

## New insights into the diversity of planktonic Chlorophytes and Charophytes from West Bengal with reports of three novel taxa from India.

Camellia Nandi, Pritha Basu and Ruma Pal\*

Phycology Laboratory, Department of Botany, University of Calcutta  
35, Ballygunge Circular Road, Kolkata-700019, West Bengal, India. \*Author for correspondence: e-mail: [rpalcu@rediffmail.com](mailto:rpalcu@rediffmail.com)

### Abstract:

Two previously unexplored sites from North 24 Parganas and Kolkata districts of West Bengal, India were selected for floristic survey of planktonic chlorophytes and charophytes as a part of our continuous survey program on Algal Flora of West Bengal. The investigation aimed at studying such planktonic populations, enumerating their diversity, abundance and morphotaxonomic characterisation supported by SEM studies. In this communication 65 taxa of Chlorophyta and 1 taxon of Charophyta belonging to the families Hydrodictyaceae, Scenedesmaceae, Chlorellaceae, Neochloridaceae, Selenastraceae, Schroederiaceae and Elakatotrichaceae have been reported. The dominating algal family recorded was Scenedesmaceae (23) followed by Selenastraceae (17 species) and Hydrodictyaceae (9). The green alga *Monoraphidium* with 10 species was found to be the dominating genus. Within the family Scenedesmaceae, *Tetrademus dimorphus* was recorded as the dominant taxon followed by *Scenedesmus obtusus*, *Pectinodesmus pectinatus* and *P. javanensis*. The 3 species reported for the first time from India include *Lauterborniella elegantissima* Schmidle, *Drepanochloris nannoselene* (Skuja) Marvan, Komárek & Comas and *Drepanochloris uherkovichii* Marvan, Komárek & Comas. *Tetraedron triangulare* Korshikov and *Keratococcus bicaudatus* (A. Braun ex Rabenhorst) J.B. Petersen were reported for the first time from West Bengal.

**Keywords:** Chlorophyceae, Phytoplankton diversity, West Bengal.

### Introduction:

India is a mega-diverse country harboring majority of the Earth's species. According to Guiry (2012) out of 72,500 algal species, names of 44,000 have been published while the rest 33,248 names are still under process of taxonomical recognition. Of the 44,000 recognized taxa, 7284 have been reported from India (Arisdason and Lakshminarasimhan, 2016) with a vast majority of algae occurring in West Bengal alone. Some of the recent explorations on phytoplanktons done in the state include reports by Mallik and Keshri (2008), Ghosh and Keshri (2011), Ghosh et al. (2012), and Keshri et al. (2013) from lentic water bodies of West Bengal; the latter reported 99 phytoplanktonic taxa from belonging to Cyanoprokaryotes, Chlorophyceae, Bacillariophyceae and Euglenophyceae. Das & Keshri (2015), reported 16 Chlorophyte taxa namely *Acutodesmus*, *Desmodesmus*, *Scenedesmus* and *Verrucodesmus* from the district of Cooch Bihar, West Bengal.

The present group have previously reported more than 200 species of microplanktonic algae from the different parts of West Bengal (Choudhury & Pal, 2008, 2010, 2011, 2012a, b; Roy & Pal, 2015a, b, 2016; Bose et al., 2016; Satpati & Pal, 2017). In this present investigation, an attempt has been made to document the floristic diversity of microplanktonic green algae from two unexplored sites of West Bengal namely Dum Dum (North 24 Parganas district) and Behala (Kolkata district).

### Materials and Methods:

Phytoplankton samples have been collected over a period of 1 year (December, 2015 to November, 2016) from fresh water habitats of North 24 Parganas and Kolkata of West Bengal. One of the study sites is a pond in Dum Dum, North 24 Parganas (22°64'44"N, 88°41'90" E) and the other is a pond in Adarsha Pally, Behala, Kolkata (22°50'01"N, 88°32'77" E).

Sampling of microplanktons was done using a phytoplankton net with a mesh size of 20 µm. The samples were passed through the net and concentrated to final volume of 500 ml. Following this the samples were preserved

in plastic voucher bottles and transferred to the laboratory and microphotography and taxonomic enumeration of the samples were done. Prior to photographic documentation, the samples were further concentrated with the help of Ultra-centrifuge at 10000 rpm and washed thereafter. Microphotographs were primarily taken under Carl Zeiss Axiostar microscope using Cannon Power Shot A80 digital camera. Scanning electron microphotographs were taken under Carl Zeiss EVO 18 (EDS 8100) microscope with Zeiss Inca Penta FETX 3 attachment following a 6 nm platinum coating of samples in Quorum (Q150 TES) platinum coater at the Centre for Research in Nanoscience and Nanotechnology facility. Voucher specimens were prepared and assigned to the Calcutta University Herbarium (CUH/AL) accession numbers. Taxonomic enumerations were done using suitable literatures like Smith(1918), Prescott (1962), Philipose(1967), Komarek and Fott(1983), Hindak(2008), Kim (2012, 2013) etc.

## Results and Discussion:

A total of 66 species of planktonic Chlorophytes have been reported in the present investigation. The majority of the taxa recorded represent the families of Selenastraceae, Scenedesmaceae, Chlorellaceae and Hydrodictyceae. The genus *Monoraphidium* happened to be the most recorded taxon with a total of 10 species found from the two sites. The other predominant genera include *Tetraëdron*, *Scenedesmus*, *Pectinodesmus*, *Desmodesmus*, *Tetrastrum*, *Tetradesmus*, *Pediastrum* and *Drepanochloris*. The collection site at Dum Dum (North 24 parganas) proved to be more diverse ecosystem of the two sites explored showing abundance of *Monoraphidium*, *Drepanochloris*, *Coelastrum*, *Elakatothrix*, *Schroederia*, *Scenedesmus*, *Desmodesmus*, *Pectinodesmus*, *Verrucodesmus*, *Comasiella*, *Acutodesmus*, *Pediastrum*, *Crucigenia*, *Tetrastrum*, *Tetraëdron*, *Willea* etc. The other site showed lesser diversity with occurrence of taxa like *Monoraphidium*, *Schroederia*, *Tetraëdron*, *Scenedesmus*, *Pectinodesmus* etc. Three taxa namely *Lauterborniella elegantissima*, *Drepanochloris nannoselene* and *Drepanochloris uherkovichii* are being reported for the first time from India. *Tetraëdron triangulare* and *Keratococcus bicaudatus* are two new reports from the state of West Bengal. From the present investigation it can be thus concluded that the pond of Dum Dum, North 24 Parganas is more diverse and has a greater abundance of Chlorophytes and Charophyte compared to the pond of Adarsha Pally, Behala, Kolkata.

The following are the taxa reported in this investigation.

### CHLOROPHYCEAE

*Pediastrum tetras* var. *tetraodon* (Corda) Hansgirg [Plate A, fig. 1], Prescott, 1962, p.227, pl. 50, fig.7  
( = *Euastrum tetraodon* Corda, *Pediastrum tetraodon* (Corda) A.Braun)

Colonies 4 celled, cell with deeply incised margins, lobes having horn like processes; cells 5-8 µm long, 9-10µm broad.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*P. duplex* Meyen [Plate A, fig. 2; Plate E, fig.7], Prescott, 1962, p.223, pl. 48, fig. 4

( = *Pediastrum duplex* var. *bracylobum* (A. Braun) Lagerheim, *Pediastrum duplex* var. *bracylobum* f. *glabrum* Krieger and *Pediastrum duplex* var. *clathratum* (A. Braun) Lagerheim).

Colony circular, 4-64 celled; 10-100 µm in diameter; marginal cells with bristles, inner cells polyhedral; cells 5-12 µm long, 5-15 µm in diameter.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Stauridium tetras* (Ehrenberg) Hegewald [Plate A, fig. 3], Prescott, 1962, p.227, pl. 50, fig.6  
( = *Micrasterias tetras* Ehrenberg and *Pediastrum tetras* (Ehrenberg) Ralfs)

Colony 8 celled, circular, 15-20 µm in diameter, marginal cells deeply incised with 2 lobes, inner cell 4-6 sided; cells 4-6 µm in diameter.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Tetraëdron minimum* (A.Braun) Hansgirg [Plate A, figs. 4-5; Plate E, fig. 8], Hansgirg 1888, p. 131 pl.60, figs. 12-15; Prescott 1962, p. 267, pl. 60, figs. 12-15 (= *Polyedrium minimum* A.Braun)

Cells flat, small, tetragonal, angles rounded without spines; margins of cell concave, with one frequently incised; cells 6 -20µ in diameter.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*T. muticum* (A.Braun) Hansgirg [Plate A, figs. 6-7], Hansgirg 1888, p.131, pl. 60, figs. 16, 17  
Cells small, flat, triangular, angles without spines; cell margin slightly convex; cells 6-18  $\mu$  in diameter.  
Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

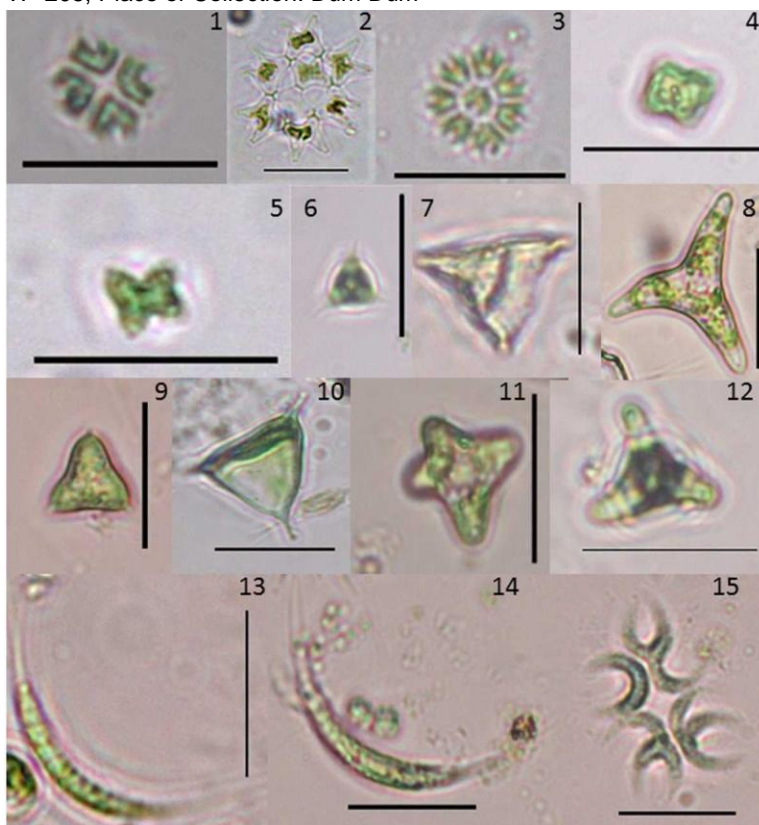


Plate A: Figure 1. *Pediastrum tetras* var. *tetraodon* 2. *Pediastrum duplex* 3. *Stauridium tetras* 4-5. *Tetraëdron minimum* 6-7. *T. muticum* 8. *T. proteiforme* 9. *T. triangulare* 10. *T. regulare* var. *papilliferum* 11-12. *T. tumidulum* 13-14. *Ankistrodesmus arcuatus* 15. *A. gracilis* (scale 10 $\mu$ m)

*T. proteiforme* (Turner) Brunthaler [Plate 1, fig. 8], Smith 1918, p.632, pl.15, figs. 4-5 (= *Polyedrium proteiforme* W.B. Turner)

Cells may be either two or three-angled, 3 angled cells 15-35 $\mu$ m in diameter.

This species forms a connecting link between the genera *Tetraedron* and *Cerasterias*.

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha pally, Behala

*T. regulare* var. *papilliferum* (Schröder) Playfair [Plate A, fig. 10], Prescott, 1962, p. 270

(= *Polyedrium trigonum* var. *papilliferum* Schröder and *T. trigonum* var. *papilliferum* (Schröder) Lemmermann )

Cells flat, triangular, apices ending in spines with blunt, wart-like papilla; cells 12-15 $\mu$ m in diameter.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*T. triangulare* Korshikov [Plate A, fig. 9], Korshikov 1953, p. 239, fig. 180

Cells flat, triangular, margins slightly convex; cells 8-14  $\mu$ m in diameter.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

This is the first report of this species from West Bengal.

*T. tumidulum* (Reinsch) Hansgirg [Plate A, fig. 11-12]; Prescott 1962, pl. 61, figs. 17, 18 (= *Polyedrium tumidulum* Reinsch and *Tetraëdriellatumidula* (Reinsch) Krienitz & Heynig)

Cells tetragonal, pyramidal, margins concave; angles bluntly rounded, ending in knob like extensions; cells 10-40, in diameter.

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha pally, Behala

*Golenkinia radiata* Chodat 1894 [Plate F, fig. 1], Prescott 1962, p.213, pl. 45, fig. 3

(=*Micractinium radiatum* (Chodat) Wille and *Golenkinia radiata* var. *longispina* G.M. Smith)

Cells solitary, spherical, free-floating, with long setae radiating from all sides of cell wall; cells 4-15 µm in diameter, setae upto 40 µm long.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

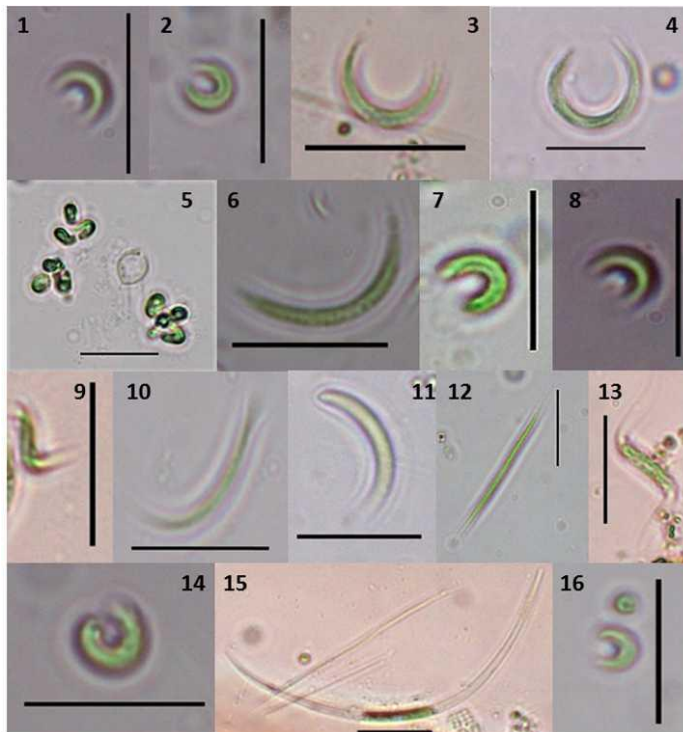


Plate B, Figure 1-2.*Drepanochloris nannoselene*3-4. *Drepanochloris uherkovichii*5.*Kirchneriella contorta*6.*Monoraphidium carybeum*7-8.*M. circinale* 9-10.*M. contortum* 11.*M. dybowskii*12.*M. griffithii*13. *M. irregulare* 14.*M. minutum* 15.*M. mirabile* 16.*M. nanum* (scale 10µm)

*Ankistrodesmus arcuatus* Korshikov [Plate A, fig. 13-14], Ramos 2012, p. 427, fig. 2g

(=*Monoraphidium arcuatum* (Korshikov) Hindák)

Cells solitary, semi-circular or arched, ends with pointed apices; Cells 27-45 µm long, 1.5-2.5 µm wide.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Ankistrodesmus gracilis* (Reinsch) Korshikov [Plate A, fig. 15], Prescott 1962, p.257, pl. 57, fig. 10

(=*Selenastrum westii* G.M.Smith)

Colony composed of 2-8 lunate to arcuate cells, arranged with their convex walls apposed; cells 1.5-2.5µm in diameter, 15-18µm long between apices.

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha Pally, Behala.

*Drepanochloris nannoselene*(Skuja) Marvan,Komárek & Comas[Plate B, fig. 1-2], Marvan et al. 1984, p. 388, fig. 10-1; Ramos et al, 2015, p.10, fig. 29

(=*Ankistrodesmus nannoselene* Skuja)

Cells solitary, lunate, gradually tapered at apices with pointed ends; cells 7-10µm x 2-3µm in size.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

This is the first report of the species from India.

*Drepanochloris uherkovichii* Marvan, Komárek & Comas [Plate B, fig. 3-4], Marvan et al. 1984, p. 388, fig. 10-3; Ramos et al, 2015, p.10, fig.30

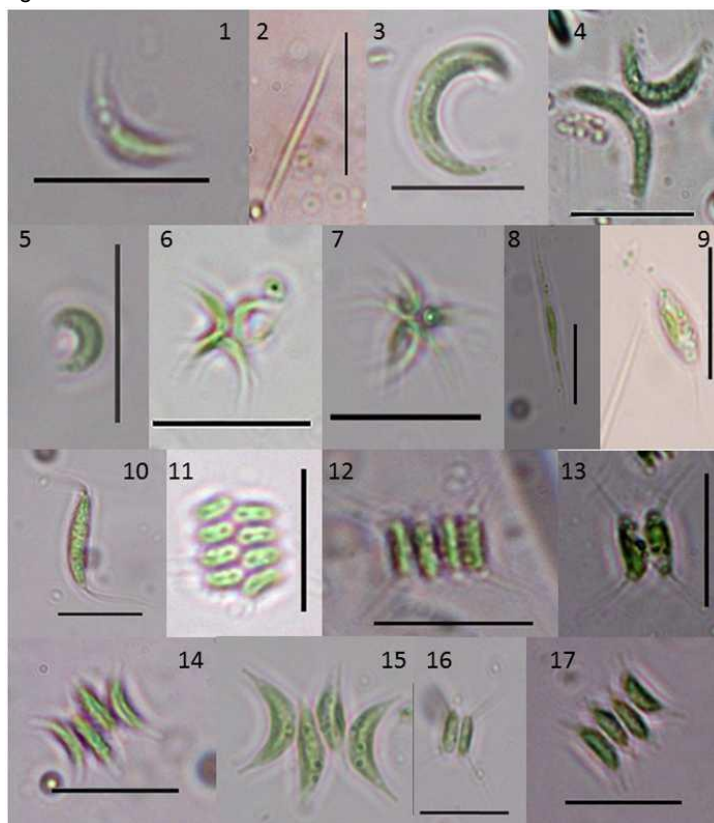


Plate C, Figure 1. *Monoraphidium subclavatum* 2. *M. tortile* 3. *Selenastrum bibraianum* (scale 20  $\mu\text{m}$ ) 4. *S. capricornutum* 5. *S. minutum* 6-7. *S. rinoi* 8. *Schroederia nitzschoides* 9. *S. setigera* 10. *S. spiralis* 11. *Comasiella arcuata* var. *platydisca* 12. *Desmodesmus opoliensis* 13. *Desmodesmus subspicatus* var. *bicaudatus* 14. *Pectinodesmus pectinatus* 15. *P. javanensis* 16. *Scenedesmus abundans* var. *longicauda* 17. *Scenedesmus ginzbergeri* (scale 10  $\mu\text{m}$ )

Cells solitary, strongly arched, gradually tapered towards the apices, ends pointed; cell wall smooth, chloroplast 1; 16-19  $\mu\text{m}$  x 2-3.5  $\mu\text{m}$  in size.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

This is the first report of the species from India.

*Kirchneriella contorta* (Schmidle) Bohlin [Plate B, fig. 5], Prescott 1962, p.258, pl. 57, figs. 7, 8

Colonies free-floating, cells cylindrical, twisted, arcuate with broad apices, scattered irregularly in the homogeneous, gelatinous envelope; cells 1-2  $\mu\text{m}$  in diameter, 5-10-12  $\mu\text{m}$  long.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Kirchneriella subsolitaria* G. S. West [Plate F, fig.2], Prescott 1962, p. 259, pl. 58, fig. 8

Colony of 3- 4 strongly curved lunate cells with bluntly rounded apices; cells 3-4  $\mu\text{m}$  in diameter, 10-14  $\mu\text{m}$  long.

Voucher no. CUH/AL/FW -204, Place of collection: Adarsha pally, Behala

*Monoraphidium carybeum* Hindák [Plate B, fig. 6], Ramos 2012, p 427, fig. 2h

Cells occurring solitary, arched in a semi-circle, tapered at the ends; Cells 13-17.5  $\mu\text{m}$  long, 1.5-3  $\mu\text{m}$  wide.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum



*Monoraphidium circinale* (Nygaard) Nygaard [Plate B, fig. 7-8], Ramos 2012, p.428, fig. 2i-2j  
(=*Monoraphidium capricornutum* var. *circinale* Nygaard)

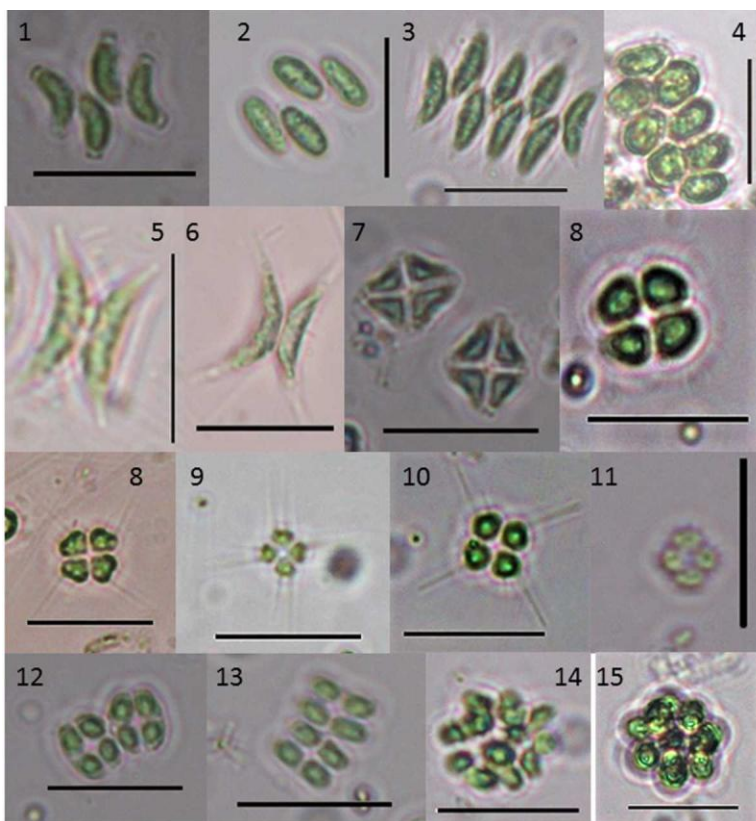


Plate D, Figure 1. *Scenedesmus indicus* 2. *S. obtusus* 3. *Tetradesmus dimorphus* 4. *Verrucodesmus verrucosus* 5-6. *Lauterborniella elegantissima* 7. *Crucigenia fenestrata* 8. *C. quadrata* 9-11. *Tetrastrum heteracanthum* 12. *T. staurogeniiforme* 13. *Willea apiculata* 14. *Willea rectangularis* 15. *Coelastrum proboscideum* 16. *Coelastrum sphaericum*

Cells occurring solitary, fusiform in shape, arched in semi-circles, ends slightly tapered; Cells 4-10  $\mu\text{m}$  long, 1.5-2  $\mu\text{m}$  wide.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Monoraphidium contortum* (Thuret) Komárková [Plate B, fig. 9-10], Ramos 2012, p.428, fig. 3a  
(=*Ankistrodesmus falcatus* var. *contortus* (Thuret) Playfair and *Ankistrodesmus contortus* Thuret)

Cells occurring solitary, curved irregularly, sigmoid to spiral (1.0-1.5 turns), with pointed ends; cells 7.5-12  $\mu\text{m}$  in length, 1.5-2  $\mu\text{m}$  in width.

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha Pally, Behala

*Monoraphidium dybowskii* (Woloszýnska) Hindák & Komárková-Legnerová [Plate B, fig. 11], Ramos 2012, p. 429, fig. 3b

Cells solitary, cylindrical, slightly curved with blunt apices; cells: 14-18.5  $\mu\text{m}$  in length, 2-5  $\mu\text{m}$  in width.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Monoraphidium griffithii* (Berkeley) Komárková- Legnerová [Plate B, fig. 12], Ramos 2012, p. 429, fig. 3c  
(=*Closterium griffithii* Berkeley, *Ankistrodesmus falcatus* var. *acicularis* (A. Braun) G.S. West)

Cells fusiform, elongated, straight, terminating in acute spine; cells: 10-45  $\mu\text{m}$  long, 2-3.5  $\mu\text{m}$  wide.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Monoraphidium irregulare* (G.M. Smith) Komárková-Legnerová [Plate B, fig. 13], Ramos 2012, p.430, fig. 3d  
(=*Dactylococcopsis irregularis* G.M.Smith)

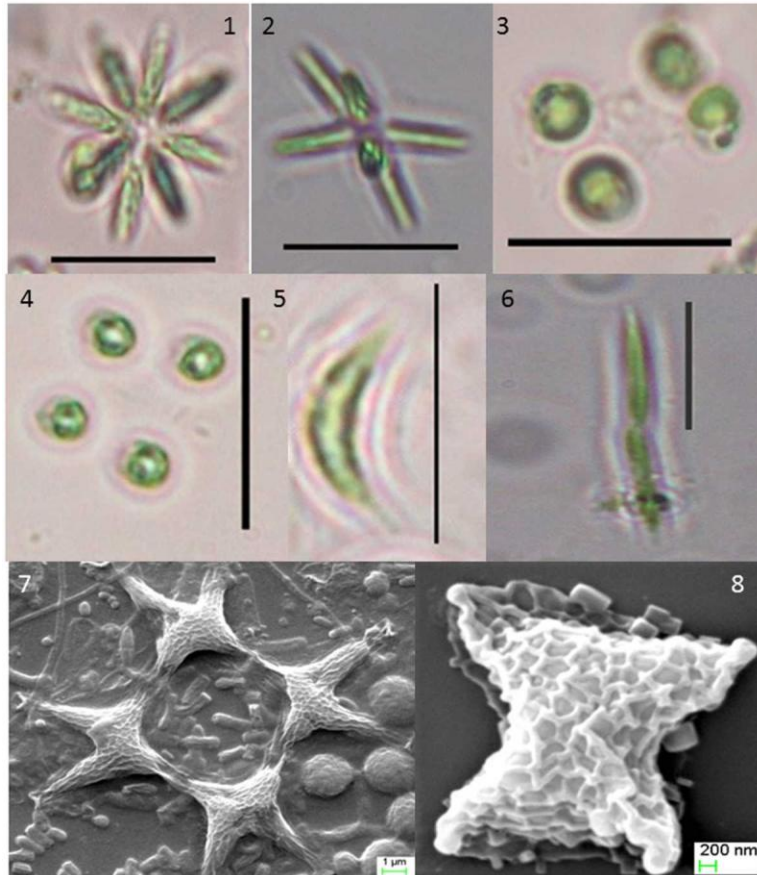


Plate E, Figure 1. *Actinastrum hantzschii* 2.*Actinastrum fluviatile* 3.*Mucidosphaerium pulchellum* 4. *Dictyosphaerium ehrenbergianum* 5.*Keratococcus bicaudatus* 6.*Elakatothrix gelatinosa* 7.SEM microphotograph of *Pediastrum duplex* 8.SEM microphotograph of *Tetraëdron minimum*

Cells solitary, fusiform to sigmoid in shape, with upto two curves, gradually tapering into pointed apices; cells 24-39 µm in length, 1-2.5 µm in width.

Voucher no. CUH/AL/FW -204, Place of Collection:Adarsha Pally, Behala

*Monoraphidium minutum* (Nägeli) Komárková- Legnerová [Plate B, fig. 14], Ramos 2012, p.432, fig. 3g

(=*Rhaphidium minutum* Nägeli, *Rhaphidium convolutum* var. *minutum* (Nägeli) Rabenhorst and *Selenastrum minutum* (Nägeli) Collins)

Cells solitary, lunate reniform, ends rounded; Cell: 9-12 µm long, 2.5-3.5 µm wide.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Monoraphidium mirabile* (West & G.S.West) Pankow [Plate B, fig. 15], Prescott 1962, p. 253, pl. 56, fig. 10

(=*Rhaphidium polymorphum* var. *mirabile* West & G.S.West, *Ankistrodesmus falcatus* var. *mirabilis* West & G.S.West)

Cells solitary, lunate, apices ending in fine points, 2-3µm wide, 50-100µm long.  
Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha Pally, Behala

*Monoraphidium nanum* (Ettl) Hindák [Plate B, fig. 16], Ramos 2012, p.432, fig.3h

(=*Nephrodiella nana* Ettl)

Cells solitary, reniform to lunate, ends rounded, chloroplast parietal without pyrenoids; cells 4-6 µm in length, 2-3 µm in width.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Monoraphidium subclavatum* Nygaard [Plate C, fig. 1], Ramos 2012, p.433, fig. 2D

Cells solitary, lunate, tapering gradually toward apices, ending in pointed poles; chloroplast single, parietal, without pyrenoids; Cells 10.5-20 µm long, 2-5 µm wide.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Monoraphidium tortile* (West & G.S. West) Komárková-Legnorová [Plate C, fig. 2], Ramos 2012, p.433, fig. 3j

(=*Ankistrodesmus tortilis* West & G.S. West)

Cells solitary, fusiform, straight or rarely curved with tapered apices; cells: 12-20 µm in length, 1.5-2.5 µm in width.

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha Pally, Behala

*Selenastrum bibraianum* Reinsch [Plate C, fig. 3], Prescott 1962, p.256, pl. 57, fig. 9

(=*Ankistrodesmus bibraianus* (Reinsch) Korshikov, *Kirchneriella bibraiana* (Reinsch) E.G. Williams)

Cells solitary or in colony, lunate or sickle-shaped with sharp apices; cells 5-8µm in diameter, 20-38µm long.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Selenastrum capricornutum* Printz [Plate C, fig. 4], Printz 1914, p.92, pl. VII: fig. 195

Colonies of 2 cells; cells strongly curved, 10-15µm long, 3-7 µm in diameter.

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha Pally

*Selenastrum minutum* (Naeg.) Collins [Plate C, fig. 5; Plate F, fig. 3], Prescott 1962, p. 256, pl. 46, fig. 10

Cells solitary, crescent-shaped, ends bluntly pointed; cells 2-3µ in diameter, 4-9µ long.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Selenastrum rinoi* Komárek & Comas [Plate C, fig. 6-7], Núñez-Avellaneda 1998, p.8, fig. 1b

Cells sickle-shaped, strongly curved, tapering in acute apices, 9-15 in length, 1.5 -4 µm in breadth.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Schroederia nitzschioides* (G.S. West) Korschikov [Plate C, fig. 8], Korschikov 1953, p.153, fig. 93

(=*Ankistrodesmus nitzschioides* G.S. West)

Cells spindle shaped, straight, poles extending into long thin setae, cells upto 40-100µm in length with setae, 3-5µm broad.

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha Pally, Behala

*Schroederia setigera* (Schröder) Lemmermann [Plate C, fig. 9], Komárek and Fott 1983, p. 250. pl. 73, fig. 2; Prescott 1962, p.256. pl. 57, fig. 4; Kim, 2012, fig. 43, 44A-E.

(=*Ankistrodesmus setigerus* (Schröder) G.S. West and *Characium setigerum* (Schröder) Bourrelly)



Cells free floating, solitary, spindle shaped, curved, crescent shaped; poles extending into long, thin setae, setae curved without disk; cells 30-50µm long, 4-6 µm broad.

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha pally, Behala

*Schroederia spiralis* (Printz) Korshikov [Plate C, fig. 10], Komarek and Fott 1983, p. 252. pl.74. fig. 4; Kim 2012, p. 57. fig. 45, 46A-H

(=*Ankistrodesmus nitzschioides* var. *spiralis* Printz)

Cells solitary, spindle shaped to crescent shaped, fusiform, poles extending into long, fine spirally twisted setae; cells 25-30 µm long, 4-6 µm broad.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

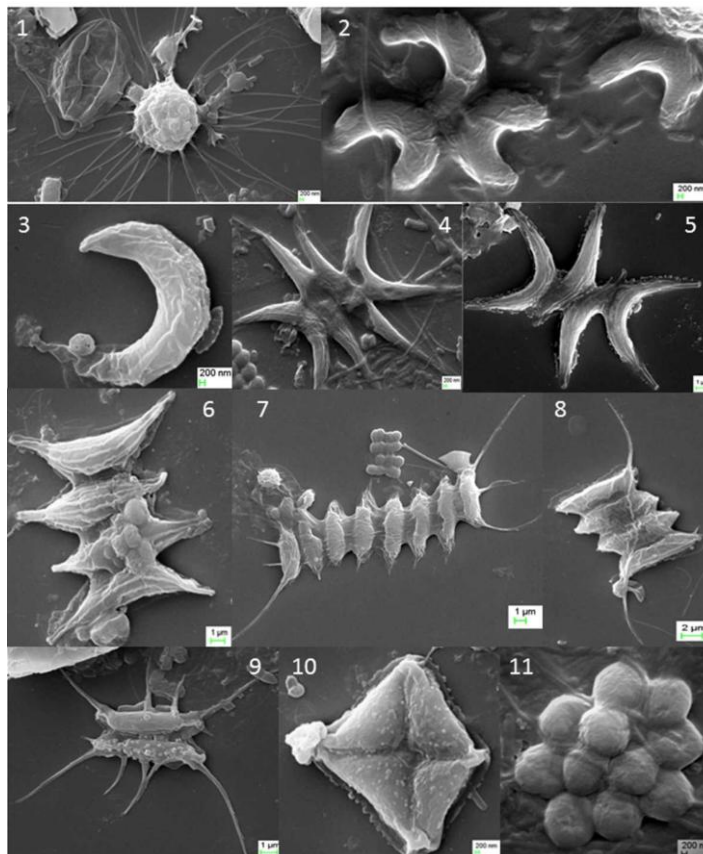


Plate F, SEM microphotographs of Figure 1. *Golenkinia radiata* 2. *Kirchneriella subsollitaria* 3. *Selenastrum minutum* 4. *Acutodesmus acuminatus* 5. *Pectinodesmus javanensis* 6. *Pectinodesmus regularis* 7. *Scenedesmus flavescens* 8. *Desmodesmus armatus* var. *bicaudatus* 9. *S. smithii* 10. *Crucigenia tetrapedia* 11. *Coelastrum microporum*

## FAMILY SCENEDESMACEAE

### SUBFAMILY SCENEDESMOIDEA

*Acutodesmus acuminatus* (Lagerheim) P.M. Tsarenko [Plate F, fig. 4], Ramos et al. 2015, p. 563, fig. 4 i-j

Coenobium flat 4-8 celled, linear or alternating; inner cells slightly curved, outer cells with pointed ends; 10-18.5µm long, 3-6.5µm broad.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Comasiella arcuata* var. *platydisca* (G.M. Smith) E. Hegewald & M. Wolf [Plate C, fig. 11], Prescott, 1962, p. 275, pl. 62, figs. 10-12; Hegewald et al. 2010, p. 332

(=*Scenedesmus arcuatus* var. *platydiscus* G.M. Smith)

Coenobium 8 celled, flat, arranged in double series; cells oblong-elliptic, 3-7.5µm broad, 10-12µm long.

Voucher no. CUH/AL/FW -204,205, Place of Collection: Dum Dum ; Adarsha pally, Behala

*Pectinodesmus javanensis*(Chodat) E.Hegewald, C.Bock & Krienitz [Plate C, fig. 15; Plate F, fig. 5], Domingues 2012, p.88, fig. 50

(=*Scenedesmus javanensis* Chodat)

Coenobium flat, 4 to 8 celled, arranged alternately, in zigzag pattern; cells lunate, with apices of each inner cell joining the convex median of the neighbouring cell; cell 7.3-18.5 µm in length, 2.0-3.5 µm in breadth.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Pectinodesmus pectinatus*(Meyen) E.Hegewald, M.Wolf, Al.Keller, Friedl & Krienitz[Plate C, fig. 14], Hegewald 2010, p.333, fig. 19

Coenobium flat- twisted upto 90°; cells spindle shaped, four- or eight-celled, cells alternatingly

Arranged; cells 10-18µm long, 2-4µm broad. SEM studies show cells having longitudinally arranged ridges.

Voucher no. CUH/AL/FW -204,205, Place of Collection: Dum Dum ;Adarsha Pally, Behala

*Pectinodesmus regularis*(Svirenko) E.Hegewald, M.Wolf, Al.Keller, Friedl & Krienitz [Plate F, fig. 6], Rosini et al. 2013, p.675, fig. 4f; Hegewald, 2010, p.333

(=*Scenedesmus regularis* Svirenko)

Coenobium formed by 4 fusiform cells, arranged linearly, joined by median region of the cells, 10-15 µm long, 3-4 µm broad; external cells curved, marginally concave, inner cells ellipsoid.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Scenedesmus abundans* var. *longicauda* G. M. Smith Krienitz[Plate C, fig. 16], Prescott 1962, p.274, pl. 62, figs. 4-5

Coenobium 2-8 celled, with long spines; cells 1-3µm in diameter, 4-9µm long; spines 6-10µm long.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Scenedesmus flavescens* Chodat Krienitz [Plate F, fig. 7], Komárek and Fott 1983, p. 916, pl.247, fig. 1; Hegewald and Silva 1988, p. 526, fig. 852

(=*Scenedesmus tenuispina* Chodat)

Coenobium composed of 2-4(-8) cells, arranged in linear series; cells ovoid with pointed poles; poles of inner cells with 1-2 spines; marginal cells with 1-3 spines; outer wall of marginal cells straight, with 2-5 spines; cells 6-15 µm long, 3-7 µm wide.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Scenedesmus ginzbergeri* Kammerer [Plate C, fig. 17], Hindak et al. 2008, p.789, figs. 46-47, 58

Coenobium 4-celled, with cells linearly to slightly alternately arranged in single row, spindle-shaped, 10–20 µm long, 2-4µm broad, inner cells straight, outer cells curved slightly, with acute apices.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Scenedesmus indicus* Philipose ex Hegewald, Engelberg & Paschma [Plate D, fig. 1], Hegewald 1988, p. 515; Kim 2013, p.313, fig 5f

Coenobium 4 celled; cells broad fusiform, lunate, both ends capped; middle part swollen; cell wall smooth; cells 3-6 µm broad, 7-12 µm long.

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*Scenedesmus obtusus* Meyen[Plate D, fig. 2], Ramos et al. 2015, p.556, fig. 3d-e

(=*Scenedesmus obtusus* var. *alternans* (Reinsch) Compère)

Coenobium 4 or 8 celled, flat or alternating; cells ovate-cylindrical with rounded apices; cells generally oblique; cells 4-7µm broad, 5-15µm long.

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*Scenedesmus smithii* Chodat [Plate F, fig. 9], Prescott 1962, p.279, pl. 63, figs. 19, 20

(=*Scenedesmus opoliensis* var. *contacta* Prescott)

Coenobium of 2-4 naviculoid cells, in a single series, adjoined along 3/4 of their lateral walls; spines of terminal cells 1 to 2 at each pole, long, curved; spines of inner cells short; cells 3-6µm in diameter, 10-22µm long.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

***Tetradesmus dimorphus*** (Turpin) M.J.Wynne [Plate D, fig. 3], Prescott, 1962, p.277, pl. 63, figs. 8, 9  
(=*Scenedesmus obliquus* var. *dimorphus* (Turpin) Hansgirg, *Scenedesmus acutus* var. *dimorphus* (Turpin) Rabenhorst)

Coenobium of 4 or 8 fusiform cells arranged in single or alternating series; inner cells with straight, sharp apices; outer cells lunate, curved, with acute apices; cells 3-6µm in diameter, 6-22µm long.

Voucher no. CUH/AL/FW -204,205, Place of Collection: Adarsha Pally, Dum Dum

*Verrucodesmus verrucosus* (Y.V. Roll) E. Hegewald [Plate D, fig. 4], Hegewald 2013, p. 151; Ramos et al. 2015, p.557, fig. 3f-g

(=*Scenedesmus verrucosus* Y.V.Roll)

Coenobium 4-8 celled, flat, arranged in double series; cell wall with granulate; Chloroplast 1, pyrenoid 1; cells 3-5µm broad, 7-12µm long.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Lauterborniella elegantissima* Schmidle [Plate D, fig. 5-6], Schmidle 1900, p.149, pl. IV:

figs 2, 3

Coenobia 4-celled, 5-10 µm wide; colony adjoined at the center by their mid portions, cells oval, 5-10µm long, 2-4 µm broad, elongated in plane perpendicular to colony; in side view cells appearing lunate with pointed tips projecting away from coenobium.

Voucher no. CUH/AL/FW -204, Place of collection: Adarsha pally, Behala

This is the first report of the species from India.

*Desmodesmus armatus* var. *bicaudatus* (Guglielmetti) E.Hegewald [Plate F, fig.8], Rosini et al. 2013, p.665. fig. 2d-e  
(=*Scenedesmus acutiformis* var. *bicaudatus* Guglielmetti)

Colony flat, oblong formed by 2-4 cells arranged linearly; cells ellipsoidal 5-13 µm long, 2-4.0 µm broad; cells with one spine on one pole of outer cells arranged diagonally, 7-13.0 µm in length; internal cells without polar spines.

Voucher no. CUH/AL/FW -204, Place of collection: Adarsha pally, Behala

*D. opoliensis* (P.G.Richter) E.Hegewald [Plate C, fig. 12], Prescott 1962, p.279, pl. 63, fig. 18

(=*Scenedesmus opoliensis* P.G.Richter)

Coenobium 4-8 celled, cells naviculoid arranged in single series, walls of outer cells convex, lateral walls adjoined along 1/3—2/3 of their length; apices of outer cells with long spines, inner cells with spine or without spines; cells 2-4µm in diameter, 8-12µm long.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*D. subspicatus* var. *bicaudatus* (Proshkina-Lavrenko) P.Tsarenko [Plate C, fig. 13]

Tsarenko 2000, p. 187

(=*Scenedesmus abundans* var. *bicaudatus* Proshkina-Lavrenko)

Coenobium of 2-4-8 cells, arranged in linear series. Cells are spindle, or elliptical shaped, and are tapered to conically rounded poles; the marginal cells have elongated ends, with slightly curved long spine at one pole. Cells are 10-25 µm long and 3-8 µm wide.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Crucigenia fenestrata* (Schmidle) Schmidle [Plate D, fig. 7], Prescott, 1962, p.284, pl. 65, fig. 5

(=*Staurogenia fenestrata* Schmidle)

Colony 4 celled; cells trapezoid with a central square opening, the free outer wall convex, longest; free angles rounded; lateral and inner walls straight, short; cells 2-5µm in diameter, 4-12µm long

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*C. quadrata* Morren [Plate D, fig. 8], Philipose, 1967, p.241, fig. 152

(=*Crucigeniella quadrata* (Morren) Gaillon and *Staurogenia quadrata* (Morren) Kützing)

Colony 4-celled, quadrate with central rectangular space; cells spherical with rounded edges, 3-4µm in diameter.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*C. tetrapedia* (Kirchner) Kuntze [Plate F, fig. 10], Prescott, 1962, p.285, pl. 65, fig. 9; pl. 66, fig. 1

(=*Pediastrum tetras* var. *quadratum* Playfair, *Pediastrum tetras* var. *tetrapedia* (Kirchner) )

Colony 4 celled; cells triangular, cruciately arranged about a tiny space; cells 2.5-9µm in diameter.

Voucher no. CUH/AL/FW -204,205, Place of Collection: Adarsha Pally, Dum Dum

*Tetrastrum heteracanthum* (Nordstedt) Chodat [Plate D, fig. 9-11], Smith 1926, p. 187, Pl. 15, fig. 16-20; Philipose 1967, p. 244, fig.156

Colonies 4 celled; cells usually heart shaped with alternating long and short setae borne on the outer surface; colonies with spines 10-70µm, without spines 4-10µm; length of longer spine- 7-24µm, length of shorter spines 1-9µm.

Voucher no. CUH/AL/FW -204,205, Place of Collection: Adarsha Pally, Dum Dum

*T. staurogeniiforme* (Schröder) Lemmermann [Plate D, fig. 12], Philipose 1967, p.243, fig. 154a

(=*Cohniella staurogeniiforme* Schöder)

Coenobium flat, 4-celled, cells arranged closely in cruciate manner; Cells triangular having 4-6 short spines; chloroplasts 1-4, parietal; cells 2-6 µm in diameter; colonies 5-15 µm in diameter; spines upto 1-3µm long.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Willea apiculata* (Lemmermann) D.M.John, M.J.Wynne & P.M.Tsarenko [Plate D, fig. 13], Prescott, 1962, p.283, pl. 65, fig. 3

(=*Staurogenia apiculata* Lemmermann and *Crucigenia apiculata* (Lemmermann) Schmidle)

Colony 4celled; cells rhomboidal to somewhat triangular with 1 short, conical apiculation at the outer apex, and one on lateral walls where cells adjoin; cells 3-7µm in diameter, 4-10 µm long.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*W. rectangularis* (A.Braun) D.M.John, M.J.Wynne & P.M.Tsarenko [Plate D, fig. 14], Prescott, 1962, p.285, pl. 65, figs. 7, 8

(=*Staurogenia rectangularis* A.Braun and *Crucigenia rectangularis* (Nägeli) Gay)

Colony 4 celled; cells oblong, regularly arranged with a rectangular central space; cells 2-7µm in diameter, 3-10µm long.

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha Pally, Behala

*Coelastrum microporum* Naegeli in A. Braun [Plate F, fig. 11], Prescott 1962, p.230, pl. 53, fig.3

Coenobium spherical, made of 8-64 ovoid-globose cells interconnected by very short processes with tiny intercellular spaces; cells 3-15µm in diameter including sheath

Voucher no. CUH/AL/FW -204, Place of collection: Adarsha pally, Behala

*C. proboscideum* Bohlin [Plate D, fig. 15], Philipose 1967, p.229, fig. 137; Prescott 1962, p.230, pl. 53, fig. 4, 5, 8

(=*Coelastrum irregulare* Schroeder)

Colonies pyramidal of 4-8-16; intercellular spaces large, polygonal; cell shape conical, truncate, six-sided; cells 5-18µm in diameter; colony as much as 30µm in diameter.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*C. sphaericum* Naegeli [Plate D, fig. 16], Prescott 1962, p.231, pl. 53, fig. 7

Coenobium ovoid, made of narrow, outward directed conical cells; cells up to 25µm in diameter.

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*Actinastrum hantzschii* Lagerheim [Plate D, fig. 1], Prescott, 1962, p. 281, pl. 64, figs. 10-11; Kim, 2013, p. 434

Cells radiating from the center; cells cylindrical, truncate at the tips; cells 8-23 µm in length, 2-4µm in diameter.

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha pally, Behala

*A. fluvatile* (Schröder) Fott [Plate D, fig. 2], Kim, 2013, p. 434

(=*Actinastrum hantzschii* var. *fluviatile* J.B.L.Schröder)

Cells radiating from the center; cells cylindrical, fusiform. Cells 5-15µm long, and 2-4 µm in diameter.

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha Pally, Behala

*Mucidosphaerium pulchellum* (H.C.Wood) C.Bock, Proschold & Krienitz [Plate D, fig. 3], Prescott 1962, p.238, pl. 51, figs. 5-7

(=*Dictyosphaerium pulchellum* H.C.Wood)

Colony ovoid to spherical, enclosed in mucilage, made of 4-32 spherical cells, arranged in series of 4 linked by dichotomously branched threads; cells 2-11 µm in diameter.

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*Dictyosphaerium ehrenbergianum* Nägeli [Plate D, fig. 4], Kim 2012, p.30, figs. 17, 18A-I; Komarek and Fott 1983, p. 356, pl.107.fig. 3

Colonies spherical, 4-64 celled, 7-50 µ m in diameter; cells ovoid to ellipsoid attached by longer side to the dichotomously branched gelatinous threads; chloroplast single, cup-shaped; cells 2-7 µ m in diameter, 3-10 µ m long.

Voucher no. CUH/AL/FW -205, Place of Collection: Dum Dum

*Keratococcus bicaudatus* (A.Braun ex Rabenhorst) J.B.Petersen [Plate D, fig. 5], Philipose 1967, p. 315

(=*Dactylococcus bicaudatus* A.Braun ex Rabenhorst and *Ourococcus bicaudatus* (A.Braun) Grobétý)

Thallus unicellular, usually solitary, semi-lunate terminating in attenuate processes; cells 2.5-9µm broad, 10-30µm long

Voucher no. CUH/AL/FW -204, Place of Collection: Adarsha Pally, Behala

This is the first report of the species from West Bengal.

*Elakatothrix gelatinosa* Wille [Plate D, fig. 6], Prescott 1962, p.93, pl. 3, figs. 13, 14

Colony free floating with 4-16 cells arranged end to end in pairs; cells fusiform, ending bluntly at one pole, tapering at the opposite pole; cells 2-4µm in diameter, 10-20µm long; colony 10-30µm in diameter, 60-160µm long.

Voucher no. CUH/AL/FW -204, Place of Collection: Dum Dum

### Acknowledgements

We would like to convey our gratitude to the Department of Science and Technology (DST), New Delhi, India for providing financial assistance. We would also like to acknowledge infrastructural facility of CAS VII, the Department of Botany, University of Calcutta and the Centre for Research in Nanoscience and Nanotechnology (CRNN).

### BIBLIOGRAPHY:

Arisdason, W. and Lakshminarasimhan, P. 2016. Status of plant diversity in India: an overview. ENVIS Centre, Ministry of Environment & Forest, Govt. of India. [http://www.bsienvi.nic.in/Database/Status\\_of\\_Plant\\_Diversity\\_in\\_India\\_17566](http://www.bsienvi.nic.in/Database/Status_of_Plant_Diversity_in_India_17566).

Bose, R., Nandi, C., Roy, A.S., Gorain, P.C. and Pal, R. 2016. Floristic Survey of Microplanktonic Cyanobacteria and Chlorophyta from Different Ecological Niches of West Bengal, India. *Phytomorphology*, 66(3&4): 77-93.

Choudhury, A.K. and Pal, R. 2008. Diversity of planktonic diatoms from West-Bengal coast with special reference to taxonomic accounts. *Phytomorphology*, 58: 29-42.

Choudhury, A.K. and Pal, R. 2010. Phytoplankton and nutrient dynamics of shallow coastal stations at Bay of Bengal, Eastern Indian Coast. *Aquatic Ecology*, 44: 55-71.

Choudhury, A.K. and Pal, R. 2011. Variations in seasonal phytoplankton assemblages as a response to environmental changes in the surface waters of a hypo saline coastal station along the Bhagirathi Hooghly estuary. *Environmental Monitoring and Assessment*, 44: 55-71.



- Choudhury, A.K. and Pal, R. 2012a. Phytoplankton studies along coastal ecosystems – a review. *Journal of Botanical Society of Bengal*, 66: 1-8.
- Choudhury, A.K. and Pal, R. 2012b. Understanding the seasonal dynamics of primary productivity in relation to phytoplankton populations from the Bhagirathi – Hooghly estuary, eastern Indian coast. *Journal of Algal Biomass Utilization*, 3: 80-88.
- Das, M. and Keshri, J. 2015. *Scenedesmus* Meyen & related genera in foot hills of Eastern Himalaya. *Phykos*, 45 (1): 75-84
- Domingues, C.D. and Torgan, L.C. 2012. *Chlorophyta* de um lago artificial hipereutrífico no sul do Brasil. *Iheringia Serie Botanica*, 67(1):75-91.
- Ghosh, S. and Keshri, J.P. 2011. Assessment of phytoplankton diversity and dynamics of a lentic water body of Belur rail station area, with reference to pollution status. *Environment and Ecology*, 29: 232-234.
- Ghosh, S., Barinova, S. and Keshri J.P. 2012. Diversity and seasonal variation of phytoplankton community in the Santragacchi Lake, West Bengal, India. *QScience Connect*, 3: 1-19.
- Guiry, M.D. 2012. How many species of algae are there? *J. Phycol.* 48: 1057–1063.
- Hegewald, E., Bock, C. and Krienitz, L. 2013. A phylogenetic study on Scenedesmaceae with the description of a new species of *Pectinodesmus* and the new genera *Verrucodesmus* and *Chodatodesmus* (Chlorophyta, Chlorophyceae). *Fottea*, 14(2): 149-164.
- Hegewald, E., Engelberg, K. and Paschma, R. 1988. Beitrag zur Taxonomie der Gattung *Scenedesmus* subgenus *Scenedesmus* (Chlorophyceae). *Nova Hedwigia*, 47(3/4): 497-533
- Hegewald, E., Wolf, M., Keller, A. Friedl, T. and Krienitz, L. 2010. ITS2 sequence-structure phylogeny in the Scenedesmaceae with special reference to *Coelastrum* (Chlorophyta, Chlorophyceae), including the new genera *Comasiella* and *Pectinodesmus*. *Phycologia*, 49(4): 325-335.
- Hindak, F. & Hindakova, A. 2008. Morphology and taxonomy of some rare chlorococcalean algae (Chlorophyta). *Biologia*, 63(6): 781—790.
- Keshri, J. P., Ghosh, S. and Bhattacharyya, S. 2013. A survey of phytoplankton diversity in Baishar Beel of Nadia District of West Bengal. *International Journal of Current Research and Review*, 5: 08-13.
- Kim, Y. J. and Kim, H. S. 2012. Algal Flora of Korea. Volume 6, Number 2. Chlorophyta: Chlorophyceae: Chlorococcales I: Micractiniaceae, Botryococcaceae, Characiaceae, Hydrodictyaceae. Freshwater Green Algae. *National Institute of Biological Resources, Ministry of Environment*. pp. 1-117.
- Kim, Y. J. 2013. Taxonomic and Ecological Study of the Families Hydrodictyaceae and Coelastraceae, Order Chlorococcales, and Class Chlorophyceae. *Korea J. Ecol. Environ*, 36(4): 421-437.
- Komarek, J. and Fott, B. 1983. Chlorophyceae (Grünalgen) Ordnung: Chlorococcales. Das Phytoplankton des Süßwassers. Systematik und Biologie. 7. Teil, 1. Hälfte (in: G. Hueber-Pestalozzi). *Schweizerbart'sche Verlagsbuchhandlung, Stuttgart*, 1044 pp.
- Korshikov, A.A. 1953. Vznachnik prisnovodnihk vodorostey Ukrainsykoj RSR [Vyp] V. Pidklas Protokokovi (Protococcineae). Bakuol'ni (Vacuolales) ta Protokokovi (Protococcales). pp. 1-439.

- Mallik, P. and Keshri, J. 2008. New records of *Pediastrum* Meyen from West Bengal, India. *Journal of Applied Bioscience*, 34: 82-85.
- Marvan, P., Komárek, J. and Comas, A. 1984. Weighting and scaling of features in numerical evaluation of coccal green algae (genera of Selenastraceae). *Arch. Hydrobiol. Suppl. 67 (Algological Studies 37)*, pp.363-399
- Núñez-Avellaneda M.1998. Chlorococcales (Algae: Chlorophyceae) Found In Aquatic Environments Of The Colombian Amazon Basin. *Caldasia*, 20(1): 5-11
- Parra, O.O., 1979. Revision der Gattung *Pediastrum* Meyen (Chlorophyta). *Bibliotheca Phycologica*, 48: 1-182.
- Prescott, G.W. 1962. Algae of the Western Great Lakes Area. *W. M. C. Brown Company Publishers. Iowa*, 977pp.
- Printz, H. 1914. Kristianiatraktens Protococcoideer. *Skrifter Utgit av Videnskapsselskapet i Kristiania, Matematisk-Naturvidenskabelig Klasse*, 6: 1-121.
- Ramos, G.J.P., Bicudo, C.E. de M. and Moura, C.W. do N.M. 2015. Scenedesmaceae (Chlorophyta, Chlorophyceae) de duas áreas do Pantanal dos Marimbus (Baiano e Remanso), Chapada Diamantina, Estado da Bahia, Brasil. *Hoehnea*, 42(3): 549-566.
- Ramos, G.J.P., Bicudo, C.E. de M. and Moura, C.W. do N.M. 2015. Scenedesmaceae (Chlorophyta, Chlorophyceae) de duas áreas do Pantanal dos Marimbus (Baiano e Remanso), Chapada Diamantina, Estado da Bahia, Brasil. *Hoehnea*, 42(3): 549-566.
- Ramos, G.J.P., Bicudo, C.E. de M., Góes-Neto, A. and Moura, C.W. do N. 2012. *Monoraphidium* and *Ankistrodesmus* (Chlorophyceae, Chlorophyta) from Pantanal dos Marimbus, Chapada Diamantina, Bahia State, Brazil. *Hoehnea*, 39(3): 421-434, 3 figs.
- Ramos, G.P.R., Bicudo, C.E. de M. and Moura, C.W. do N. 2015. Novos registros de algas verdes cocoides (Chlorophyceae, Chlorophyta) para o estado da Bahia e para o Brasil. *Sitientibus Série Ciências Biológicas*, 15: 1-13.
- Rosini E.F., Sant'Anna C.L. and Tucci A. 2013. Scenedesmaceae(Chlorococcales, Chlorophyceae) de pesqueiros da Região Metropolitana de São Paulo, SP, Brasil: levantamento florístico. *Hoehnea*, 40(4): 661-678.
- Roy, A.S., and Pal, R. 2015a. Planktonic Cyanoprokaryota and Bacillariophyta of East Kolkata wetlands ecosystem, a Ramsar Site of India with reference to diversity and taxonomic study. *Journal of Algal Biomass Utilization*, 6: 47-59.
- Roy, A.S., and Pal, R. 2015b. An investigation on morpho-taxonomy and diversity of planktonic chlorophytes from fresh water eutrophic wetland of Indian Ramsar site. *Phykos*, 45: 29-42.
- Satpati, G.G. and Pal, R. 2017. Taxonomic diversity and SEM study of Euglenoids from Brackish Water Ecosystems of Indian Sundarbans Biosphere Reserve. *Phykos*, 47 (1): 105-122.
- Smith, G.M. 1918. A second list of algae found in Wisconsin lakes. *Transactions of the Wisconsin Academy of Science, Arts and Letters*, 19: 614-654
- Smith, G.M. 1926. The plankton algae of the Okoboji Region. *Transactions of the American Microscopical Society*, 45(3): 156-233
- Tsarenko, P. 2000. Chlorococcales. In: Wasser, S.P. & Tsarenko, P. Diversity of algae in Ukraine. *Algologia*, 10(4): 1-309.