

## ALGAL FLORA OF MIZORAM, INDIA

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Forty algal taxa collected from different water bodies and sub-aerial sites of Mizoram. These belong to Family Cyanophyceae (17), Chlorophyceae (14), Zygnematophyceae (1) and Bacillariophyceae (8). All these taxa have been recorded for the first time from this region.

**Key words:** Algae, Mizoram, fresh water, sub-aerial habitat, systematic account

Mizoram, which is known as the 'Land of mizos', of the north-eastern part of India. It has a geographical area of over 21,000 sq. km. and possesses a bountiful of fresh water bodies including several ponds, lakes, rivers and perennial streams. But the algal taxa of this region have not been investigated. Samples were collected from different fresh water and sub-aerial habitats of Mizoram covering Aizawl, Sairang, Lengpui, Shimni and the Phunchawng water fall and studied. In this paper we have documented 40 different algal species occurring in this region.

### MATERIALS AND METHODS

A total of 19 samples were collected from few different localities of Mizoram covering Shimni, Lengpui, Sairang, Aizawl and Phunchawng area (between 23° 45' 03" to 23° 48' 48" N and 92° 37' 42" to 92° 43' 28" E) comprising of various habitats, e.g. ponds, rivers, streams, waterfall, rock surface, limestone and soil surfaces etc. during March 2008. Freshwater samples were collected by using plankton net (45µm pore size) and fixed with Lugol's iodine on spot. The samples from sub-aerial habitats were collected by gently scrapping the surfaces using blade or sterile needle and stored in sterilized Tarson specimen

tubes. Voucher specimens were deposited at Utkal University assigning a collection number and mentioning the date and place of collection. Microphotograph of each specimen was taken using a Meiji Trinocular research microscope fitted with Nikon coolpix 4500 digital camera. The crust samples were soaked in sterile distilled water for few hours and observed under microscope for presence of algal forms. Though the cells/filaments of the organisms in the crusts were observed soon after wetting. The morphological features were not distinct on which the identification could be made. So a pinch of the crust samples were cultured in the laboratory with BG-11 medium with or without nitrogen (Rippka *et al.* 1979) in agarised medium (1.1 % w/v agar-agar in the mineral medium). The algal taxa appeared in the cultures were photographed. Measurement of cell length and breadth were calculated by micrometry and identified following standard monographs (Desikachary 1959, Hindák 1973, Komárek and Fott 1983, Krishnamurthy 1998, Kützing 1865, Prescott 1962, Randhawa 1959) and research papers (Barberousse *et al.* 2006, Uher *et al.* 2005).

### SYSTEMATIC ENUMERATION

**Cyanoprokaryota/Cyanophyceae (Cyano-**

**bacteria)**

**1. *Microcystis aeruginosa*** Kützing (Pl. 1, fig. 1) (Synonym: *Clathrocystis aeruginosa* var. *major*) Desikachary, 1959, p. 93, pl. 17, fig. 1, 2, 6 and pl. 18, fig. 10

Colonies when young round or slightly longer than broad, solid, when old becoming clathrate, with distinct hyaline colonial mucilage; cells 5-6 µm diameters.

Place of collection: Shimni; habitat: Planktonic in fish pond (Voucher no. 1428, Date of collection: 25-03-08)

**2. *Microcystis flos-aquae*** (Wittrock) Kirchner (Pl. 1, fig. 2) (Synonym: *Microcystis prasina* (Wittrock) Lemmermann; *Microcystis aeruginosa* f. *flos-aquae* (Wittrock) Elenkin) Desikachary, 1959, p. 94, pl. 17, fig. 11 and pl. 18, fig. 11

Colonies roughly spherical, ellipsoidal, not clathrate, with indistinct colonial mucilage; cells 3-5 µm in diameter.

Place of collection: Shimni; habitat: Planktonic in fish pond (Voucher no. 1428, Date of collection: 25-03-08).

**3. *Microcystis lamelliformis*** Holsinger (Pl. 1, fig. 3) Desikachary, 1959, p. 91, pl. 19, fig. 1, 2

Colonies free-floating, spherical, lamellate or lenticular, mucilage envelope; cells spherical, 3-5 µm diameters, loosely aggregated.

Place of collection: Lengpui; habitat: Planktonic in fish pond (Voucher no. 1423, Date of collection: 24-03-08)

**4. *Chroococcus globosus*** (Elenkin) Hindák (Pl. 1, fig. 4) Hindák, 1973, p. 365, fig. 5

Colonies 4 or 8 celled or multicelled, cells placed mostly into two, 15-17 µm diameter; mucilaginous envelope; cells spherical or oval, 4.5-6.0 µm diameter, blue green.

Place of collection: Hotel tourist lodge, Aizawl; habitat: Cement wall surfaces (Voucher no. 1415, Date of collection: 25-03-2008).

**5. *Gloeocapsa sanguinea*** (Agardh) Kützing (Pl. 1, fig. 12) Barberousse *et al.* 2006, p. 86, pl. 89, fig. 33 and 72.

Cells spherical to oval, surrounded by distinctly stratified envelopes and distributed in intensely red or yellowish, spherical

mucilaginous colonies; 3-6 µm diameter.

Place of collection: Hotel tourist lodge, Aizawl; habitat: Cement wall surface (Voucher no. 1415, Date of collection: 25-03-2008).

**6. *Oscillatoria animalis*** Agardh ex. Gomont (Pl. 1, fig. 5) Desikachary, 1959, p. 239, pl. 40, fig. 14

Filaments straight, blue green, not constricted at the cross-walls; cells 3.0-4.0 µm broad; briefly attenuated at the ends and slightly bent; end cell pointed conical or acute.

Place of collection: Sairang; habitat: Soil surface (Voucher no. 1416, Date of collection: 23-03-2008).

**7. *Oscillatoria princeps*** Vaucher ex. Gomont (Pl. 1, fig. 6) Desikachary 1959, p. 210, pl. 37, fig. 10

Trichomes blue-green, straight, not constricted at the cross walls, 16-50 µm broad; slightly or briefly attenuated at the apices, bent; cells as long as broad, 3.5-7.0 µm long; end cells rounded.

Place of collection: Sairang; habitat: Stream, floating green mats, (Voucher no. 1427, Date of collection: 23-03-08)

**8. *Phormidium inundatum*** Kützing ex. Gomont (Pl. 1, fig. 7) Desikachary, 1959, p. 271

Filaments straight or bent; sheath thin; blue green, not constricted at the cross walls; cells nearly quadrate or longer than broad, 4-5 µm broad and 6.4-8.0 µm long; end cell obtuse conical.

Place of collection: Sairang; habitat: Soil surface (Voucher no. 1416, Date of collection: 23-03-2008).

**9. *Phormidium tenue*** (Meneghini) Gomont (Pl. 1, fig. 8) Desikachary, 1959, p. 259, pl. 43, fig. 13-15

Filament straight, slightly bent, densely entangled, pale blue green; constricted at the cross walls, attenuated at the ends; sheath thin; cells 2.5-3.0 µm broad and 2.5 µm long; end cells acute conical.

Place of collection: Sairang; habitat: Soil surface (Voucher no. 1416, Date of collection: 23-03-2008).

**10. *Nostoc muscorum*** Agardh ex. Bornet & Flahault (Pl. 1, fig. 9) Desikachary, 1959, p. 385, pl. 70, fig. 2

Filaments flexuous, densely entangled; dull olive green or brownish colored; cells spherical or barrel-shaped, 3.3-4.0  $\mu\text{m}$  diameter; heterocyst globose, intercalary, spherical, 4.6-5.0  $\mu\text{m}$  diameter.

Place of collection: Near waterfall Phunchawang (14 km from Aizawl on way to Lengpui airport); habitat: Rock surface (Voucher no.1420, Date of collection: 24-03-2008).

**11. *Nostoc piscinale*** Kützing ex. Bornet & Flahault (Pl. 1, fig. 10) Desikachary, 1959, p. 377, pl. 69, fig.3

Thallus gelatinous, light blue green; filament loosely entangled; cell barrel-shaped, sub-spherical, 3.4-4.0  $\mu\text{m}$  in diameter; heterocyst sub-spherical, 4.9-5.5  $\mu\text{m}$  diameter. Place of collection: Sairang; habitat: Soil surface (Voucher no.1416, Date of collection: 23-03-2008).

**12. *Nostoc punctiforme*** (Kützing) Hariot (Pl. 1, fig. 11) Desikachary, 1959, p.374, pl. 69, fig.1

Thallus sub-globose, up to 2 mm diameter, scattered or confluent, attached; filaments flexuous, densely entangled; sheath delicate, hyaline, mucous; cells short barrel-shaped or ellipsoidal, 4.0-5.0  $\mu\text{m}$  broad; heterocyst 3.0-4.0  $\mu\text{m}$  broad.

Place of collection: Sairang; habitat: Soil surface (Voucher no.1416, Date of collection: 23-03-2008).

**13. *Scytonema burmanicum*** Skuja (Pl. 1, fig. 13) Desikachary, 1959, p.460, pl. 97, fig.1-9

Thallus expanded; filament erect, parallel, false branching; bluish green; sheath thick, yellowish colour; cell less constricted at the cross wall, 10  $\mu\text{m}$  broad and 5  $\mu\text{m}$  long; heterocyst cylindrical to discoid with slightly rounded apices, 10  $\mu\text{m}$  broad and 7  $\mu\text{m}$  long; apical cell rounded.

Place of collection: Hotel tourist lodge, Aizwal; habitat: Cement wall surfaces (Voucher no.1415, Date of collection: 25-03-2008).

**14. *Scytonema mirabile*** (Dillwyn) Bornet (Pl. 1, fig. 14) Desikachary, 1959, p.483, pl. 91, fig.3

Filament tortuous yellowish to blue-green

or olive- green; cells cylindrical, 4.8-5.0  $\mu\text{m}$  broad and 6.0-6.5  $\mu\text{m}$  long; heterocyst nearly quadratic or longer than broad, 3.6-4.0  $\mu\text{m}$  broad and 6-7  $\mu\text{m}$  long.

Place of collection: Near waterfall Phunchawang; habitat: Rock surface (Voucher no.1420, Date of collection: 24-03-2008).

**15. *Tolypothrix bouteillei*** (Breb. & Desm.) Forti (Pl. 1, fig. 15) Desikachary 1959, p. 499, pl. 101, fig.8

Filamentous, false branched, short, deciduous, blackish brown; sheath thin, colorless; cell 6.6-7.0  $\mu\text{m}$  broad and 3.3-4.0  $\mu\text{m}$  long; heterocyst basal, rarely intercalary, single.

Place of collection: Hotel tourist lodge, Aizwal; habitat: Rock surface (Voucher no.1412, Date of collection: 25-03-2008).

**16. *Calothrix elenkinii*** Kossinskaja (Pl. 1, fig. 16) Desikachary, 1959, p.531, pl. 114, fig.6, 11

Filament long, united in tufts, bent at the base, interlaced with each other; sheath close to the trichome, thin, colorless; trichome blue or olive green, 5.0-7.5  $\mu\text{m}$  broad at the base, 4.5-5.0  $\mu\text{m}$  broad in the middle; not constricted at the base; heterocyst basal, 4.5-7.0  $\mu\text{m}$  broad.

Place of collection: Hotel tourist lodge, Aizawl; habitat: Cement wall surface (Voucher no. 1415, Date of collection: 25-03-2008).

**17. *Calothrix marchia*** Lemmermann **var. *crassa*** Rao, C.B (Pl. 1, fig. 17) Desikachary, 1959, p.543, pl. 113, fig.3 and 4

Filaments long, straight, sometimes bent, slightly swollen at the base, gradually tapers; sheath yellowish brown; constricted at the septa; cell at the base much broader than long, 5.0-13.8  $\mu\text{m}$  broad and 7.5-6.9  $\mu\text{m}$  long; heterocyst single, basal, sub-spherical, 7.5-10.5  $\mu\text{m}$  broad and 6.9-10.5  $\mu\text{m}$  long; end cell conical with a rounded apex.

Place of collection: Near waterfall Phunchawang; habitat: Rock surface, (Voucher no.1420, Date of collection: 24-03-2008).

#### **Chlorophyceae**

**18. *Chlorococcum humicola*** (Nägeli) Rabenhorst (Pl. 2, fig. 18) Komárek and Fott, 1983, p. 36, fig. 3

Cells spherical, light green in color, solitary or a number of cell crowded together to

form a stratum; chloroplast with a hollow sphere with a lateral notch; cells 6.6-20.0  $\mu\text{m}$  in diameter.

Place of collection: Sairang; habitat: Soil surface (Voucher no.1417, Date of collection: 23-03-2008).

**19. *Brateococcus minor*** (Chodat) Petrová (Pl. 2, fig. 19) Komárek and Fott, 1983, p. 136, pl. 37, fig. 2 (a-d)

Cells spherical, single or in group; globose; polygonal parietal chloroplast many, without pyrenoid; 6.8-23.0  $\mu\text{m}$  in diameter.

Place of collection: Sairang; habitat: Soil surface (Voucher no.1416, Date of collection: 23-03-2008).

**20. *Radiococcus nimbatu*** (De Wildman) Schmidle (Pl. 2, fig. 20) Komárek and Fott, 1983, p. 399, pl. 120, fig. 3

Colonies 4 celled 14 -20  $\mu\text{m}$  diameter; chloroplast single, parietal without pyrenoid; cells more or less pyramidal and angular, remaining in a group; cells 5 -12  $\mu\text{m}$  diameter.

Place of collection: Hotel tourist lodge, Aizawl; habitat: Bark of trees (Voucher no.1414, Date of collection: 25-03-2008).

**21. *Ankistrodesmus densus*** Korshikov (Pl. 2, fig. 21) (Synonym: *Ankistrodesmus spiralis* var. *fasciculatus* G.M.Smith 1922) Hindák 1988, p.237, pl. 87

Coenobia multicelled, denser with interlaced cells; relatively free, slightly detached from each other, colonies assume to spherical shape; cells are equal in length and width, normal from center towards the ends, ends pointed, 1.5-2.5  $\mu\text{m}$  broad and 20-50  $\mu\text{m}$  long.

Place of collection: Lengpui; habitat: Planktonic in fish pond (Voucher no. 1423, Date of collection: 24-03-08)

**22. *Desmodesmus armatus*** (Chodat) var. *spinosus* (Fritsch et. Ritch) Hegewald (Pl. 2, fig. 22) (Basionym: *Scenedesmus armatus* (Chodat) var. *spinosus* (Fritsch et. Ritch) 1929) [Synonym: *Scenedesmus armatus* var. *brevicaudatus* (L.Piterfi) Hegewald 1982, *Scenedesmus armatus* var. *boglariensis* f. *brevicaudatus* L. Piterfi] Hegewald *et al.* 1990, p. 21, pl. 30, fig. 2a, and pl. 32b.

Coenobia 2-4 celled; cells oblong to

ellipsoid, arranged in a linear series; single short spine arising from each pole of terminal cells, spine sometimes curved towards tips; cells 2.5 -4.0  $\mu\text{m}$  broad and 5.0 -7.5  $\mu\text{m}$  long.

Place of collection: Lengpui; habitat: Planktonic in fish pond (Voucher no. 1423, Date of collection: 24-03-08).

**23. *Desmodesmus spinosus*** (Chodat) Hegewald (Pl. 2, fig. 23).

(Basionym: *Scenedesmus spinosus* R. Chodat 1913) [Synonym: *Scenedesmus brevicauleatus* R. Chodat 1926, *Scenedesmus corallinus* R. Chodat 1926] Hegewald *et al.* 1990, p. 38, pl. 104 (d)

Coenobia 2-4 celled; cells oblong-ellipsoid arranged in a linear series; single short spine arising at each pole of terminal cell, straight, one spine at the middle of terminal cell; spines 4 - 8  $\mu\text{m}$  long; cells 1.5 -4.0  $\mu\text{m}$  broad and 7.0 -10  $\mu\text{m}$  long.

Place of collection: Sairang town; habitat: Planktonic in stream (Voucher no. 1426, Date of collection: 23-03-08)

**24. *Pleurogaster oocystoides*** Prescott in Prescott (Pl. 2, fig. 24) Prescott, 1962, p. 353, pl. 95, fig. 20

Cells solitary, ovate, unsymmetrical reniform, broadly elliptic, one side flattened or concave, the other broadly convex, the poles broadly rounded and furnished with a nodular thickening at one or both ends; chromatophores numerous; cells 8 -10  $\mu\text{m}$  broad and 12 -14  $\mu\text{m}$  long.

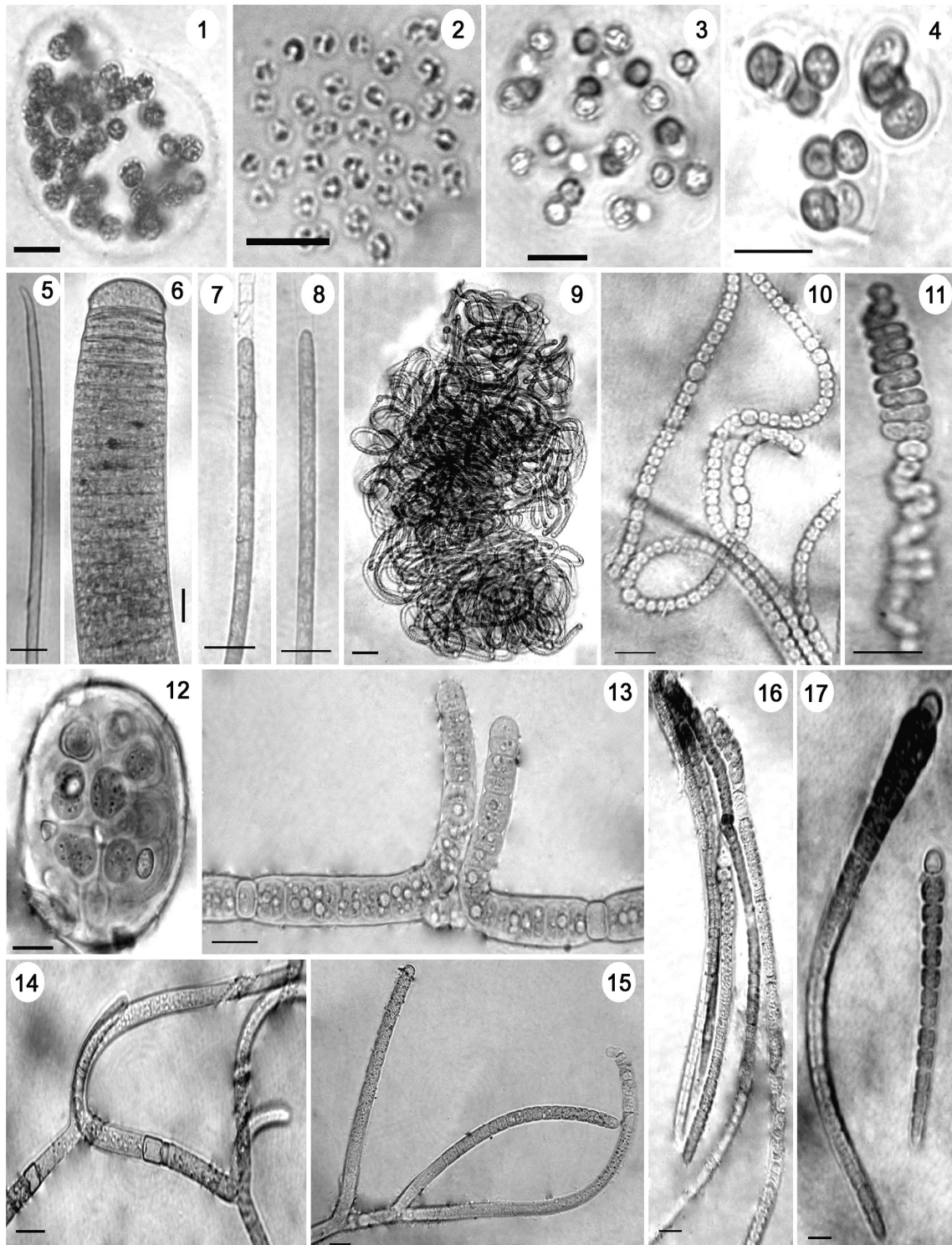
Place of collection: Hotel tourist lodge, Aizawl; habitat: Bark of trees (Voucher no.1414, Date of collection: 25-03-2008).

**25. *Keratococcus bicaudatus*** (A. Braun) Petersen (Pl. 2, fig. 25) Barberousse *et al.* 2006, p. 81, fig. 8, 52

Cells solitary, ellipsoidal to crescent shaped, sometime asymmetrical, with apices acute and sometimes prolonged into a spine; one parietal and cup-shaped chloroplast with one pyrenoid, 3.0-5.5  $\mu\text{m}$  broad and 8 -16  $\mu\text{m}$  long.

Place of collection: Hotel tourist lodge, Aizawl; habitat: Bark of trees (Voucher no.1414, Date of collection: 25-03-2008).

**26. *Klebsormidium nitens*** (Meneghini in



**Plate: 1.** Figures 1-17 1. *Microcystis aeruginosa* Kützing, 2. *Microcystis flos-aquae* (Wittrock) Kirchner, 3. *Microcystis lamelliformis* Holsinger, 4. *Chroococcus globosus* (Elenkin) Hindák Comb nova. 5. *Oscillatoria animalis* Agardh ex. Gomont, 6. *Oscillatoria princeps* Vaucher ex. Gomont, 7. *Phormidium inundatum* Kützing ex. Gomont, 8. *Phormidium tenue* (Meneghini) Gomont, 9. *Nostoc moscorum* Agardh ex. Bornet & Flahault, 10. *Nostoc piscinale* Kützing ex. Bornet & Flahault, 11. *Nostoc punctiforme* (Kützing) Hariot, 12. *Gloeocapsa sanguinea* (Agardh) Kützing, 13. *Scytonema burmanicum* Skuja, 14. *Scytonema mirabile* (Dillwyn) Bornet, 15. *Tolypothrix bouteillei* (Breb. & Desm.) Forti, 16. *Calothrix elenkinii* Kossinskaja, 17. *Calothrix marchia* Lemmermann var. *crassa* Rao, C.B. Scale bar: Fig. 1-17 = 10  $\mu$ m.

kützing) Lockport (Pl. 2, fig. 26) Uher *et al.* 2005, p.298, pl. 299, fig. 39

Filaments straight or slightly bent, dark green; cell dimension 5.0-6.25  $\mu\text{m}$  broad and 10.0-12.5  $\mu\text{m}$  long; chloroplast in cells typically parietal, plate-shaped, one pyrenoid; apical cell obtuse.

Place of collection: Sairang; habitat: Soil surface (Voucher no.1417, Date of collection: 23-03-2008).

**27. *Trentepohlia angadickalensis*** Panikkar & Sindhu (Pl. 2, fig. 27) Krishnamurthy, 1998, p.189, pl. 31, fig. c

Filaments highly branched; erect; cell 5.0-7.5  $\mu\text{m}$  broad and 9.0-15.0  $\mu\text{m}$  long.

Place of collection: Sairang; habitat: Bark of trees (Voucher no.1419, Date of collection: 23-03-2008).

**28. *Trentepohlia aurea*** (Linn.) Martius var. *tenuior* Brühl & Biswas (Pl. 2, fig. 28) Krishnamurthy, 1998, p.187, pl. 30, fig. c

Filament thin, golden-yellow or orange, densely felt like; cells cylindrical, often slightly and irregularly swollen in middle, 4.0-6.5  $\mu\text{m}$  broad and 12-13  $\mu\text{m}$  long; terminal cells tapering; sporangia lateral as well as terminal, spherical.

Place of collection: Sairang; habitat: Bark of trees (Voucher no.1419, Date of collection: 23-03-2008).

**29. *Scenedesmus acuminatus*** (Lagerheim) Chodat var. *acuminatus* Komárek and Fott (Pl. 2, fig. 29) [Synonym: *Selenastrum acuminatum* Lagerheim 1883, *Scenedesmus falcatus* f. *tortuosus* (Skuja) Koršikov 1953] Komárek and Fott 1983, p. 842, fig. 229.1

Coenobia 4-8 celled, arranged in linear to sub alternating series, outer cells of the coenobia more or less lunate apices of the cells attenuated; chloroplast single or parietal with a pyrenoid at the centre; cells 10-14  $\mu\text{m}$  long and 2-5  $\mu\text{m}$  broad.

Place of collection: Lengpui; habitat: planktonic in fish pond (Voucher no. 1423, Date of collection: 24-03-08)

**30. *Scenedesmus acuminatus*** (Lagerheim) Chodat var. *minor* G.M. Smith (Pl. 2, fig. 30) [Synonym: *Scenedesmus falcatus* Chodat 1894] Komárek and Fott 1983, p. 841, fig.

228.4.

Coenobia 4 celled; outer cell of the coenobia less lunate, the central cell of the colony at an angle to the axes of the terminal cells instead of the being parallel to them; chloroplast single and parietal with a pyrenoid; cells 15-22  $\mu\text{m}$  long and 3-6  $\mu\text{m}$  broad.

Place of collection: Lengpui; habitat: planktonic in fish pond (Voucher no. 1423, Date of collection: 24-03-08).

**31. *Scenedesmus pseudopoliensis*** Hortobagyi (Pl. 2, fig. 31) [Synonym: *Scenedesmus columnatus* var. *sexangularis* Hortobagyi] Komárek and Fott 1983, p. 910, fig. 245.9

Coenobia 2-4 celled, arranged in a linear series; cells oblong, slightly truncate at the end; long spine arising at each pole of the terminal cells, spine curved; Cells 2-5  $\mu\text{m}$  broad and 5-13  $\mu\text{m}$  long; spine 8-19  $\mu\text{m}$  long.

Place of collection: Lengpui; habitat: Planktonic in fish pond (Voucher no. 1423, Date of collection: 24-03-08).

#### **Zygnematophyceae**

**32. *Spirogyra hydrodictya*** Transeau (Pl. 2, fig. 36) Randhawa, M.S. 1959, p. 409, fig. 492 (a-c)

Vegetative cells 80-100  $\mu\text{m}$  broad and 150-200  $\mu\text{m}$  long with plane end walls; 7-10 chloroplasts, straight or making 0.1-0.5 turn; conjugation scalariform and lateral; tubes formed by the male gametangia; fertile cells shortened, inflated; zygospores lenticular to lenticular-globose, 80-100  $\mu\text{m}$  broad and 100-125  $\mu\text{m}$  long.

Place of collection: Sairang; habitat: Planktonic in stream (Voucher no.1427, Date of collection: 23-03-08)

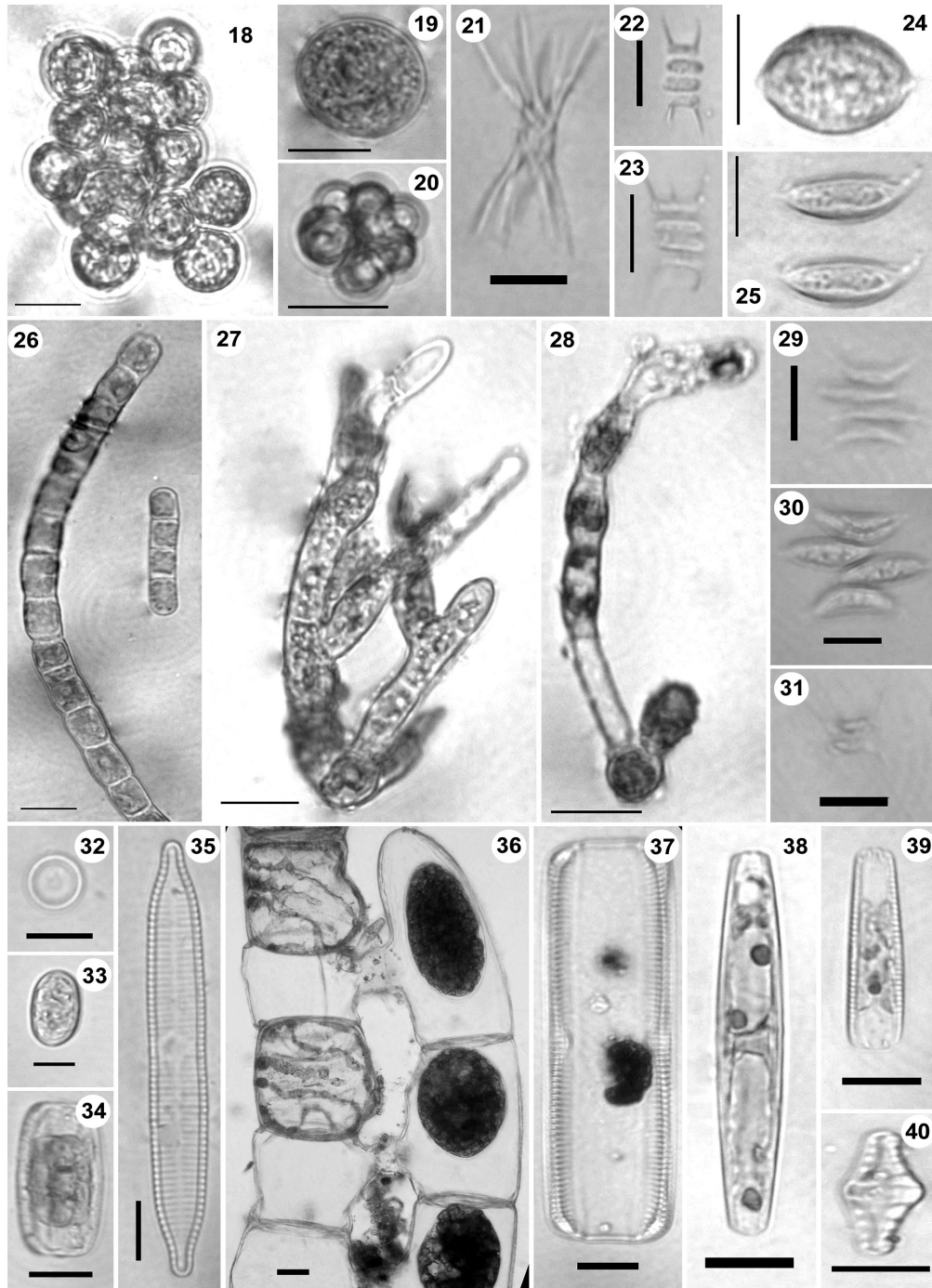
#### **Bacillariophyceae**

**33. *Cyclotella meneghiniana*** Kützing (Pl. 2, fig. 32) Kützing 1865, p.50, pl. 30, fig. 68

Cells mostly disc-shaped and usually solitary, Ornamentation of valve in two unlike concentric patterns, 6-9  $\mu\text{m}$  diameter, central zone is finely punctuate.

Place of collection: Lengpui; habitat: Planktonic in fish pond (Voucher no. 1423, Date of collection: 24-03-08)

**34. *Synedra ulna*** (Nitzsch) Ehrenberg var. *aequalis* (Kützing) Hustedt (Pl. 2, fig. 35)



**Plate: 2.** Figs 18-40 18. *Chlorococcum humicola* (Nägeli) Rabenhorst, 19. *Brateacoccus minor* (Chadot) Petrová, 20. *Radiococcus nimbatu* (De Wildman) Schmidle, 21. *Ankistrodesmus densus* Korshikov, 22. *Desmodesmus armatus* (Chodat) var. *spinus* (Fritsch et. Ritch) Hegawald, 23. *Desmodesmus spinus* (Chodat) Hegewald, 24. *Pleurogaster oocystoides* Prescott in Prescott, 25. *Keratococcus bicaudatus* (A. Braun) Petersen, 26. *Klebsormidium nitens* (Meneghini in Kützing) Lockport, 27. *Trentepohlia angadickalensis* Panikkar & Sindhu, 28. *Trentepohlia aurea* (Linn.) Martius var. *tenuior* Brühl & Biswas, 29. *Scenedesmus acuminatus* (Lagerheim) Chodat var. *acuminatus* Komárek and Fott, 30. *Scenedesmus acuminatus* (Lagerheim) Chodat var. *minor* G.M. Smith, 31. *Scenedesmus pseudopoliensis* Hortobagyi, 32. *Cyclotella meneghiniana* Kützing, 33. *Cocconeis pediculus* Ehrenberg, 34. *Navicula sphaerophora* Kützing, 35. *Synedra ulna* (Nitzsch) Ehrenberg var. *aequalis* (Kützing) Hustedt, 36. *Spirogyra hydrodictya* Transeau, 37. *Navicula viridis* Kützing, 38. *Navicula viridula* Kützing, 39. *Gomphonema elegans* var. *robusta* var. *novo.*, 40. *Nitzschia sinuata* var. *tabellaria*. Scale bar: Fig. 18-35, 37-40 = 10 µm; Fig. 36 = 30 µm.

[Synonym: *Synedra aequalis* Kützing; *Synedra obtuse* Wm. Smith] Huber Pestalozzii 1942, p. 461, pl. CXXXV, fig. 542.

Frustules linear, straight, slender, at the end narrow and slightly constricted to form an obtuse end, many times longer than broad, 50 - 90  $\mu\text{m}$  long and 8 - 12  $\mu\text{m}$  broad; striation distinct and parallel, striae 9 - 12 in 10  $\mu\text{m}$ .

Place of collection: Phunchawng waterfall; habitat: rock surface (Voucher no. 1425, Date of collection: 24-03-2008).

**35. *Cocconeis pediculus*** Ehrenberg (Pl. 2, fig. 33) Kützing 1865, p.71, pl. 5, fig. IX (1)

Frustules subcircular or broadly elliptical, with marginal bend, lanceolate outline, rounded end, 22-27 $\mu\text{m}$  long and 10-17  $\mu\text{m}$  broad; striation not visible in fresh material.

Place of collection: Phunchawng waterfall; habitat: rock surface (Voucher no. 1425, Date of collection: 24-03-2008).

**36. *Navicula sphaerophora*** Kützing (Pl. 2, fig. 34) Kützing 1865, p.95, pl. 4, fig. XVII.

Frustules elliptic-lanceolate; at the middle area dorsal side strongly convex, central area broad, constricted apices, obtuse, raphae median wide; striation thin, not visible in fresh material; 30 - 40  $\mu\text{m}$  long and 10 - 15  $\mu\text{m}$  broad. Place of collection: Sairang town; habitat: Epiphytic in stream (Voucher no. 1426, Date of collection: 23-03-2008).

**37. *Navicula viridis*** Kützing (Pl. 2, fig. 37) (Synonym: *Bacillaria viridis* Nitzsch; *Frustulia viridis* Kützing) Kützing 1865, P. 97, pl. 4, fig. XVIII.

Frustules linear oblong, rectangular in valve view, slightly rotundatum towards apices, 60-86  $\mu\text{m}$  long and 14-22  $\mu\text{m}$  broad; striation transverse, striae 8-12 in 10  $\mu\text{m}$ .

Place of collection: Lengpui; habitat: Planktonic in fish pond (Voucher no. 1423, Date of collection: 24-03-08).

**38. *Navicula viridula*** Kützing (Pl. 2, fig. 38) [Synonym: *Frustulia viridula* Kützing] Kützing 1865, P.91, pl. 3, fig. XLIV.

Frustules linear lanceolate, elongated, attenuated towards apices to obtuse end, 40-45  $\mu\text{m}$  long and 5-12  $\mu\text{m}$  broad; raphae not clear; striation clearly visible in fresh material.

Place of collection: Phunchawng waterfall; habitat: rock surface (Voucher no.

1425, Date of collection: 24-03-2008).

**39. *Gomphonema elegans* var. *robusta*** var. novo. (Pl. 2, fig. 39) Kant and Gupta 1998, pl. 125, fig. 1

Valve lanceolate, central portion constricted at both ends from inside, striae marginal, valve length 30-33  $\mu\text{m}$  and breadth 4-7  $\mu\text{m}$ .

Place of collection: Phunchawng waterfall; habitat: rock surface (Voucher no. 1425, Date of collection: 23-03-2008).

**40. *Nitzschia sinuata* var. *tabellaria*** Hassall (Pl. 2, fig. 40) Wehr and Sheath 2003, P. 677, fig. 20

Frustules with curved septa, fusiform, the poles narrowed from an enlarged central region, length 17-20  $\mu\text{m}$  and breadth 7-8  $\mu\text{m}$ .

Place of collection: Sairang; habitat: Epiphytic in stream (Voucher no. 1426, Date of collection: 23-03-2008).

## DISCUSSION

Analysis of the habitat wise occurrence of the algae showed that five green algal species, e.g. *Trentepohlia angadickalensis*, *Trentepohlia aurea* var. *tenuior*, *Keratococcus bicaudatus*, *Pleurogaster oocystoides* and *Radiococcus nimbatus* occur on the bark of trees. To the contrary, on the surface of dried soils near trees, three other green algal species, e.g. *Chlorococcum humicola*, *Brateococcus minor* and *Klebsormidium nitens* and five species of blue-green algae, e.g. *Oscillatoria animalis*, *Phormidium inundatum*, *Phormidium tenue*, *Nostoc piscinale* and *Nostoc punctiforme* occurred. On other sub-aerial habitats like exteriors of building walls and exposed rock surfaces, only number of cyanobacteria of the genera *Chroococcus*, *Gloeocapsa*, *Calothrix*, *Nostoc*, *Scytonema* and *Tolypothrix* were found growing. All of the species possess well developed sheath or slime layers around the cell wall, which possibly make them to thrive the desiccation stress prevailing on such habitats. In fish ponds few species of green micro algae, e.g. *Ankistrodesmus spinosus*, *Desmodesmus armatus* var. *spinosus*, *Scenedesmus acuminatus* var. *minor* and *Scenedesmus*



*pseudopoliensis*, two species of diatoms, e.g. *Cyclotella meneghiniana* and *Navicula viridis* and three species of bloom forming Cyanobacterium *Microcystis* were dominant, indicating their selective preference to occur in organic rich water bodies. But in streams and waterfalls, six diatom species under the genera, *Navicula*, *Nitzschia*, *Synedra*, *Gomphonema* and *Cocconeis*, two green algae, *Desmodesmus spinosus* and *Spirogyra hydrodictya* and the cyanobacterium *Oscillatoria princeps* were found occurring, showing the habitat specificity to oligotrophic water.

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