>		+		
<i>Gomphonema olivaceum</i>				+
<i>Gomphonema parvulum</i>			+	
<i>Gomphonema telegraphicum</i>	+	+		
<i>Gomphonema vibrio</i>		+		
<i>Cymbella ehrenbergii</i>			+	
<i>Cymbella tumida</i>			+	+
<i>Amphora elliptica</i>				+
<i>Nitzschia sigmoidea</i>			+	
<i>Epithemia gibberula</i> var. <i>producta</i>			+	
<i>Surirella tenera</i>			+	
<i>Gloeobotrys limneticus</i>			+	
<b>Total taxa</b>	<b>20</b>	16	56	9

stream, epilithic filamentous; Voucher number 2696; Date of collection 29.10.2010 (reported first time in India)

Family - Oscillatoriaceae

**Genus - *Oscillatoria* Vaucher ex Gomont**

**8. *Oscillatoria yamadae* Kamat** (Plate 1, Fig. 8)

Komárek and Anagnostidis 2005, p. 602, fig. 910

Trichome long, straight, 8 - 9  $\mu\text{m}$  broad, cells 2.5- 4.4  $\mu\text{m}$  long, cross wall slightly granulated, but not constricted, filaments slightly attenuated towards the end, apical cell capitate, without calyptra.

Place of collection Doimukh; Habitat stream, epilithic; Voucher number 2766; Date of collection 03.11.2010

Eukaryotic algae

Phylum Chlorophyta

Class - Charophyceae

Order Zygnematales

Family Zygnemataceae

**Genus *Spirogyra* Link**

**9. *Spirogyra acanthophora*** (Skuja) Czurda (Plate 1, Fig. 29)

Randhawa 1959, p. 376, fig. 413

Vegetative cells 350 - 375  $\mu\text{m}$  long and 50  $\mu\text{m}$  broad, chloroplast 3, making 2.5 - 3 turns in the cell.

Place of collection Tarin, Ziro; Habitat fish pond, floating; Voucher number 2756; Date of collection 03.11.2010 (reported first time in India)

**10. *Spirogyra parvula*** (Transeau) Czurda (Plate 1, Fig. 30)

(Synonym *Spirogyra catanaeformis* var. *parvula* Transeau)

Randhawa 1959, p. 298, fig. 259

Vegetative cells 23-35  $\mu\text{m}$  broad, 81 - 90  $\mu\text{m}$  long, each cell has one chromatophore of 2-4 turns, septa plain.

Place of collection Jaswant garh; Habitat stream, floating; Voucher number 2694; Date of collection 29.10.2010

Family Desmidiaceae

**Genus *Closterium* Nitzsch ex Ralfs**

**11. *Closterium moniliferum*** (Borge) Ehrenberg forma Bourrelly (Plate 1, Fig. 31)

Prasad and Misra 1992, p. 113, pl. 12, fig. 4

Cells of medium size, stout, 6 - 7 times longer than broad, moderately curved, inner margin inflated in the middle, cells uniformly narrowed to obtusely rounded apices, cell wall smooth, chloroplasts with 4 - 5 ridges and 7 - 10 pyrenoids arranged in a median series, cells 120 - 150  $\mu\text{m}$  long, 11 - 22  $\mu\text{m}$  broad, apex 5.5 - 6  $\mu\text{m}$  broad.

Place of collection Jaswant garh; Habitat stream, epilithic; Voucher number 2698; Date of collection 29.10.2010

**Genus *Staurastrum* (Meyen) Ralfs**

**12. *Staurastrum bicorne*** Hauptfleisch (Plate 2, Fig. 32)

West *et al.* 1923, p. 117, pl. 143, fig. 17

Cells solitary, widely constricted at the middle, apical margin of semi cell curved and having one lateral process on each side, tip of the lateral processes bifurcated and with spines, cells 19 - 23  $\mu\text{m}$  long and 27 - 28  $\mu\text{m}$  broad with processes, isthmus 3.5  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

**13. *Staurastrum bieneanum*** Rabenhorst var. *ellipticum* Wille fa. Skuja (Plate 2, Fig. 33)

Misra and Srivastava 2003, p. 90, pl. 1, fig. 12

Cells slightly broader than long, very deeply constricted, sinus widely open, semi cells narrowly elliptic, 22-33.3  $\mu\text{m}$  long, 24 - 27.8  $\mu\text{m}$  broad, isthmus is 9.5 - 12.2  $\mu\text{m}$  broad.

Place of collection Sangey, Jaswant garh; Habitat stream, epilithic; Voucher number

2684, 2695; Date of collection 29.10.2010

**14. *Staurostrum gracile*** Ralfs forma Iyengar *et* Vimala Bai (Plate 2, Fig. 34)

Prasad and Srivastava 1992, p. 197, pl. 25, fig. 14, 18

Cell small, semi cells slightly broad towards the faintly convex apex, upper angles produced into more or less horizontally disposed long processes, tipped with 3 minute spines and sharing many concentric series of denticulations, cells 24 - 27  $\mu\text{m}$  long, 37 - 39  $\mu\text{m}$  broad with processes, isthmus 4 - 5  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

#### Genus- *Cosmarium* Ralfs

**15. *Cosmarium awadhense*** Prasad *et* Mehrotra (Plate 2, Fig. 35)

Misra and Srivastava 2003, p. 87, pl. 1, fig. 21

Cells solitary, green, slightly longer than broad, sinus shallow constricted, linear, closed, semi cells semicircular, apex with flattened margin, truncate, lateral side with crenations or wavy, chloroplast axial, cells 30-33  $\mu\text{m}$  long, 23-27  $\mu\text{m}$  broad, isthmus 5 - 5.3  $\mu\text{m}$  broad.

Place of collection Sangey; Habitat stream, epilithic; Voucher number 2684; Date of collection 29.10.2010

**16. *Cosmarium miscellum*** Skuja (Plate 2, Fig. 36)

Misra and Srivastava 2003, p. 87, pl. 2, fig. 3

Cells longer than wide, constriction deep, sinus broad, closed, semi cells have broad base, narrow towards apex, cell wall with fine granulation, semi cells 40 - 44  $\mu\text{m}$  long, 35 - 37  $\mu\text{m}$  broad, isthmus 16.6  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

**17. *Cosmarium radiosum*** Wolle (Plate 2, Fig. 37)

Prasad and Srivastava 1992, p. 179, pl. 24, fig.

12

Cells longer than broad, deeply constricted, sinus narrowly linear with slightly dilated extremity, semi cells sub-semicircular, sides strongly convex, apex rounded, semi cells 37 - 40  $\mu\text{m}$  long, 30 - 31  $\mu\text{m}$  broad, isthmus 12.5  $\mu\text{m}$  broad.

Place of collection Jaswant garh; Habitat stream, epilithic; Voucher number 2695; Date of collection 29.10.2010

#### Genus *Desmidium* C. Agardh ex Ralfs

**18. *Desmidium pseudostreptonema*** W. *et* G.S. West (Plate 2, Fig. 38)

West *et al.* 1923, p. 244, pl. 165, fig. 6

Thallus filamentous, green, cells elliptical, broader than long, deeply constricted at the middle, sinus widely open, cells 8-10  $\mu\text{m}$  long and 2  $\mu\text{m}$  broad, isthmus 5 - 6  $\mu\text{m}$  broad.

Place of collection Sela Pass, Habitat lake, benthic; Voucher number 2692; Date of collection 29.10.2010; and also from Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

Order Coleochaetales

Family Coleochaetaceae

#### Genus *Coleochaete* Brébisson

**19. *Coleochaete scutata*** Brébisson (Plate 1, Fig. 9)

Prescott 1961, p. 130, pl. 18, fig. 9

Discoid thallus, filaments compactly arranged, radiating from a common centre, almost quadrangular cells, 12-13.6  $\mu\text{m}$  in diameter.

Place of collection Sangey; Habitat stream, epilithic; Voucher number 2687; Date of collection 29.10.2010

Class Ulvophyceae

Order Ulotrichales

Family Gloeotilaceae

#### Genus *Radiofilum* Schmidle

**20. *Radiofilum transversalis*** (Brébisson)

Ramanathan (Plate 1, Fig. 11)

Ramanathan 1964, p. 75, pl. 20 (a), fig. F H

Filaments pseudomembranous, cells ellipsoidal, plate like, 3 - 3.5  $\mu\text{m}$  long and 2.2 - 2.4  $\mu\text{m}$  broad, sometimes divided in both horizontal and longitudinal plane, branches present sometimes.

Place of collection Sangey; Habitat stream, filamentous; Voucher number 2686; Date of collection 29.10.2010

Class Chlorophyceae

Order Chlorococcales

Family Characiaceae

**Genus *Characium* A. Braun in Kützing****21. *Characium ambiguum*** Hermann ex Rabenhorst (Plate 1, Fig. 13)

Philipose 1967, p. 82, fig. 7

Cells small, elongated, oblique, apex in the form of a slightly bent hyaline beak, attached by a short stalk without basal thickening, cells 30 - 34  $\mu\text{m}$  long and 5 - 6  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat planktonic; Voucher number 2753; Date of collection 02.11.2010

Family Hydrodictyaceae

**Genus *Pediastrum* Meyen****22. *Pediastrum tetras*** (Ehrenberg) Ralfs (Plate 1, Fig. 14)(Basionym *Micrasterias tetras* Ehrenberg)(Synonym *Pediastrum ehrenbergii* (Corda) A. Braun)

Komárek and Jankovska 2001, p. 68, fig. 43

Coenobia 8 celled, spherical, 22 - 23  $\mu\text{m}$  in diameter, cells without intercellular spaces, marginal cells divided into 2 lobes with a deep single linear incision, inner cell 4-6 sided with a single linear incision, cells 6 - 7  $\mu\text{m}$  in diameter.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date

of collection 02.11.2010

Family Botryococcaceae

**Genus *Dictyosphaerium* Nägeli****23. *Dictyosphaerium pulchellum*** Wood (Plate 1, Fig. 15)(Synonym *Actidesmium pulchellum* (Wood) Kuntze, *Dictyosphaerium incipiens* Deason)

Prescott 1961, p. 238, pl. 51, fig. 5 7

Sixteen celled colony with cells arranged in a series of 4 on dichotomously branched threads, enclosed in mucilage, cells almost spherical, 4.5 - 5  $\mu\text{m}$  in diameter.

Place of collection Ganga lake, Itanagar; Habitat planktonic; Voucher number 2753; Date of collection 02.11.2010

**Genus *Botryococcus* Kützing****24. *Botryococcus braunii*** Kützing (Plate 1, Fig. 16)(Synonym *Ineffiqiata neglecta* W. West and G. S. West)

Philipose 1967, p. 195, fig. 108

Colonies free floating, irregular, completely enclosed by a tough, hyaline, orange colored membrane that is produced into irregular wrinkles or folds, cells ovoid to ellipsoid and arranged radially at the periphery of the colony, cells 5 - 6  $\mu\text{m}$  long and 3 - 4  $\mu\text{m}$  broad, colony 86  $\mu\text{m}$  in diameter.

Place of collection Ganga lake, Itanagar; Habitat planktonic; Voucher number 2752; Date of collection 02.11.2010

Family Scenedesmaceae

**Genus *Coelastrum* Nägeli****25. *Coelastrum reticulatum*** var. *cubanum* Dangeard (Plate 1, Fig. 17)

Rott and Lenzenweger 1994, p. 484, fig. 24

Coenobia spherical, mostly 16-32 celled, cells spherical, connected with processes to the other cells, cells 1.6 - 2.5  $\mu\text{m}$  in diameter, diameter of the coenobia 10.5  $\mu\text{m}$ .



Place of collection Ganga lake, Itanagar;  
Habitat epilithic; Voucher number 2749; Date  
of collection 02.11.2010

### Genus *Scenedesmus* Meyen

**26. *Scenedesmus bijugatus*** (Turpin) Kützing  
(Plate 1, Fig. 18)

(Synonym *Heterocarpela bijuga* Turpin,  
*Trochiscia bijuga* (Turpin) Kützing)

Philipose 1967, p. 252, fig. 164

Coenobia 4 celled, flat, cells arranged in a  
linear series, cells oblong-ellipsoid to ovoid  
with the ends broadly rounded, cells 7-8  $\mu\text{m}$   
long and 2  $\mu\text{m}$  broad.

Place of collection Sangey; Habitat stream,  
epilithic; Voucher number 2684; Date of  
collection 29.10.2010

**27. *Scenedesmus bijugatus* var. *bicellularis***  
Chodat (Plate 1, Fig. 19)

(Basionym *Scenedesmus bicellularis* Chodat)

Philipose 1967, p. 253, fig. 164 d

Coenobia 4 celled, arranged linearly, cells  
ellipsoid, a small apical spine is seen in some  
cells, cells 11 - 12  $\mu\text{m}$  long and 3  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar;  
Habitat planktonic; Voucher number 2749;  
Date of collection 02.11.2010

**28. *Scenedesmus bijugatus* f. *parvus*** (G.M.  
Smith) (Plate 1, Fig. 20)

Philipose 1967, p. 256, fig. 164 f

Coenobia 4 celled, arranged linearly, cells  
oblong-ovoid, cell wall smooth, cells 10.5-13  
 $\mu\text{m}$  long and 3  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar;  
Habitat planktonic; Voucher number 2749;  
Date of collection 02.11.2010

**29. *Scenedesmus ecornis* var. *ecornis*** Chodat  
(Plate 1, Fig. 21)

Komárek and Fott 1983, p. 826, pl. 225, fig. 1

Coenobia 4 celled, cells broadly elliptical,  
small, with rounded tip, 7.7-9.3  $\mu\text{m}$  long and  
1.6  $\mu\text{m}$ , cells attached side by side.

Place of collection Jaswant garh; Habitat  
stream, epilithic; Voucher number 2698; Date  
of collection 29.10.2010 (reported first time in  
India)

**30. *Scenedesmus pseudopoliensis*** Hortobagyi  
(Plate 1, Fig. 22)

Komárek and Fott 1983, p. 910, fig. 245.9

Coenobia 2 celled, arranged in a linear series,  
cells oblong, slightly truncate at the end, long  
spine arising at each pole of the terminal cell,  
spine curved, cells 11-13.4  $\mu\text{m}$  long and 3.5 - 4  
 $\mu\text{m}$  broad.

Place of collection Siang river, Pasighat;  
Habitat planktonic; Voucher number 2781;  
Date of collection 05.11.2010

**31. *Scenedesmus quadricauda*** (Turpin)  
Brébisson var. *quadrispina* (Chodat) G.M.  
Smith (Plate 1, Fig. 23)

Philipose 1967, p. 285, fig. 187 a, j

Coenobia 4 celled, cells cylindrical, 14 -16  $\mu\text{m}$   
long and 4.5 - 5  $\mu\text{m}$  broad, obtuse end, short  
spines present on both the poles of the terminal  
cells.

Place of collection Ganga lake, Itanagar;  
Habitat planktonic; Voucher number 2749;  
Date of collection 02.11.2010

### Genus *Dimorphococcus* A. Braun

**32. *Dimorphococcus lunatus*** A. Braun (Plate  
1, Fig. 24)

(Synonym *Dictyosphaerium reniforme*  
Bulnheim)

Komárek and Fott 1983, p. 944, pl. 253, fig. 2

Cells in groups of 4 on the ends of fine  
branched threads, inner cells sub-cylindric and  
the outer cells cordate, cells 12-17.5  $\mu\text{m}$  long  
and 5.5  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar;  
Habitat planktonic; Voucher number 2749;  
Date of collection 02.11.2010

Family Ankistrodesmaceae

Genus *Monoraphidium* Komárková-

**Legnerová**

**33. *Monoraphidium fontinale*** Hindák (Plate 1, Fig. 25)

Komárek and Fott, 1983, p. 632, pl. 177, fig. 2  
Small thin arcuated cells, slightly bent, 23 - 25  $\mu\text{m}$  long and 2 - 3  $\mu\text{m}$  broad, chloroplast parietal.

Place of collection Jaswant garh; Habitat stream, epilithic; Voucher number 2698; Date of collection 29.10.2010 (reported first time in India)

**Genus *Kirchneriella* Schmidle**

**34. *Kirchneriella irregularis*** (Smith) Koršhikov var. *irregularis* Komárek et Fott (Plate 1, Fig. 26)

Komárek and Fott 1983, p. 668, pl. 186, fig. 4  
Cells solitary, green in colour, broadly arcuately bent, forming an arc, tip of the cell rounded, cells 23 - 24  $\mu\text{m}$  long and 3 - 4  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

**35. *Kirchneriella lunaris*** (Kirchner) Möbius (Plate 1, Fig. 27)

(Synonym *Raphidium convolutum* var. *lunare* Kirchner, *Kirchneriella lunata* Schmidle)

Prescott 1961, p. 258, pl. 58, fig. 2

Colonies with 16 cells, arranged in a gelatinous envelope, cells strongly curved to lunate structure, tip obtuse, cells 18 - 19  $\mu\text{m}$  long and 4 - 5  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2750; Date of collection 02.11.2010

**Genus *Ankistrodesmus* Corda**

**36. *Ankistrodesmus densus*** Koršhikov (Plate 1, Fig. 28)

(Synonym *Ankistrodesmus spiralis* var. *fasciculatus* G.M. Smith)

Hindák 1988, p. 237, pl. 87

Shurb like dense colonies, cells narrowed from the centre towards the ends, end pointed, cells straight but some are slightly arcuate, 37 - 40  $\mu\text{m}$  long and 1.5 - 2  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

Order Sphaeropleales

Family Microsporaceae

**Genus *Microspora* Thuret**

**37. *Microspora amoena*** (Kützing) Rabenhorst (Plate 1, Fig. 10)

(Synonym - *Conferva amoena* Kützing)

Ramanathan 1964, p. 132, pl. 29, fig. A; pl. 30, fig. A

Thallus filamentous, unbranched, thickened cell wall, 5  $\mu\text{m}$  broad, cells 31.3 - 32  $\mu\text{m}$  broad, 46

57  $\mu\text{m}$  long, cross wall lamellated, 8.7  $\mu\text{m}$  broad, pear shaped zoospores present, 8 per cell, released by openings in lateral walls.

Place of collection Sangey; Habitat stream, floating; Voucher number 2686; Date of collection 29.10.2010

Order Oedogoniales

Family Oedogoniaceae

**Genus *Oedogonium* Link ex Hirn**

**38. *Oedogonium platygynum*** var. *osiliaa* Skuja (Plate 1, Fig. 12)

Gonzalves 1981, p. 385, fig. 9.279 A'

Macrandrous, dioecious, vegetative cells cylindrical, 26-30  $\mu\text{m}$  long, 6-7  $\mu\text{m}$  broad, oogonia solitary, 20  $\mu\text{m}$  wide and 8  $\mu\text{m}$  long.

Place of collection Sela Pass; Habitat lake, benthic; Voucher number 2692; Date of collection 29.10.2010

Phylum Euglenophyta

Order Euglenales

Family Euglenaceae

**Genus *Euglena* Ehrenberg**

**39. *Euglena oxyuris*** Schmarda (Plate 2, Fig. 39)

Wołowski and Hindák 2005, p. 29, fig. 37-40  
Cells very long, cylindrical, twisted at the posterior end, anterior end rounded, posterior end slightly tapered to form a small tail, chloroplasts numerous, cells 390 - 395  $\mu\text{m}$  long and 39 - 40  $\mu\text{m}$  broad.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2759; Date of collection 03.11.2010

**40. *Euglena sanguinea*** Ehrenberg (Plate 2, Fig. 40)

(Synonym *Euglena viridis* var. *sanguinea* (Ehrenberg) Playfair, *Oscillatoria sanguinea* (Ehrenberg) Itzigsohn and Rothe)

Wołowski and Hindák 2005, p. 31, fig. 112-120  
Cells cylindrical to broadly spindle shaped, 105 - 114.4  $\mu\text{m}$  long and 36-58.6  $\mu\text{m}$  broad, red with haematochrome, chloroplasts numerous, deeply incised, thickly packed, each with pyrenoid from which chloroplast bands radiate, some of them bifurcate before touching the pellicle.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2763; Date of collection 03.11.2010

**Genus *Phacus* Dujardin****41. *Phacus caudatus*** Hübner (Plate 2, Fig. 41)

Wołowski and Hindák 2005, p. 35, fig. 202, 203  
Cells pear shaped, flattened, 43 - 45  $\mu\text{m}$  long and 30  $\mu\text{m}$  broad, anterior end broadly rounded, posterior end tapers to form slightly bent cauda, chloroplast parietal, small, paramylon bodies ring like, 2 in number.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2758; Date of collection 03.11.2010

**Genus *Trachelomonas* Ehrenberg****42. *Trachelomonas abrupta*** Swirenko var. *minor* Deflandre (Plate 2, Fig. 42)

Wołowski and Hindák 2005, p. 50, fig. 366-369  
Elongated ellipsoidal lorica, 25.2-28.5  $\mu\text{m}$  long and 12.6-20.8  $\mu\text{m}$  broad, wall yellow or reddish brown, covered with granules, cells with small discoid chloroplasts.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2758; Date of collection 03.11.2010

**43. *Trachelomonas armata* f. *punctata*** (Swirenko) Deflandre (Plate 2, Fig. 43)

Huber Pestalozzi 1955, pl. LXVII, fig. 586

Lorica oval shaped, brown in colour, small spines present near the anterior end and spines quite larger at the posterior end, lorica 28 - 30  $\mu\text{m}$  long and 20 - 21  $\mu\text{m}$  broad.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2759; Date of collection 03.11.2010 (reported first time in India)

**44. *Trachelomonas hispida*** (Perty) Stein var. *granulata* Playfair (Plate 2, Fig. 44)

Wołowski and Hindák 2005, p. 44, fig. 410, 411  
Lorica ellipsoidal, 15 - 22.8  $\mu\text{m}$  long and 10.6 - 17  $\mu\text{m}$  broad, reddish brown, punctate with a small number of granules, apical pore without collar.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2758; Date of collection 03.11.2010

**45. *Trachelomonas volvocina*** Deflandre (Plate 2, Fig. 45)

(Synonym *Microglena volvocina* Ehrenberg)  
Srivastava and Odhwani 1990, p. 122, pl. 2, fig. 1

Spherical lorica with depressed collar, yellowish brown in colour, pellicle smooth, lorica 10.3-13.8  $\mu\text{m}$  in diameter.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2763; Date of collection 03.11.2010; Place of collection Sela Pass; Habitat lake, benthic; Voucher number 2692; Date of collection 29.10.2010

**46. *Trachelomonas volvocina*** Ehrenberg var.

**punctata** Playfair (Plate 2, Fig. 46)

Wołowski and Hindák 2005, p. 40, fig. 382

Cells reddish brown, lorica spherical or oval, membrane thick, cells 22 - 25  $\mu\text{m}$  long and 21 - 24  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat planktonic; Voucher number 2749; Date of collection 02.11.2010

Phylum Heterokontophyta

Class Bacillariophyceae

Order Biddulphiales

Family Melosiraceae

**Genus *Melosira* C. Agardh**

**47. *Melosira granulata*** (Ehrenberg) Ralfs (Plate 2, Fig. 48)

(Basionym *Gaillonela granulata* Ehrenberg) Huber-Pestalozzi 1942, p. 380, fig. 451

Frustules cylindrical, closely fitting, long chains, walls punctuate, end with spine, valves 15-18.8  $\mu\text{m}$  long and 6.5 - 10  $\mu\text{m}$  broad.

Place of collection Jaswant garh; Habitat stream, epiphytic; Voucher number 2694; Date of collection 29.10.2010; Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2750; Date of collection 02.11.2010

**48. *Melosira granulata*** (Ehrenberg) Ralfs **var. *muzzanensis*** Meister (Plate 2, Fig. 49)

Gonzalves and Gandhi 1952, p. 119, fig. 3

Frustules short, cylindrical, flat, united in chains, edges of the valves rounded, mantle line straight and parallel, punctuate, punctae coarse, the spines project outside and inside in the same cell, 18-22.2  $\mu\text{m}$  long and 12 - 14  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

**49. *Melosira islandica*** O. Müller subspecies ***helvetica*** O. Müller (Plate 2, Fig. 50)

Gonzalves and Gandhi 1952, p. 120, fig. 4

Frustules cylindrical, united in chains, valves

thin with parallel margins, ring like neck, wall clearly punctuate, 24.5- 27.2  $\mu\text{m}$  long and 4.5 - 5  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

Order Bacillariales

Family Stephanodiscaceae

**Genus *Cyclotella* (Kützing) Brébisson**

**50. *Cyclotella stelligera*** Cleve et Grunow (Plate 2, Fig. 52)

Gonzalves and Gandhi 1952, p. 120, fig. 5

Discoid frustule, margin coarse with radiate striae, middle field has a punctum and short thin radiating lines forming a star like structure, 14 - 16  $\mu\text{m}$  in diameter.

Place of collection Ganga lake, Itanagar; Habitat planktonic; Voucher number 2750; Date of collection 02.11.2010

Family Tabellariaceae

**Genus *Tabellaria* Ehrenberg**

**51. *Tabellaria fenestrata*** (Lyngbye) Kützing (Plate 2, Fig. 51)

(Synonym *Diatoma fenestratum* Lyngbye, *Tabellaria floculosa* var. *fenestrata* (Lyngbye) Rabenhorst, *Striatella fenestrata* (Lyngbye) Kuntze))

Huber-Pestalozzi 1942, p. 429, pl. CXXVII, fig. 519

United frustules forming zig-zag chain like colonies, inflated laterally in the middle and at the poles, septa more than two, longitudinal, straight, perforate, present between the girdle, intercalary, 17 - 20  $\mu\text{m}$  long and 16.5  $\mu\text{m}$  broad, striae transverse and finely punctuate.

Place of collection Sangey; Habitat stream, epilithic; Voucher number 2684; Place of collection Jaswant garh; Habitat stream, epiphytic; Voucher number 2694; Date of collection 29.10.2010

Family Fragilariaceae

**Genus *Fragilaria* Lyngbye**

**52. *Fragilaria arcus*** (Ehrenberg) Cleve (Plate 2, Fig. 54)

(Basionym *Navicula arcus* Ehrenberg)

Cho 2000, p. 211, pl. 1, fig. 23

Valve linear, slightly bend, slightly attenuated towards the apex to form capitate end, 77 - 80  $\mu\text{m}$  long and 7  $\mu\text{m}$  broad, striation faint, parallel, 10-12 in 10  $\mu\text{m}$  area.

Place of collection Doimukh; Habitat stream, epilithic; Voucher number 2766; Date of collection 03.11.2010

**53. *Fragilaria capucina*** Desmazieres (Plate 2, Fig. 53)

(Synonym *Fragilaria capucina* var. *lanceolata* Grünow, *Fragilaria capucina* f. *lanceolata* (Grünow in Van Heurck) Hustedt, *Fragilaria capucina* f. *lanceolata* (Grünow) Skabichevshii)

Ettl and Gartner 1995, p. 42, fig. 8 h

Valve linear, united laterally forming free floating ribbon shaped colonies, rectangular elongated cells, bilaterally symmetrical, pseudoraphe present, 73-86  $\mu\text{m}$  long and 8-9  $\mu\text{m}$  broad, striae coarse, lineate, parallel through out the valve, 10-12 in 10  $\mu\text{m}$  area.

Place of collection Doimukh; Habitat stream, epilithic; Voucher number 2766; Date of collection 03.11.2010

**54. *Fragilaria construens* f. *venter*** (Ehrenberg) Hustedt (Plate 2, Fig. 55)

(Basionym *Fragilaria venter* Ehrenberg)

Cho 2000, p. 235, pl. 1, fig. 14

Valves linear, quadrangular, attached side by side to form long chains, valve 16.6-18  $\mu\text{m}$  long and 11.6 -16  $\mu\text{m}$  broad, striation clear, parallel, 5- 6 in 10  $\mu\text{m}$  area.

Place of collection Sangey; Habitat stream, epilithic; Voucher number 2686; Date of collection 29.10.2010; Place of collection Jaswant garh; Habitat stream, epiphytic; Voucher number 2694; Date of collection

29.10.2010 (reported first time in India)

**55. *Fragilaria leptostauron*** (Ehrenberg) Hustedt (Plate 2, Fig. 56)

(Basionym *Biblarium leptostauron* Ehrenberg)

Cho 2000, p. 235, pl. 2, fig. 23

Frustules linear, central area much wider, apical area narrow and constricted to form a capitate end, 14 - 25  $\mu\text{m}$  long and 9 - 12  $\mu\text{m}$  broad, striation not clearly visible in fresh materials.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2757; Date of collection 03.11.2010 (reported first time in India)

**56. *Fragilaria virescens*** Ralfs (Plate 2, Fig. 57)

Ettl and Gartner 1995, p. 42, fig. 8 m

Valves united laterally, girdle view rectangular, linear, striation transverse, marginal, 11 in 10  $\mu\text{m}$  area, valve 5.5 - 11  $\mu\text{m}$  broad, 53.3 - 82.5  $\mu\text{m}$  long.

Place of collection Tarin, Ziro; Habitat fish pond, epiphytic; Voucher number 2756; Date of collection 03.11.2010

**Genus *Synedra* Ehrenberg**

**57. *Synedra crystallina*** Kützing (Plate 2, Fig. 58)

(Synonym - *Diatoma crystallinum* Agardh)

Kützing 1865, p. 69, pl. 16, fig. (I). 2

Valve slender, long, linear, straight, end rounded, obtuse, apices truncate, striation not clearly visible, longer than broad, 75.5 - 220  $\mu\text{m}$  long, 7 - 11.7  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

**58. *Synedra delicatissima*** W. Smith (Plate 2, Fig. 59)

Prasad and Srivastava 1992, p. 167, pl. 24, fig. 9

Frustule linear, elongated, straight, middle area slightly wider, attenuated towards the apices to form rostrate end, 104 - 140  $\mu\text{m}$  long and 4.3 - 5

$\mu\text{m}$  broad, striation not clearly visible in fresh material.

Place of collection Siang river, Pasighat;  
Habitat planktonic; Voucher number 2769;  
Date of collection 05.11.2010

**59. *Synedra tenera*** W. Smith (Plate 2, Fig. 60)  
Prasad and Srivastava 1992, p. 169, pl. 24, fig. 22

Valves linear, narrowly lanceolate with rounded ends, pseudoraphe thin, narrow, formed by the union of axial and central area, central area absent,  $103.8 \mu\text{m}$  long and  $5 \mu\text{m}$  broad, striation fine, lineate, transverse, parallel through out the valve, 8-10 in  $10 \mu\text{m}$  area.

Place of collection Siang river, Pasighat;  
Habitat planktonic; Voucher number 2776;  
Date of collection 05.11.2010

**60. *Synedra ulna*** (Nitzsch) Ehrenberg var. *amphirhynchus* (Ehrenberg) Grunow (Plate 2, Fig. 61)

(Synonym *Synedra amphirhynchus* Ehrenberg)

Huber-Pestalozii 1942, p. 462, fig. 545

Valve slender, linear, straight, at the end narrow and suddenly constricted to form capitate end, striation distinct, parallel, absent at the middle, 9 - 12 in  $10 \mu\text{m}$  area, many times longer than broad,  $42 - 114 \mu\text{m}$  long and  $6 - 13.3 \mu\text{m}$  broad.

Place of collection Sangey; Habitat stream, epilithic; Voucher number 2684; Date of collection 29.10.2010; Place of collection Siang river, Pasighat; Habitat - planktonic; Voucher number 2768; Date of collection 05.11.2010

**61. *Synedra ulna*** (Nitzsch) Ehrenberg var. *oxyrhynchus* (Kützing) Van Heurck (Plate 2, Fig. 62)

(Synonym *Synedra oxyrhynchus* Kützing)

Huber-Pestalozii 1942, p. 461, fig. 542

Valve linear to slightly lanceolate, long, straight, end narrow, roundly capitate, striation parallel through out the valve, slightly radiate

at the apices, striae 10 - 14 in  $10 \mu\text{m}$  area, many times longer than broad,  $54 - 94.6 \mu\text{m}$  long and  $7.5 - 10 \mu\text{m}$  broad.

Place of collection Sangey; Habitat stream, epilithic; Voucher number 2684; Place of collection Jaswant garh; Habitat stream, epiphytic; Voucher number 2694; Date of collection 29.10.2010

Family Achnantheaceae

**Genus *Achnanthes* Bory de Saint-Vincent**

**62. *Achnanthes coarctata* var. *elliptica*** Krasske (Plate 3, Fig. 63)

Gonzalves and Gandhi 1952, p. 147, fig. 55 a, b  
Elliptical valves, poles slightly narrowed and broadly rounded, axial area narrow, central area broad,  $45 - 95.7 \mu\text{m}$  long,  $13.8 - 21.3 \mu\text{m}$  broad, striae slightly radial, punctuate, 8-10 in  $10 \mu\text{m}$  area.

Place of collection Sangey; Habitat stream, epilithic; Voucher number 2684; Date of collection 29.10.2010; Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2750; Date of collection 02.11.2010

**63. *Achnanthes convergens*** H. Kobayasi (Plate 3, Fig. 64)

Cho 2000, p. 259, pl. 2, fig. 15

Valve linear, elliptical, with moderately flat margin, raphe median and thin,  $26 - 31 \mu\text{m}$  long and  $7 - 8 \mu\text{m}$  broad, striation coarse, parallel, slightly convergent towards the pole, 8-10 in  $10 \mu\text{m}$  area.

Place of collection Siang river, Pasighat; Habitat planktonic; Voucher number 2781; Date of collection 05.11.2010; Place of collection Jaswant garh; Habitat stream, epilithic; Voucher number 2698; Date of collection 29.10.2010 (reported first time in India)

Family Diadesmidaceae

**Genus *Diadesmis* Kützing**

**64. *Diadesmis confervacea*** Kützing (Plate 3, Fig. 65)

(Synonym *Diadesmis confervaceoides* Lange-Bertalot and Rumrich)

Kützing 1865, p. 109, pl. 30, fig. 8 a, b

Valve attached side by side to form ribbon shaped colony, filamentous, gelatinous, rectangular in girdle view, end truncate flated, at the middle slightly gap between the valves, longer than broad, 13-36.4  $\mu\text{m}$  long and 5-10  $\mu\text{m}$  broad.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2756; Date of collection 03.11.2010; Place of collection Sangey; Habitat stream, epiphytic; Voucher number 2686; Place of collection Sela Pass; Habitat lake, benthic; Voucher number 2692; Date of collection 29.10.2010

Family Pinnulariaceae

**Genus *Pinnularia* Ehrenberg**

**65. *Pinnularia interrupta*** W. Smith (Plate 3, Fig. 66)

Ettl and Gartner 1995, p. 106, fig. 18 i

Valves linear, with parallel margins and deeply constricted, broadly rounded capitate ends, axial area broad, central area rectangular, 29 - 40  $\mu\text{m}$  long and 5.8 - 7.7  $\mu\text{m}$  broad, striae coarse, marginal, radiate in the middle, convergent towards the apices, 5- 8 in 10  $\mu\text{m}$  area.

Place of collection Doimukh; Habitat stream, epilithic; Voucher number 2766; Date of collection 03.11.2010; Place of collection Sela Pass; Habitat lake, epilithic; Voucher number 2693; Date of collection 29.10.2010

**66. *Pinnularia nodosa*** (Ehrenberg) W. Smith (Plate 3, Fig. 67)

(Synonym *Navicula nodosa* Ehrenberg, *Pinnularia mesolepta* var. *nodosa*

(Ehrenberg) Brun, *Schizonema nodosum* (Ehrenberg) Kuntze, *Navicula mesolepta* var. *nodosa* (Ehrenberg) Gutwinski)

Ettl and Gärtner 1995, p. 102, fig. 18 c

Valve linear lanceolate with parallel margins having slight undulations, end broadly rounded, central area slightly widened, raphe thin, straight, with distinct polar nodule, 43 - 70  $\mu\text{m}$  long and 12 - 19  $\mu\text{m}$  broad, striae smooth, transverse, 10-12 in 10  $\mu\text{m}$  area.

Place of collection Tarin, Ziro; Habitat fish pond, epiphytic; Voucher number 2756; Date of collection 03.11.2010 (reported first time in India)

**67. *Pinnularia subsimilis*** Gandhi (Plate 3, Fig. 68)

Gandhi 1970, p. 789, fig. 116 118

Valves linear, lanceolate, slightly attenuated towards the apices, rounded ends, raphe thin, median, axial area linear, narrow, gradually widening towards the centre, central area broad, 55 - 60  $\mu\text{m}$  long and 7-9  $\mu\text{m}$  broad, striation not clearly visible.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

Family Naviculaceae

**Genus *Navicula* Bory de Saint-Vincent**

**68. *Navicula amphirhynchus*** Ehrenberg (Plate 3, Fig. 69)

Kützing 1865, p. 95, pl. 4, fig. XIII

Frustules elliptical, lanceolate, with narrowly rostrate apices, raphe thin, central area slightly widened, 33-42.3  $\mu\text{m}$  long and 9.6-10.8  $\mu\text{m}$  broad, striation barely visible in fresh material.

Place of collection Doimukh; Habitat stream, benthic; Voucher number 2767; Date of collection 03.11.2010

**69. *Navicula cryptocephaloides*** Hustedt (Plate 3, Fig. 70)

Gandhi 1959, p. 316, fig. 36, 53

Valves linear lanceolate with rounded ends,

raphe thin and straight, axial area narrow and linear, central area fairly wide, 22-37.3  $\mu\text{m}$  long and 6.4-10.5  $\mu\text{m}$  broad, striation clear, slightly radial at the middle and convergent towards the ends, 10-12 in 10  $\mu\text{m}$  area.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

**70. *Navicula dicephala*** (Ehrenberg) Wm. Smith var. *sphaerophora* A. Cleve (Plate 3, Fig. 71)

Gandhi 1958, p. 258, fig. 14

Valve linear-elliptical, with constriction, capitate rounded ends, axial area narrow, linear, central area fairly roundish, 27.3 - 32.6  $\mu\text{m}$  long and 11-11.3  $\mu\text{m}$  broad, striae not visible in the fresh material.

Place of collection Jaswant garh; Habitat stream, epilithic; Voucher number 2698; Date of collection 29.10.2010; Place of collection Ganga lake, Itanagar; Habitat planktonic; Voucher number 2751; Date of collection 02.11.2010

**71. *Navicula pupula*** Kützing (Plate 3, Fig. 72)

Kützing 1865, p. 93, pl. 30, fig. 40

Frustules linear, lanceolate, slightly attenuated apices to rounded end, central area wide, axial area narrow, striation not clear in fresh material, 21-22  $\mu\text{m}$  long and 5-8  $\mu\text{m}$  broad, striation not clearly seen in fresh materials.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2757; Date of collection 03.11.2010

**72. *Navicula sphaerophora*** Kützing (Plate 3, Fig. 73)

Kützing 1865, p. 95, pl. 4, fig. XVII

Valve broadly lanceolate or elliptical with produced end, apices acutely rounded, valves 17.7 - 42  $\mu\text{m}$  long and 7.7 - 10  $\mu\text{m}$  broad, striae distinct, transverse, 5-7 in 10  $\mu\text{m}$  area.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

**73. *Navicula viridis*** Kützing (Plate 3, Fig. 74)

Kützing 1865, p. 97, pl. 4, fig. XVIII

Frustules linear oblong, rectangular in valve view, slightly attenuated towards the apex, apices rotundatus, striation transverse, striae 8 - 12 in 10  $\mu\text{m}$  area, 37.3-81.4  $\mu\text{m}$  long and 10-25  $\mu\text{m}$  broad.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2763; Date of collection 03.11.2010; Place of collection Jaswant garh; Habitat stream, epiphytic; Voucher number 2696; Date of collection 29.10.2010

Family Anomoeoneidaceae

Genus *Anomoeoneis* Pfitzer

**74. *Anomoeoneis vitrea*** (Grunow) Ross comb. Patrick and Reimer (Plate 3, Fig. 75)

(Basionym *Gomphonema vitreum* Grunow)

Sreenivasa and Duthie 1973, p. 188, fig. 105

Lanceolate frustule, elliptical, rostrate or capitate apices, axial area narrow, linear, median, central area broad, raphe thin, median, straight, 36-39  $\mu\text{m}$  long and 9-10.5  $\mu\text{m}$  broad, striation is not clearly visible.

Place of collection Siang river, Pasighat; Habitat planktonic; Voucher number 2781; Date of collection 05.11.2010

Family Gomphonemataceae

Genus *Gomphonema* Ehrenberg

**75. *Gomphonema montanum* var. *genuina*** Mayer (Plate 3, Fig. 76)

Pal and Santra 1992, p. 75, pl. 1, fig. 15

Frustules slightly clavate with rounded poles, central area broad, one side normal, where as the other side attenuated, 41.8-61.7  $\mu\text{m}$  long and 10.5-14.2  $\mu\text{m}$  broad, striation distinct, transverse, convergent towards the base, 5-8 in 10  $\mu\text{m}$  area.

Place of collection Sangey; Habitat stream, epiphytic; Voucher number 2686; Date of collection 29.10.2010



**76. *Gomphonema olivaceum*** (Lyngbye)

Kützing (Plate 3, Fig. 77)

(Basionym *Ulva olivacea* Hornemann)(Synonym *Gomphonema olivacea* (Hornemann) Dawson ex Ross and Sims)

Kützing 1865, p. 85, pl. 7, fig. XIII, XV

Frustules lanceolate clavate with broad rounded apices, attenuated base, middle wide, striation coarse and distinct, parallel, 8 - 11 in 10  $\mu\text{m}$  area, 39-48  $\mu\text{m}$  long and 11  $\mu\text{m}$  broad.

Place of collection Siang river, Pasighat; Habitat planktonic; Voucher number 2776; Date of collection 05.11.2010

**77. *Gomphonema parvulum*** (Kützing)

Kützing (Plate 3, Fig. 78)

(Synonym *Sphenella parvula* Kützing, *Sphenoneis parvula* (Kützing) Trevisan, *Gomphonema parvula* (Kützing) Rabenhorst, *Gomphonema parvulum* (Kützing) Van Heurck)

Cho 2000, p. 243, pl. 4, fig. 12 - 15

Elliptic lanceolate frustule, truncated and constricted at the apex to form capitate end, raphe not clear, 27 - 29  $\mu\text{m}$  long and 6.5  $\mu\text{m}$  broad, striation transverse, 10-12 in 10  $\mu\text{m}$  area.

Place of collection Doimukh; Habitat stream, epilithic; Voucher number 2765; Date of collection 03.11.2010

**78. *Gomphonema telegraphicum*** Kützing (Plate 3, Fig. 79)

Kützing, 1865, p. 84, pl. 8, fig. IX

Frustules cuneate, apices slightly wide, truncate, base acute, stipe long with 2-3 valves at the end, 21 - 65  $\mu\text{m}$  long and 5.7-10  $\mu\text{m}$  broad, striation distinct, marginal, striae 8-10 in 10  $\mu\text{m}$  area.

Place of collection Sangey; Habitat stream, epiphytic; Voucher number 2686; Place of collection Jaswant garh; Habitat stream, epilithic; Voucher number 2695; Date of collection 29.10.2010

**79. *Gomphonema vibrio*** Ehrenberg (Plate 3, Fig. 80)

Kützing 1865, p. 87, pl. 29, fig. 75

Frustules linear-lanceolate, elongated, attenuated to long, sub acute, rostrate end, raphae thin, median, striation transverse, parallel, striae 10 - 12 in 10  $\mu\text{m}$  area, 48.3 - 70  $\mu\text{m}$  long and 7.8 - 13.3  $\mu\text{m}$  broad.

Place of collection Sangey; Habitat stream, epilithic; Voucher number 2684; Date of collection 29.10.2010

**Genus *Cymbella* C. Agardh****80. *Cymbella ehrenbergii*** Kützing (Plate 3, Fig. 81)

Kützing 1865, p. 79, pl. 6, fig. X 1-2

Frustules biraphid, asymmetrical, lanceolate, end obtuse, raphae located at the middle, striation indistinct, transverse, radial towards the centre, 5-8 in 10  $\mu\text{m}$  area, central nodule present, 30.8- 45  $\mu\text{m}$  long and 8- 11.5  $\mu\text{m}$  broad.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

**81. *Cymbella tumida*** (Brebisson) Van Heurck (Plate 3, Fig. 82)(Synonym - *Cocconema tumidum* Brébisson)

Kant and Gupta 1998, p. 163, pl. 72, fig. 13

Valve broadly lanceolate, dorsal and ventral margins bent in opposite directions, ends obtuse, dorsally constricted, valve 20-23  $\mu\text{m}$  broad and 55-71.5  $\mu\text{m}$  long, striation radial at the middle and slightly convergent at the end, 9 - 10 in 10  $\mu\text{m}$  area.

Place of collection Doimukh; Habitat stream, epilithic; Voucher number 2766; Date of collection 03.11.2010; Place of collection Siang river, Pasighat; Habitat planktonic; Voucher number 2776; Date of collection 05.11.2010

Family Catenulaceae

**Genus *Amphora* Ehrenberg ex Kützing****82. *Amphora elliptica*** Kützing (Plate 3, Fig. 83)

(Basionym *Frustulia elliptica* Agardh)

Kützing 1865, p. 107, pl. 5, fig. XXXI

Frustules in girdle view elliptic lanceolate, slightly biconvex, apices slightly attenuated, obtuse truncate, striation distinct, transverse at both the sides, striae 7 - 8 in 10  $\mu\text{m}$  area, 54.4 - 68.6  $\mu\text{m}$  long and 15.7- 17.8  $\mu\text{m}$  broad.

Place of collection Siang river, Pasighat; Habitat planktonic; Voucher number 2776; Date of collection 05.11.2010

Family Bacillariaceae

**Genus *Nitzschia* Hassal**

**83. *Nitzschia sigmoidea*** (Nitzsch) Wm. Smith (Plate 3, Fig. 86)

(Synonym - *Bacillaria sigmoidea* Nitzsch, *Nitzschia elongata* Hassal)

Desikachary 1989, p. 4, pl. 663, fig. 3

Frustules linear, sigmoid with rounded ends, raphe thin, central, striation not clearly visible, 82-87.5  $\mu\text{m}$  long and 6 - 7.2  $\mu\text{m}$  broad, striae fine, dense, lineate and parallel through out the valve.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2764; Date of collection 03.11.2010

Family Rhopalodiaceae

**Genus *Epithemia* Brébisson**

**84. *Epithemia gibberula* var. *producta*** Grunow (Plate 3, Fig. 84)

Prasad and Srivastava 1992, p. 278, pl. 32, fig. 10

Frustules broadly elliptical, with sub truncate ends, dorsal margin strongly arcuate, ventral margin with a very slight curvature, ends rostrate, costae distinct, radiate, slightly dilated below the apices, 33.6-47.7  $\mu\text{m}$  long and 23.2 - 27.7  $\mu\text{m}$  broad, striae fine, 2-8 in two consecutive costae.

Place of collection Ganga lake, Itanagar; Habitat epilithic; Voucher number 2749; Date of collection 02.11.2010

Family Surirellaceae

**Genus *Surirella* Turpin**

**85. *Surirella tenera*** Gregory (Plate 3, Fig. 85)

(Synonym *Surirella robusta* var. *tenera* (Gregory) Van Heurck)

Prasad and Srivastava 1992, p. 318, pl. 38, fig. 1

Valve linear, elongated, narrowly ovate with broadly rounded apex, end attenuated, cuneately rounded base, raphe present, thin, axial area narrow, linear, marginal folds thick, wavy with clear projections, costae thick, strong, radial at the end, striae not visible, 187.5 - 218  $\mu\text{m}$  long and 50  $\mu\text{m}$  broad.

Place of collection Tarin, Ziro; Habitat fish pond, planktonic; Voucher number 2755, 2763; Date of collection 03.11.2010

Class Xanthophyceae

Order Mischoococcales

Family Gloeobotrydaceae

**Genus *Gloeobotrys* Pascher**

**86. *Gloeobotrys limneticus*** (Smith) Pascher (Plate 2, Fig. 47)

(Synonym *Gloeocystopsis limneticum* G.M. Smith)

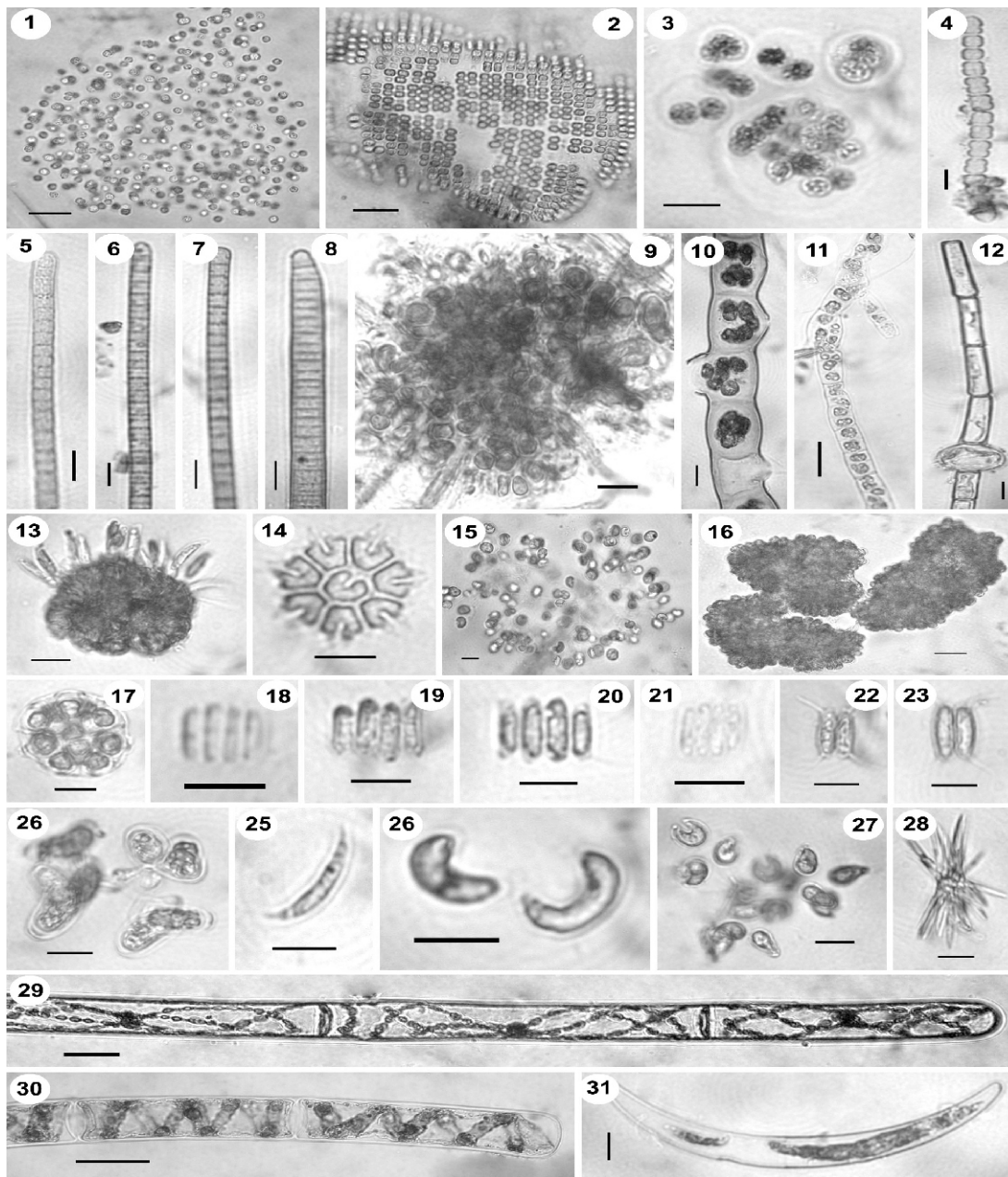
Prescott 1961, p. 356, pl. 93, fig. 35, 36

Colony ovate, 20 cells are present in a gelatinous envelope, diameter of the colony 30 - 33  $\mu\text{m}$ , cells 4.4-5  $\mu\text{m}$  in diameter.

Place of collection Ganga lake, Itanagar; Habitat planktonic; Voucher number 2749; Date of collection 02.11.2010 (reported first time in India)

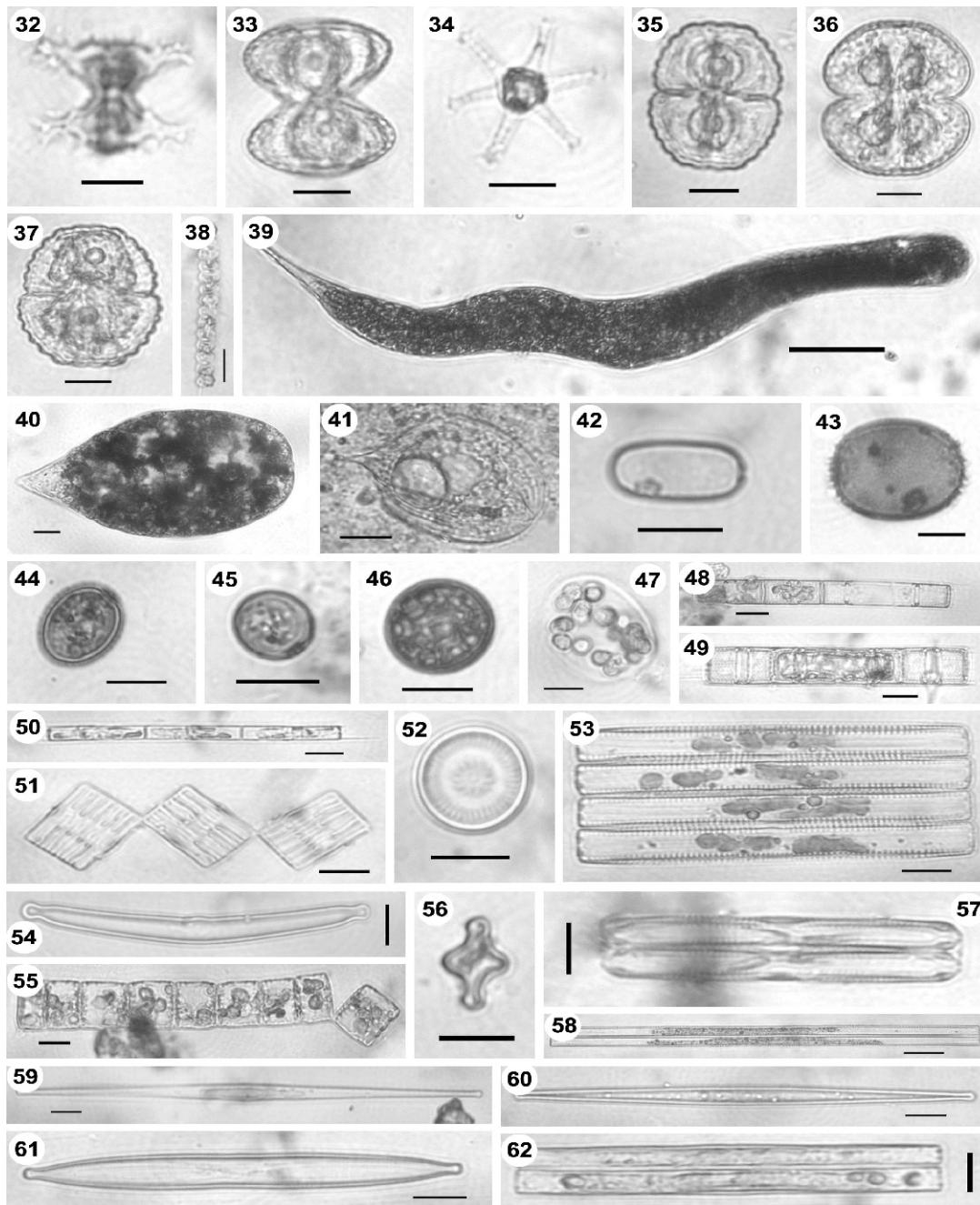
## DISCUSSION

Habitat wise distribution of all the 86 freshwater algal species showed that the diversity was maximum in the lakes (37), followed by streams (33), ponds (20) and rivers (9). A habitat specificity of their occurrence was also observed. Chlorococcalean members were mostly recorded in the lakes, showing the

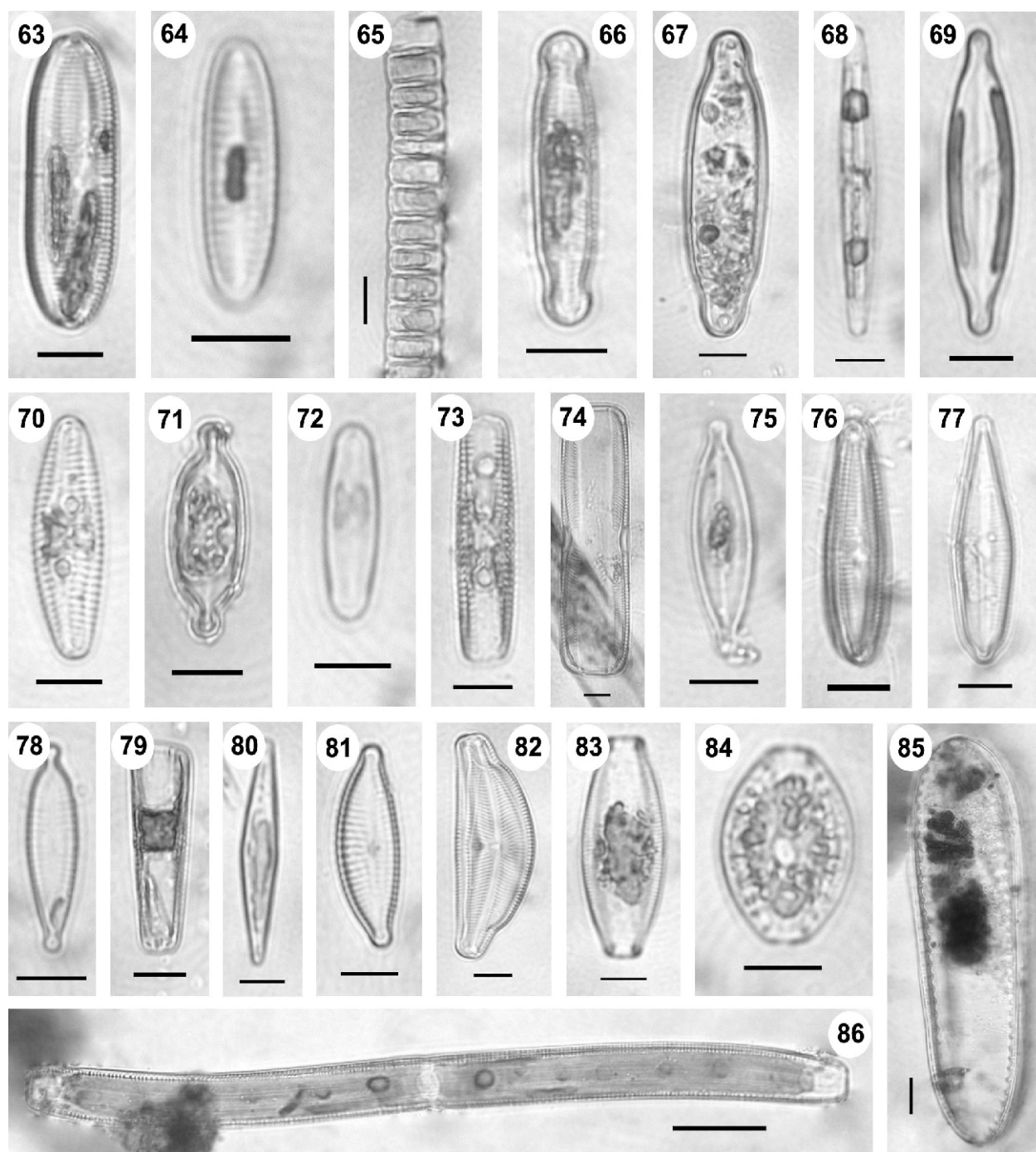
**Plate 1:**

1. *Aphanocapsa conferta*, 2. *Merismopedia glauca*, 3. *Microcystis wesenbergii*, 4. *Komvophoron crassum*, 5. *Planktothrix cryptovaginata*, 6. *Phormidium chlorinum*, 7. *Phormidium numidicum*, 8. *Oscillatoria yamadae*, 9. *Coleochaete scutata*, 10. *Microspora amoena*, 11. *Radiofilum transversalis*, 12. *Oedogonium platygynum* var. *osilia*, 13. *Characium ambiguum*, 14. *Pediastrum tetras*, 15. *Dictyosphaerium pulchellum*, 16. *Botryococcus braunii*, 17. *Coelastrum reticulatum* var. *cubanum*, 18. *Scenedesmus bijugatus*, 19. *Scenedesmus bijugatus* var. *bicellularis*, 20. *Scenedesmus bijugatus* f. *parvus*, 21. *Scenedesmus ecornis* var. *ecornis*, 22. *Scenedesmus pseudopoliensis*, 23. *Scenedesmus quadricauda* var. *quadrispina*, 24. *Dimorphococcus lunatus*, 25. *Monoraphidium fontinale*, 26. *Kirchneriella irregularis* var. *irregularis*, 27. *Kirchneriella lunaris*, 28. *Ankistrodesmus densus*, 29. *Spirogyra acanthophora*, 30. *Spirogyra parvula*, 31. *Closterium moniliferum*

Scale bar: Fig. 3-28, 32 = 10 µm; Fig. 1, 2 = 20 µm; Fig. 30 = 30 µm and Fig. 29 = 50 µm.

**Plate 2:**

32. *Staurastrum bicornis*, 33. *Staurastrum bienanum* var. *ellipticum*, 34. *Staurastrum gracile*, 35. *Cosmarium awadhense*, 36. *Cosmarium miscellum*, 37. *Cosmarium radiosum*, 38. *Desmidiium pseudostreptonema*, 39. *Euglena oxyuris*, 40. *Euglena sanguinea*, 41. *Phacus caudatus*, 42. *Trachelomonas abrupta* var. *minor*, 43. *Trachelomonas armata* f. *punctata*, 44. *Trachelomonas hispida* var. *granulata*, 45. *Trachelomonas volvocina*, 46. *Trachelomonas volvocina* var. *punctata*, 47. *Gloeobotrys limneticus*, 48. *Melosira granulata*, 49. *Melosira granulata* var. *muzzanensis*, 50. *Melosira islandica* subspecies *helvetica*, 51. *Tabellaria fenestrata*, 52. *Cyclotella stelligera*, 53. *Fragilaria capucina*, 54. *Fragilaria arcus*, 55. *Fragilaria construens* f. *venter*, 56. *Fragilaria leptostauron*, 57. *Fragilaria virescens*, 58. *Synedra crystallina*, 59. *Synedra delicatissima*, 60. *Synedra tenera*, 61. *Synedra ulna* var. *amphirhynchus*, 62. *Synedra ulna* var. *oxyrhynchus*  
 Scale bar: Fig. 32- 38, 40- 57, 59- 62 = 10  $\mu$ m; Fig. 58 = 20  $\mu$ m; Fig. 39 = 50  $\mu$ m.

**Plate 3:**

63. *Achnanthes coarctata* var. *elliptica*, 64. *Achnanthes convergens*, 65. *Diadesmis confervacea*, 66. *Pinnularia interrupta*, 67. *Pinnularia nodosa*, 68. *Pinnularia subsimilis*, 69. *Navicula amphirhynchus*, 70. *Navicula cryptocephaloides*, 71. *Navicula dicephala* var. *sphaerophora*, 72. *Navicula pupula*, 73. *Navicula sphaerophora*, 74. *Navicula viridis*, 75. *Anomooneis vitrea*, 76. *Gomphonema montanum* var. *genuina*, 77. *Gomphonema olivaceum*, 78. *Gomphonema parvulum*, 79. *Gomphonema telegraphicum*, 80. *Gomphonema vibrio*, 81. *Cymbella ehrenbergii*, 82. *Cymbella tumida*, 83. *Amphora elliptica*, 84. *Epithemia gibberula* var. *producta*, 85. *Surirella tenera*, 86. *Nitzschia sigmoidea*.

Scale bar: Fig. 63- 84 = 10  $\mu$ m; Fig. 85 = 20  $\mu$ m; Fig. 86 = 30  $\mu$ m.

oligotrophic condition. Majority of Euglenophytes were restricted to ponds only. However, Bacillariophycean members showed diverse in distribution except a few epilithic ones, e.g. *Fragillaria* and *Gomphonema*, confined only to the streams. Distribution pattern in different altitudinal gradients also showed specificity of certain species with respect to the altitude (Table 2). Only one diatom taxa i.e. *Achnanthes convergens* occurred at all the altitudes ranging between 436 ft - 13792 ft a.s.l.. Seven diatom species e.g., *Navicula viridis*, *Navicula dicephala* var. *sphaerophora*, *Pinnularia interrupta*, *Diademsis confervacea*, *Synedra ulna* var. *amphirhynchus* and *Melosira granulata* and one desmid *Desmidium pseudostreptonema* were recorded at higher altitudes, only ranging from approximately 10000 to 13000 ft a.s.l.. Six other diatoms *Tabellaria fenestrata*, *Fragilaria construens* f. *venter*, *Synedra ulna* var. *oxyrhynchus*, *Achnanthes coarctata* var. *elleptica*, *Gomphonema telographicum* and *Cymbella tumida* were confined to relatively lower altitudes upto 6000 ft a.s.l.. Most of the Cyanophytes, e.g. *Aphanocapsa coforta*, *Merismopedia glauca*, *Microcystis aeruginosa*, *Komvophoron crassum* and *Planktothrix cryptovaginata*, and all the Euglenophytes, which were planktonic in ponds and lakes occurred at lowest altitude of Arunachal Pradesh ranging from 2297 to 5087 ft. a.s.l.. Mostly diatom members and a species of *Scenedesmus*, i.e. *Scenedesmus pseudopoliensis* occur in the plains of the state at 436-451 ft a.s.l.. It was interesting that one species of Euglenophyta, i.e. *Trachelomonas volvocina* was also recorded from Sela lake, at an altitude of 13792 ft a.s.l. in oligotrophic condition, contrary to the belief that Euglenophytes are confined to eutrophic ponds enriched with organic matters from anthropogenic sources.

The authors thank the Ministry of Environment and Forests, Government of India, for financial assistance. We also thank the authorities of Visva-Bharati for providing laboratory facilities.

#### REFERENCES

- Cho KJ 2000 Epilithic Diatom flora of the Pukchong-Namdaechon river of North Korea. *Algae* **15** 209-231.
- Cho KJ 2000 Epipsammic Diatom flora of the Pukchong-Namdaechon river of North Korea. *Algae* **15** 233-254.
- Cho KJ 2000 Epiphytic Diatom flora of the lakes around Kumho district of North Korea. *Algae* **15** 255-286.
- Desikachary TV 1959 *Cyanophyta*. I.C.A.R. monograph on Algae. New Delhi. Pp 686.
- Desikachary TV 1989 *Atlas of Diatoms* (Marine diatoms of the Indian Ocean region). Madras Science Foundation, Madras. **VI** 1-13, Pl. 622-809.
- Devi SD, Indrama T & Tiwari ON 2010 Biodiversity analysis & reproductive / cultural behaviour of Cyanobacteria of north eastern region of India having acidic properties. *The International Journal of Plant Reproductive Biology* **2** 127-135.
- Ettl H & Gärtner G 1995 *Syllabus der Boden-, Luft- und Flechtenalgen*. Stuttgart. Pp 699.
- Gandhi HP 1958 The freshwater diatom flora of the Hirebhasgar Dam area, Mysore state. *Journal of Indian Botanical Society* **37** 249-265.
- Gandhi HP 1959 Freshwater diatoms from Sagar in the Mysore state. *Journal of Indian Botanical Society* **38** 305-331.
- Gandhi HP 1970 A further contribution to the diatom flora of the Jog-falls, Mysore state, India. *Nova Hedwigia* **31** 757-813.
- Gonzalves EA 1981 *Oedogoniales*, Indian Council of Agricultural Research, New Delhi. Pp 757.
- Gonzalves EA & Gandhi HP 1952 A systematic account of the diatoms of Bombay and Salsette, Part-I, *Journal of Indian Botanical Society* **31** 117-151.
- Hindák F 1988 *Studies on the Chlorococcal Algae (Chlorophyceae)*. IV. Slovak Academy of Sciences, VEDA publishing house, Bratislava, Slovakia. Pp 263.
- Huber-Pestalozii G 1942 *Das phytoplankton des Süßwassers*. 2. Teil, 2. Hälfte, Schweizerbart'she Verlagsbuchhandlung, Stuttgart. Pp 545.
- Huber-Pestalozii G 1955 *Das phytoplankton des Süßwassers: Systematic und Biologie*, **XVI**, Pp 606.
- Kant S & Gupta P 1998 *Algal flora of Ladakh*. Scientific

- Publication, Jodhpur, India. Pp 341.
- Komárek J and Anagnostidis K 1989 Modern approach to the classification system of cyanophytes. 4 Nostocales. *Archiv für Hydrobiologie. Algological Studies* **56** 247-345.
- Komárek J & Anagnostidis K 1998 *Cyanoprokaryota I. Teil: Chroococcales*. In: Herausgegeben von H. Ettl, G. Gärtner, H. Heynig, D. Mollenhauer (eds.), *Süßwasserflora von Mitteleuropa*, Gustav Fischer, Verlag, **19** Pp 548.
- Komárek J & Anagnostidis K 2005 *Cyanoprokaryota II. Teil: Oscillatoriales*. In: Büdel B, Gartner G, Krienitz L and Schagerl M (eds.), *Süßwasserflora von Mitteleuropa*, Elsevier, **19** Pp 759.
- Komárek J & Fott B 1983 *Das phytoplankton des Süßwassers*, 7. Teil: - E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart. Pp 1001.
- Komárek J & Jankovská V 2001 Review of the algal genus *Pediastrum*; implication for pollen analytical research. *Bibliotheca Phycologica* J. Cramer, Stuttgart Band **108** Pp 127.
- Kützing FT 1865 *Bracillarian order Diatomeen*, Verlag von Ferd Förstemann, Nordhausen. Pp 152.
- Lee RE 1999 *Phycology*, Cambridge University Press, United Kingdom. Pp 614.
- Mishra PK & Srivastava AK 2003 Some desmids (Chlorophyceae) from North-Eastern Uttar Pradesh, India. *Journal of Indian Botanical Society* **82** 85-92.
- Oinam G, Singh KO & Tiwari ON 2010 An account of morphological and biochemical characterization of some heterocystous Cyanobacteria (Nostocales) of NE region of India falling under Indo-Burma biodiversity hot spots. *Bioscience Biotechnology Research Communications* **3** 26-32.
- Pal UC & Santra SC 1992 Algae of Midnapore, West Bengal II Bacillariophyceae. *Phykos* **29** 73-81.
- Philipose MT 1967 *Chlorococcales*. I.C.A.R. Monographs on Algae, New Delhi. Pp 365.
- Prasad BN and Mishra PK 1992 *Fresh water algal flora of Andaman and Nicobar Islands*. Vol. **II**. Bishen Singh Mahendra Pal Singh, Dehra Dun. Pp 284.
- Prasad BN and Srivastava MN 1992 *Fresh water algal flora of Andaman and Nicobar Islands*. Vol. **I**. Bishen Singh Mahendra Pal Singh. Dehra Dun. Pp 369.
- Prescott GW 1961 *Algae on the Western Great Lakes Area*. Wm. C. Brown Company Publishers. Dubuque, Iowa. Pp 977.
- Ramanathan KR 1964 *Ulotrichales*. ICAR, New Delhi. Pp 188.
- Randhawa MS 1959 *Zygnemataceae*. ICAR, New Delhi. Pp 478.
- Reddy PM, Yumnam DD & Imchen TY 1986 Investigations on the blue green algae of north east India: Distribution and habitat preferences. *Phykos* **25** 148-158.
- Rott E & Lenzenweger R 1994 Some rare and interesting plankton algae from Srilankan reservoirs. *Biologia* **49** 479-500.
- Singh NI, Singh NS, Devi GA and Singh SM 1997 Blue green algae from rice growing areas of Arunachal Pradesh. *Phykos* **36** 21-26.
- Sreenivasa MR & Duthie HC 1973 Diatom flora of the Grand river, Ontario, Canada. *Hydrobiologia* **42** 161-224.
- Srivastava PN & Odhwani BR 1990 *Trachelomonas Ehrenberg* (Euglenophyta) from semi arid region of Western Rajasthan. *Phykos* **29** 121-126.
- West W, West GS & Carter N 1923 *A Monograph of the British Desmidiaceae*. The Ray Society London. Vol. **V** Pp 300.
- Wołowski K & Hindák F 2005 *Atlas of Euglenophytes*. VEDA, Publishing House of the Slovak Academy of Sciences. Pp 136.