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# HYDROBIOLOGICAL STUDIES WITHIN THE TEA GARDENS AT SRIMANGAL, BANGLADESH. V. DESMIDS (*EUASTRUM, MICRASTERIAS, ACTINOTAENIUM* AND *COSMARIUM*)

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*Key words:* acidic habitats, species diversity, phytoplankton, desmids, new taxa, new records

## Abstract

Ninety-three desmid taxa belonging to four genera, namely *Euastrum*, *Micrasterias*, *Actinotaenium* and *Cosmarium* have been recorded from different aquatic habitats located within the tea gardens at Srimangal, Maulvi Bazar. Of these, 20 are described as new records for Bangladesh, including a new variety, *E. substellatum* Nordst. var. *bangladeshicum* Islam & Irfanullah var. nov. and a new forma, *Cosmarium depressum* (Näg.) Lund. var. *apertum* (Turner) Hirano fa. *spinosum* Islam and Irfanullah fa. nov.

## Introduction

The aquatic macrophytes (Islam and Irfanullah, 2000) and a significant proportion of the algal flora (Islam and Irfanullah, 2005 a, b, c) of some selected habitats within the tea gardens at Srimangal, Maulvi Bazar, have recently been described in a series of hydrobiological papers. The present paper is the penultimate instalment of this series dealing with four desmid genera from these habitats.

## Materials and Methods

Islam and Irfanullah (2000) described the present study area in Srimangal and also presented some meteorological data. The studied water bodies, namely, Baraoora Lake, the Burburia River, ditches and paddy fields were mainly acidic (Islam and Irfanullah, 2005a). A total of 120 algal samples were collected in different seasons of 1996 and 1997, namely winter (9 January 1996 and 6 January 1997), spring (18 March 1997), rainy season (20 July 1997) and autumn (20 October 1997). See Islam and Irfanullah (2005a) for sample collection methods, and their preservation and examination.

## Taxonomic enumeration

This study revealed 93 desmid taxa belonging to four genera, namely *Euastrum* (18 taxa), *Micrasterias* (9 taxa), *Actinotaenium* (10 taxa) and *Cosmarium* (56 taxa), of which 20 are new records for Bangladesh including a new variety and a new forma. The new

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records are marked with asterisk. Twenty-seven desmid taxa have already been reported from this area by the same authors as new records for Bangladesh (Islam and Irfanullah, 1998, 1999 a, b), thus are not marked in this account.

**Class: Chlorophyceae; Order: Zygnematales; Family: Desmidiaceae;**
**Genus: Euastrum** Ehr. ex Ralfs, 1848

1. ***E. boldtii** Schmidle (Pl. **7**, Fig. **73**)
(Růžička 1981, 80:1-7)
L. 23 µm, W. 16.2-17.5 µm, I. 4.7 µm, t. 12-13.5 µm; granules are sparsely arranged in a regular fashion. River; autumn 1997; few.

2. **E. ceylanicum** (W. & W.) Krieger (Pl. **2**, Fig. **12**)
(Scott and Prescott 1961, 11:3-5; Islam and Haroon 1980, 13:176; 19:282)
L. 56.7 µm, W. 43.2 µm, I. 9.4 µm. River; spring 1997; rare.

3. ***E. denticulatum** (Kirch.) Gay var. **quadrifarium** Krieger fa. **incisum** Scott & Prescott (Pl. **4**, Fig. **32**)
(Scott and Prescott 1958, 6:1)
L. 29.7 µm, W. 23-24.3 µm, I. 5.4 µm, t. csp. 19-20.3 µm, t. ssp. 16.2-17.5 µm; finely punctate cell wall. Lake; autumn 1997; rare.

4. **E. didelta** Ralfs var. **bengalicum** Lagerh. (Pl. **2**, Fig. **16**)
(Scott and Prescott 1961, 9:5-6)
L. 87.7 µm, W. 43.2 µm, I. 10.8 µm, t. 20.2 µm. River; spring 1997; few.

5. ***E. didelta** Ralfs var. **bengalicum** Lagerh. fa. **minus** Scott & Prescott
(Scott and Prescott 1958, Fig. 4, No. 7)
L. 84 µm, W. 42.5 µm, I. 12 µm, t. 20 µm. River; spring 1997; rare.

6. ***E. elegans** (Bréb.) Kütz. fa. (Pl. **2**, Fig. **14**)
L. 35.8 µm, W. 20.2 µm, I. 4.7 µm, t. 9.4-10.8 µm; sparsely granulated cell wall. Lake; winter 1996; rare.

7. **E. gnathophorum** W. & W. var. **bulbuosum** Scott & Prescott (Pl. **2**, Fig. **10**)
(Scott and Prescott 1961, 9:9-10; Islam and Haroon 1980, 7:116-117)
L. 62 µm, W. 33 µm, I. 8.8 µm. River; spring 1997; common.

8. **E. horikawae** Hinode (Pl. **1**, Fig. **1**)
(Scott and Prescott 1961, 15:1; Islam and Haroon 1980, 2:31-35)
L. 94.5 µm, W. 74.2 µm, I. 27 µm. Paddy field; autumn 1997; rare.

9. ***E. inerme** (Ralfs) Lund. var. **inerme** (Pl. **2**, Fig. **15**)
(Růžička 1981, 61:8-10)
L. 58 µm, W. 27 µm, I. 9.4 µm, t. 14.8 µm; diameter of the perforation 4.7 µm; smooth wall. River; spring 1997; common.

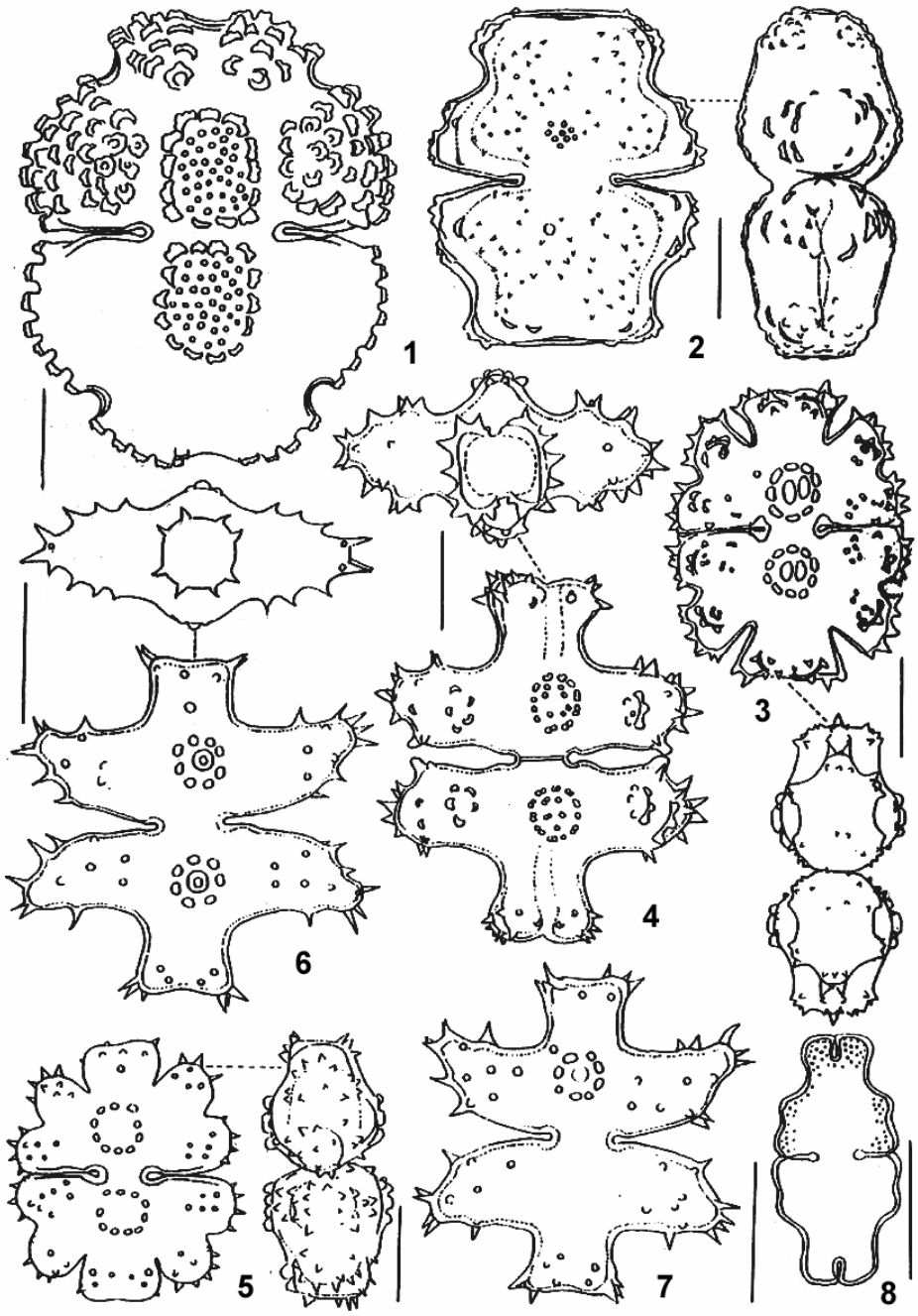


**Plate 1** (Figs. 1-8)

Figs. 1. *Euastrum horikawae*, 2. *E. turgidum* var. *turgidum*, 3. *E. spinulosum* var. *burmense*, 4. *E. substellatum* var. *bangladeshicum* var. nov., 5. *E. quadratum*, 6-7. *E. substellatum*, 8. *E. sinuosum var. parallelum*. [Scales: Fig. 8 = 30 μm, rest = 20 μm]

10. **E. longicolle** Nordst. var. **capitatum** W. & W. fa. **minus** Scott & Prescott (Pl. **2**, Fig. **11**)
(Scott and Prescott 1961, 8:4-5; Islam and Haroon 1980, 7:120-121)
L. 68.8 µm, W. 31 µm, I. 9.4 µm, t. 20.2 µm. Lake; winter 1997; few.

11. **E. quadratum** Nordstedt (Pl. **1**, Fig. **5**)
(Růžička 1981, 534)
L. 51.3 µm, W. csp. 46 µm, W. ssp. 43.2 µm, I. 10.8 µm, t ssp. 16.2 µm. Lake; winter 1996 and 1997 and rainy 1997; few.

12. **E. sinuosum** Lenorm. var. **capitatum** Scott & Prescott (Pl. **2**, Fig. **17**)
(Scott and Prescott 1961, 7:8-9)
L. 70.2 µm, W. 41 µm, I. 8.8 µm, t. 21.7 µm. Paddy field; autumn 1997; rare.

13. ***E. sinuosum** var. **parallelum** Krieger (Pl. **1**, Fig. **8**)
(Prescott *et al.* 1977, 60:20)
L. 54 µm, W. 27.7 µm, I. 7.4 µm; finely pitted cell wall. River; spring 1997; few.

14. ***E. sinuosum** var. **subjenneri** W. & W. (Pl. **2**, Fig. **9**)
(Skuja 1949, 24:5-6; Prescott *et al.* 1977, 60:18)
L. 70.2 µm, W. 40.5 µm, I. 10.8 µm, t. 21.6 µm; nine minute warts on each front surface of each semicell; cell wall punctate. It also resembles var. *reductum* W. & W. (Irene-Marie 1938, 15:1-2). Lake; winter 1997; rare.

15. **E. spinulosum** Delponte var. **burmense** (W. & W.) Krieger (Pl. **1**, Fig. **3**)
(Skuja 1949, 24:9-11; Islam and Haroon 1980, 6:102-103)
L. csp. 64.8 µm, L. ssp. 58.7 µm, W. csp. 51.3 µm, I. 8 µm. River; spring 1997; rare.

16. **E. substellatum** Nordst. (Pl. **1**, Figs. **6-7**)
(Scott and Prescott 1961, 11:1-2)
L. csp. 52.6-56.7 µm, L. ssp. 50-52.6 µm, W. csp. 51.3-59.4 µm, W. ssp. 47.2-58 µm, I. 8.8-12 µm, t. csp. 17.5-20.2 µm, t. ssp. 12.8-14.8 µm. Lake (autumn 1997) and river (spring 1997); few.

17. ***Euastrum substellatum** Nordst. var. **bangladeshicum** Islam & Irfanullah var. nov.
*Cellulis mediocris, sed magnus quam typicus; incisura mediano profundus. Varietas a planta typica differens possessione per semi-cellulis lobo basalis horizontalis latus et lobo apicalis truncatis; lobo basalis et polaris separatio per sinum concavatis latumque; lobis basalibus parallelis, ad extremum lobo polaris et lobo basalis cum spinis coroniformis; ad centralis lobo basalibus tumorem magnum et duo protuberationis in lateribus; marginalis apicalis cum depressus distinctus ad medianus (incisura apicalis absens); cellulis 71.5 µm longis sine spinis; 67.5 µm in medio diam. cum spinis, et 62 µm sine spinis; isthmus 10.8 µm latus; sinus linearis, anguste aperiens intra-marginem interius, sed fere clausus extrinsecus; tumidus*

*mediano circumcinctus ab ca. 16-20 granulis et interius hic 6-7 granulis parvulus praesentia (planctonicus).*

***Holotypus:*** *Collectio no. H-43; 19 March 1997.*

***Locus typus:*** *In fluvium* Burburia *ad* Srimangal, Moulvi Bazar, *in hortus Camellia sinensis; aquas pH 6.7, aquas temp. 27°C.*

**Euastrum substellatum** Nordst. var. **bangladeshicum** Islam & Irfanullah var. nov. Cells medium-sized, fairly bigger than the typical, with deep median incision; incision narrow, linear, open inside, but almost closed outside; each semicell with a basal and an apical lobe, separated by a broad sinus; basal lobes almost parallel with a crown of spines at each terminal end; each basal lobe with a big central swelling and two smaller swellings, one on each side of it at equal distance; apical lobe corners each with a crown of spines, apical margin truncate with median distinct, shallow depression but without any apical notch; in top view 1-central and 2-lateral tumour-like protrusions clearly visible; below the polar and lateral margins of each semicell several spines are present; median tumours are also surrounded by ca. 16-20 granules on outer side and 6-7 smaller granules are present in the inner side; cell length 71.5 µm without spines; mid-diam. with spines 67.5 µm and 62 µm without spines; isthmus 10.8 µm broad (planktonic). Rare in the collection.

*Note:* It is distinct from the typical by its parallel basal lobes with 1-median big swelling and 2-smaller lateral swellings or processes/protrusions and a crown of apical spines at the terminal ends of the basal and apical lobes. The typical form does not have the 2 extra lateral swellings in each semicell. Also apical margin shows distinct median shallow depression. Besides, the apical and basal lobes are separated by broad concave sinus.

18. **E. turgidum** Wallich var. **turgidum** (Pl. **1**, Fig. **2**)
(Scott and Prescott 1961, 12:4-5)
L. 127 µm, W. 78.3 µm, I. 25.6 µm, t. 56.7-59.4 µm. Lake; winter 1997; few.

**Genus: Micrasterias** Agardh ex Ralfs, 1848

19. **M. alata** Wallich (Pl. **3**, Fig. **23**)
(Islam 1970, 12:1-2)
L. cpr. 159 µm, W. cpr. 139-147 µm, I. 17.5 µm. Lake; winter 1996; common.

20. **M. foliacea** Bail.
Lake; winter 1996; common.

21. **M. mahabuleshwarensis** Hobson var. **surculifera** Lagerh. (Pl. **3**, Fig. **18**)
(Islam 1970, 7:7-8)

L. cpr. 129-135 µm, L. spr. 103 µm, W. 116 µm, I. 16.2 µm, t. cpr. 60.7 µm, t. spr. 19 µm. Lake; winter 1996; common.

22. **M. pinnatifida** (Kg.) Ralfs var. **pinnatifida** (Pl. **3**, Figs. **19-20**)
(Růžička 1981, 93:1-6)
L. 46-59 µm, W. csp. 54-64.7 µm, I. 9.4-10.6 µm, t. csp. 37.8-50.6 µm. Lake (winter 1997; common) and (autumn 1997; rare); and river (spring 1997; few).

23. **M. pinnatifida** (Kg.) Ralfs var. **pinnatifida** fa. **inflata** (Wolle) Croasdale
(Islam and Irfanullah, 1999b, 95, 3:34)
River; spring 1997; rare.

24. **M. radians** Turner (Pl. **3**, Fig. **24**)
(Islam 1970, 11:1-2)
L. 111 µm, L. csp. 138-139 µm, W. csp. 116-123 µm, I. 23 µm, t. csp. 50-51 µm. Lake; winter 1996 and 1997; rare to common.

25. **M. thomasiana** Arch. var. **notata** (Nordst.) Grönbl.
(Scott and Prescott, 1961, 17:6; Růžička 1981, 114:1-8)
L. 211 µm, W. 190 µm, I. 22 µm. Here, the apical lobes show swollen lateral margins at the tip. River; spring 1997; rare.

26. **M. thomasiana** var. **pulcherrima** G. West (Pl. **4**, Fig. **26**)
(Islam and Haroon 1980, 8:122-123; Růžička 1981, 114:9)
L. 173 µm, W. 151 µm, I. 23 µm. Paddy field; autumn 1997; rare.

27. **M. zeylanica** Fritsch var. **wallichiana** (Turner) Krieger (Pl. **3**, Fig. **22**)
(Islam 1970, 8:37)
L. 47.2 µm, W. csp. 52.6 µm, I. 10.8 µm, t. csp. 37.8 µm, t. ssp. 31 µm. Lake; winter 1997; rare.

### Genus: *Actinotaenium* (Näg.) Teiling, 1954

28. **A. australe** (Racib.) Teil. var. **crassius** (G.S. West) Krieger & Gerloff
(Krieger & Gerloff 1969, 59:13)
L. 81 µm, W. 59.4-60.7 µm, I. 54 µm. Lake; spring 1997; few.

29. **A. capax** (Joshua) Teil. var. **minus** (Schm.) Teil. (Pl. **4**, Fig. **28**)
(Ling and Tyler 1986, 23:20)
L. 75.6 µm, W. 47.2-48.6 µm, I. 44.5 µm. A smaller form. River; spring 1997; rare.

30. **A. cruciferum** (De Bary) Teil. var. **cruciferum**
(Islam and Irfanullah, 1999a, 118, 2:18-21)
River; rainy and autumn 1997; common.

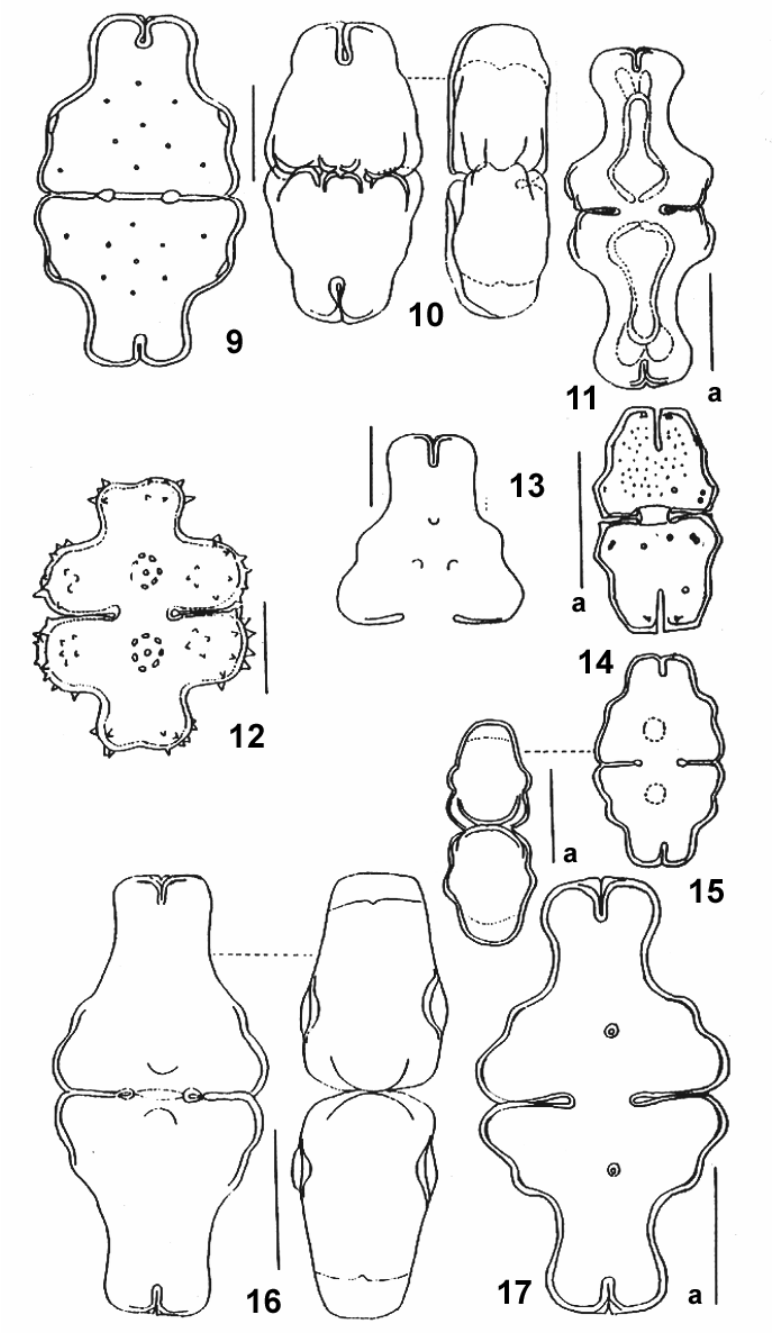


**Plate 2** (Figs. 9-17)

Figs. 9. *Euastrum sinuosum* var. *subjenneri*, 10. *E. gnathophorum* var. *bulbuosum*, 11. *E. longicolle* var. *capitatum* fa. *minus*, 12. *E. ceylanicum*, 13. *E. didelta* var. *bengalicum* fa. *minus*, 14. *E. elegans* fa., 15. *E. inerme* var. *inerme*, 16. *E. didelta* var. *bengalicum*, 17. *E. sinuosum* var. *capitatum*. [Scales: Fig. 16 = 30 μm, rest = 20 μm]

31. **A. cucurbita** (Bréb.) Teil var. **attenuatum** (G.S. West) Teil.
(Islam and Irfanullah, 1999a, 118, 2:15)
Lake; winter 1996; rare.

32. **A. cucurbitinum** (Biss.) Teil. (Pl. **4**, Fig. **27**)
(Islam and Haroon 1980, 7:114; Ling and Tyler 1986, 23:19)
L. 71.5 µm, W. 25.6 µm, I. 20.2 µm, t. 10.8 µm. Cell wall granulated. River; spring 1997; rare.

33. ***A. cucurbitinum** var. **truncatum** Krieger (Pl. **4**, Fig. **29**)
(Scott and Prescott 1961, 23:9)
L 64.8 µm, W. 28.3 µm, I. 25.6 µm, t. 13.5 µm. Poles truncate. River; spring 1997; rare.

34. **A. diplosporum** (Lund.) Teil. var. **diplosporum**
(Islam and Irfanullah, 1999a, 118, 2:13)
Lake; winter and spring 1997; rare.

35. **A. subglobosum** (Nordst.) Teil. var. **subglobosum**
(Islam and Irfanullah, 1999a, 120, 2:16-17)
Lake; year round; few to common.

36. **A. turgidum** (Bréb) Teil. var. **turgidum** (Pl. **6**, Fig. **50**)
(Islam and Haroon 1980, 13:175; Růžička 1981, 54:1-9)
L. 159 µm, W. 81 µm, I. 69 µm. Lake; winter 1997; rare.

37. **A. wollei** (W. & W.) Teil. var. **wollei**
(Islam and Irfanullah, 1999a, 120, 2:14)
Lake; spring and autumn 1997; few.

**Genus: Cosmarium** Corda, 1834

38. **C. alpestre** Roy & Biss.
(Islam and Irfanullah, 1999a, 120, 2:12)
Lake; winter 1996; few.

39. **C. angulatum** (Perty) Rab. fa. **major** Grunow (Pl. **5**, Fig. **41**)
(Scott and Prescott 1958, Fig. 13, No. 8)
L. 73 µm, W. 44.5 µm, I. 17.5 µm, t. 21.6-24.3 µm. Lake; winter 1996 (few) and autumn 1997 (rare).

40. **C. askenasyi** Schmid. (Pl. **6**, Fig. **45**)
(Islam 1970, 6:16)
L. 144 µm, W. 109 µm, I. 42 µm, t. 32 µm. Lake (winter 1996; rare), ditch (rainy 1997; rare) and river (spring 1997; few).

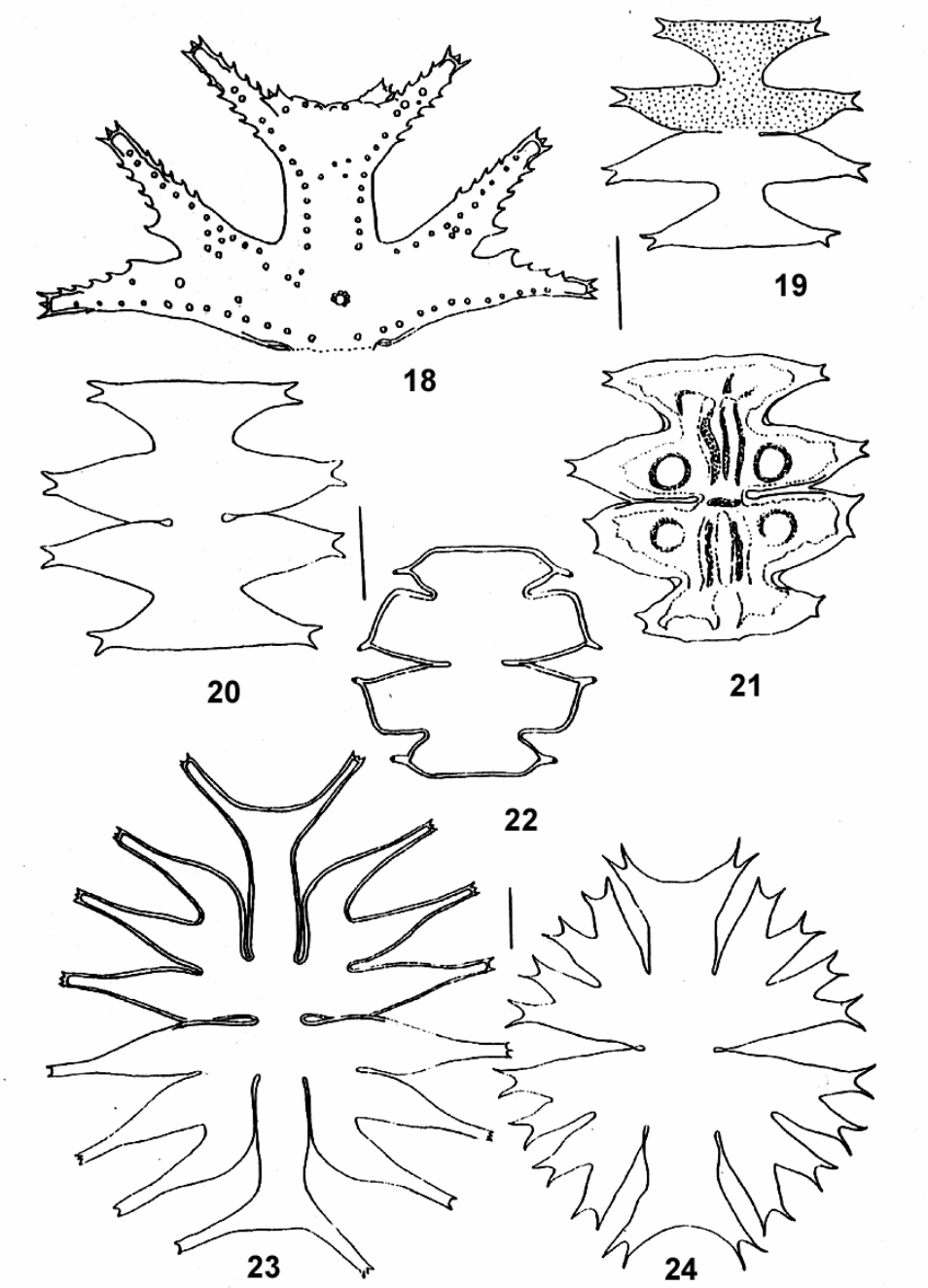


**Plate 3** (Figs. 18-24)
Figs. 18. *Micrasterias mahabuleshwarensis* var. *surculifera*, 19-20. *M. pinnatifida* var. *pinnatifida*, 21. *M. pinnatifida* var. *pinnatifida* fa. *inflata* (after Islam and Irfanullah 1999b), 22. *M. zeylanica* var. *wallichiana*, 23. *M. alata*, 24. *M. radians*. [Scales = 20 μm]

41. **C. bioculatum** Bréb. var. **excavatum** Gutw. fa.
(Islam and Irfanullah, 1999b, 92, 2:28-29)
Lake; autumn 1997; common.

42. ***C. bireme** Nordst. var. **barbadense** G.S. West (Pl. **7**, Fig. **60**)
(Krieger and Gerloff 1965, 40:2)
L. 10 µm, W. 12-13 µm, t. 6 µm, I. 3 µm; one protrusion on each front surface of each semicell, cell poles flat. Slightly bigger than the typical. Lake; winter 1996; rare.

43. **C. blyttii** Wille
(Islam and Irfanullah, 1999b, 92, 2:19-21)
Lake; winter 1996 and 1997 (few) and river; spring (few).

44. ***C. blytii** fa. **australicum** Schm. (Pl. **7**, Fig. **71**)
(Scott and Prescott 1961, 31:15)
L. 17.5 µm; W. 14.8 µm; I. 6 µm; t. 8 µm. Lake; winter 1997; rare.

45. ***C. clepsydra** Nordst fa. (Pl. **6**, Figs. **48-49**)
L. 16 µm, W. 13.5-16 µm, I. 3.5-8.5 µm. Cell wall smooth, relatively thick; in front view each semi-cell bears an elliptical protrusion on both side near the cell pole, which is flat from top view. Lake; winter 1996; few.

46. **C. connatum** Bréb. (Pl. **7**, Fig. **52**)
(Islam and Haroon 1980, 12:164)
L. 56.7-67.5 µm, W. 44.5-51.3 µm, I. 31-37.8 µm. Lake and river; spring 1997; few.

47. **C. contractum** Kirchn. var. **ellipsoideum** (Elfv.) W. & W. (Pl. **7**, Fig. **53**)
(Okada 1934, 27:8; Hirano 1957, 20:3-4; Krieger and Gerloff 1962, 17:4)
L 32.4 µm, W. 23-24.3 µm, I. 4.7 µm. Pitted cell wall. Lake; winter 1997; few.

48. **C. contractiforme** Groenbl. and Scott fa.
(Islam and Irfanullah 1999b, 92, 2:25–27)
Lake; winter 1996; common.

49. **C. decoratum** W. & W. (Pl. **5**, Fig. **40**)
(Islam and Haroon 1980, 106-108)
L. 86.4 µm, W. 64.8 µm, I. 24.3. Lake (spring 1997; few) and paddy field (autumn 1997; rare) and river (spring 1997; few).

50. **C. depressum** (Näg.) Lund var. **intermedium** (Gutw.) Messik. (Pl. **7**, Fig. **57**)
(Krieger and Gerloff 1962, 8:7)
L. 30.5 µm, W. 30.5 µm, I. 5.6. µm, t. 4.8-5.6. The present material is only slightly smaller than the typical. Lake; winter 1996; few.

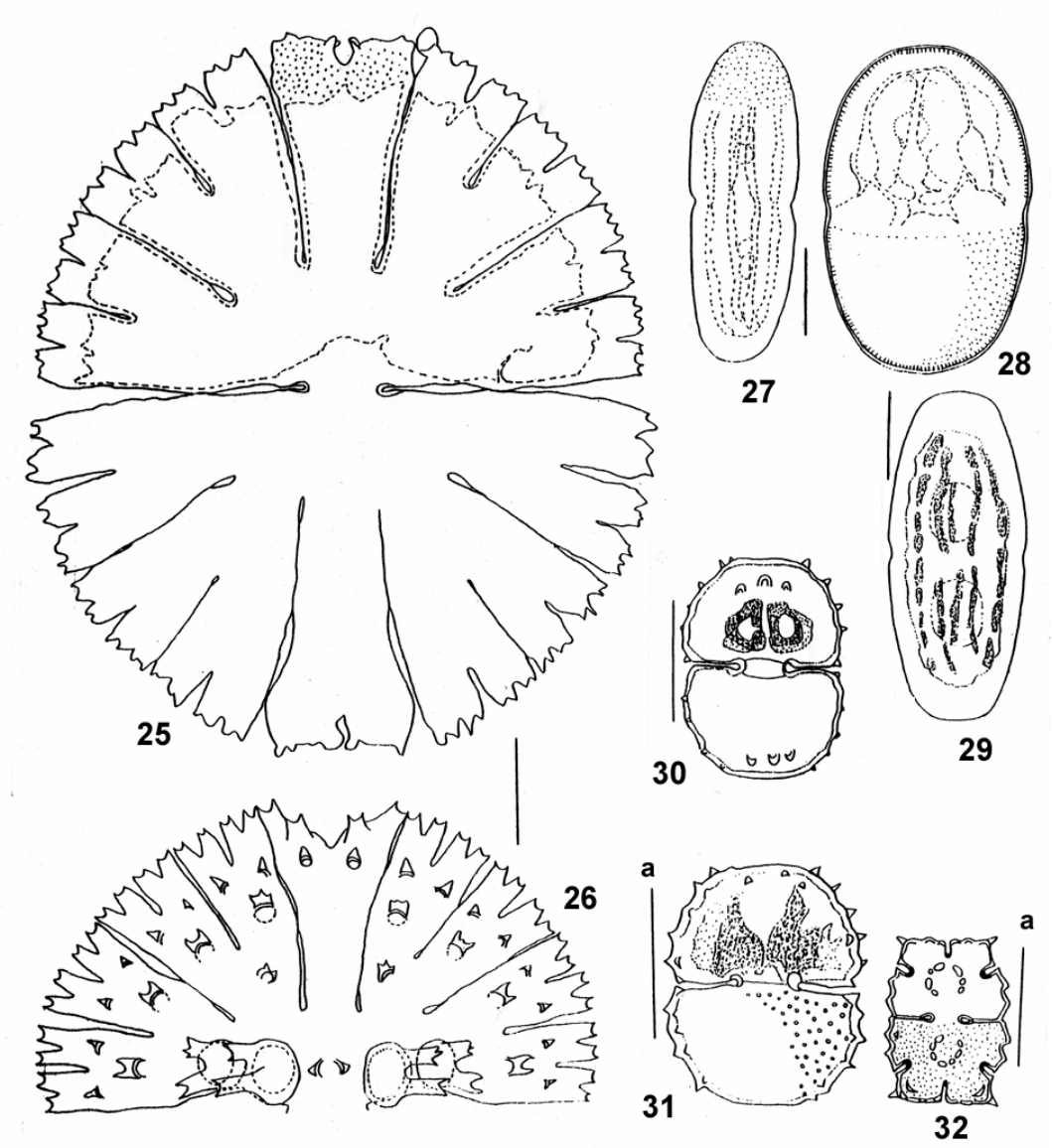


**Plate 4** (Figs. 25-32)

Figs. 25. *Micrasterias thomasiana* var. *notata*, 26. *M. thomasiana* var. *pulcherrima*, 27. *Actinotaenium cucurbitinum*, 28. *A. capax* var. *minus*, 29. *A. cucurbitinum* var. *truncatum*, 30-31. *C. freemanii* var. ? *verrucosum*, 32. *Euastrum denticulatum* var. *quadrifarium*? fa. *incisum*. [Scale: Figs. 25-26 = 30 μm, rest = 20 μm]

51. *__Cosmarium depressum__ (Näg.) Lund. var. __apertum__ (Turner) Hirano
fa. __spinosum__ Islam & Irfanullah fa. nov. (Pl. **7**, Fig. **70**)
*Cellulis in structura simil ad var. apertum et in statura similaris ad var. minor; sed differt e uterque a membrane spinosus (spinae parvulus) et in aspectu vertice late ellipticus; cellulis* 23.6 µm longum; diametro 24.8 µm; isthmus 5.2 µm.
***Holotypus:*** *Collectio no. H-103; 21 October 1997.*
***Locus typus:*** *In* lake Baraoora *ad* Srimangal, Moulvi Bazar, *in hortus Camellia sinensis; aquas pH 5.5; aquas temp. 27°C.*

**Cosmarium depressum** (Nag.) Lund. var. **apertum** (Turner) Hirano
fa. **spinosum** Islam & Irfanullah fa. nov. (Pl. **7**, Fig. **70**)
Cell shape like var. *apertum* and in size similar to var. *minor* (Hirano 1956); but it differs from both by its spiny cell wall (spines very small), and top view broadly elliptical. Cell length 23.6 µm, diam. 24.8 µm, isthmus 5.2 µm. Common in the collection.

52. **C. depressum** (Näg.) Lund. var. **minutum** (Heimerl) Krieger & Gerloff
(Islam and Irfanullah 1998, 90, Pl. 1:7)
Lake; winter 1996; few.

53. *__C. freemanii__ W. & W. var. ? __verrucosum__ Scott & Prescott (Pl. **4**, Figs. **30-31**)
(Scott and Prescott 1961, 31:3-4)
L. 35-40.5 µm, W. 28.3-30.4 µm, I. 6.7-8.8 µm, top view elliptical, two parallel rows of small spines encircling the cell can be seen from the top view; three warts on each side of the semicell near the pole. It is also close to *C. ceylanicum* W. & W. fa. *minus* Scott & Prescott (Scott and Prescott 1961, 31:5). Lake; winter 1996 and autumn 1997; rare.

54. *__C. geometricum__ W. & W. var. __latum__ Printz (Pl. **7**, Fig. **58**)
(Krieger and Gerloff 1965, 40:33)
L. 9 µm, W. 9.5 µm, I. 5 µm, t. 6.5 µm. Lake; winter 1996 and 1997, and spring 1997; few.

55. **C. granatum** Bréb. (Pl. **7**, Fig. **65**)
(Islam and Hossain 1979, 1:4)
L. 27 µm, W. 18.2 µm, t. 5.4 µm. Lake; winter 1996 and 1997 (few) and spring 1997 (rare).

56. **C. javanicum** Nordst. var. **tumescens** (Turner) Islam & Irfanullah
(Islam and Irfanullah 1999b, 92, 1:10-11)
River; spring 1997; rare.

57. **C. lundellii** Delp. var. **circulare** (Reinsch.) Krieger
(Islam and Irfanullah, 1999b, 93, 1:4-5)
Lake (autumn 1997) and river (spring 1997); rare.

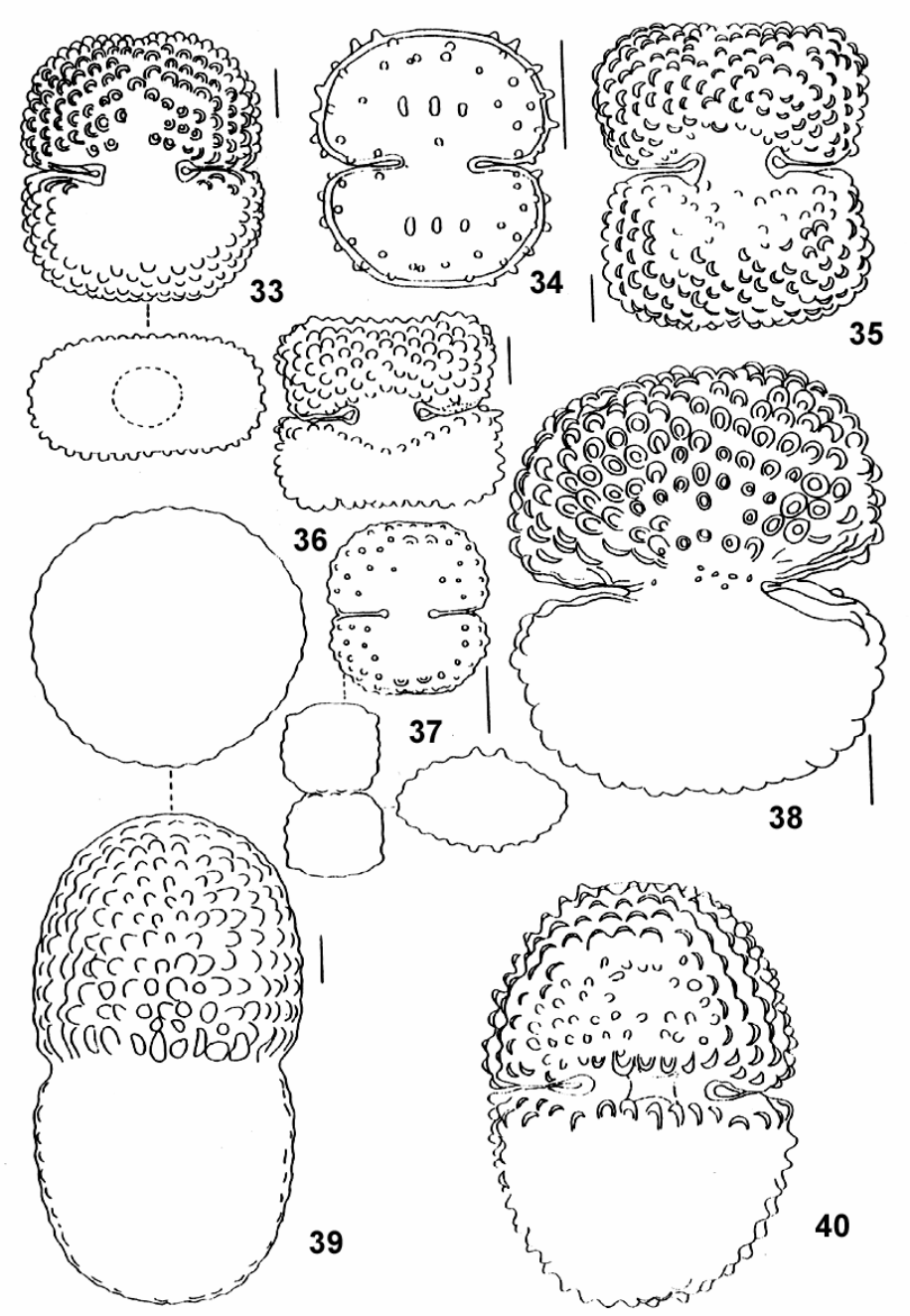


**Plate 5** (Figs. 33-40)
Figs. 33. *Cosmarium margaritatum*, 34. *C. spinuliferum*, 35. *C. quadrum*, 36. *C. scabrum*, 37. *C. quinarium*, 38. *Cosmarium* sp., 39. *C. striolatum*, 40. *C. decoratum*. [Scales = 10 μm]

58. **C. lundellii** var. **ellipticum** W.S. West
(Islam and Irfanullah, 1999b, 93, 1:6-7)
River; spring 1997; rare.

59. **C. lundellii** Delp. fa (Pl. **7**, Fig. **59**)
L. 44.5 µm, W. 40.5 µm, I. 20.2 µm. Lake; spring 1997; rare.

60. **C. margaritatum** Roy & Biss. (Pl. **5**, Fig. **33**)
(Hirano 1957, 29:3; Islam and Zaman 1975, 6:75)
L. 55.3 µm, W. 50 µm, I. 14.8 µm. Lake (winter 1996; rare) and river (spring 1997; few)

61. **C. margaritatum** var. **quadrum** Krieger
(Islam and Irfanullah, 1998, 90, 1:8)
Lake; winter 1997; rare.

62. **C. maximum** (Boerges.) W. & W. fa.
(Islam and Irfanullah, 1999b, 94, 1:1)
Lake; autumn 1997; common.

63. **C. nudum** (Turner) Gutw.
(Islam and Irfanullah, 1998, 90, 1:10)
Lake; autumn 1997; rare.

64. **C. obliquum** Nordst. var. **symmetricum** Groenblad
(Islam and Irfanullah, 1998, 92, 1:1-2)
Lake (winter 1996) and paddy field (autumn 1997); few.

65. **C. obsoletum** (Hantz.) Reinsch var. **sitvense** Gutw. (Pl. **7**, Fig. **55**)
(Islam 1970, 13:11)
L. 44.5-46 µm, W. 59.4 µm, I. 21.6 µm. Lake; winter 1996 (few), spring 1997 (rare) and autumn 1997 (common).

66. **C. pakistanicum** Islam (Pl. **5**, Fig. **42**)
(Islam, 1970, 14:2, 23:1-10)
L. 111-116 µm, W. 62 µm, I. 42-47 µm. Lake (winter 1996) and river (spring 1997); few.

67. ***C. paucigranulatum** Borge (Pl. **7**, Fig. **72**)
(Scott and Prescott 1961, 31:14)
L.11 µm, W. 15-16 µm, I. 6.8, t. 9.2-10 µm. Lake; winter 1996; few.

68. ***C. phaseolus** Bréb. var. **minutum** (Biswas) Krieger & Gerloff Pl. **6**, Figs. **43-44**)
(Krieger and Gerloff 1962, 14:6; Hirano 1972, 3:14)
L. 7.4-9.4 µm, W. 9.4-10.2 µm, I. 4.7-5.4 µm, t. 6.7-8 µm. Cells are in short chains. Lake; autumn 1997; few.

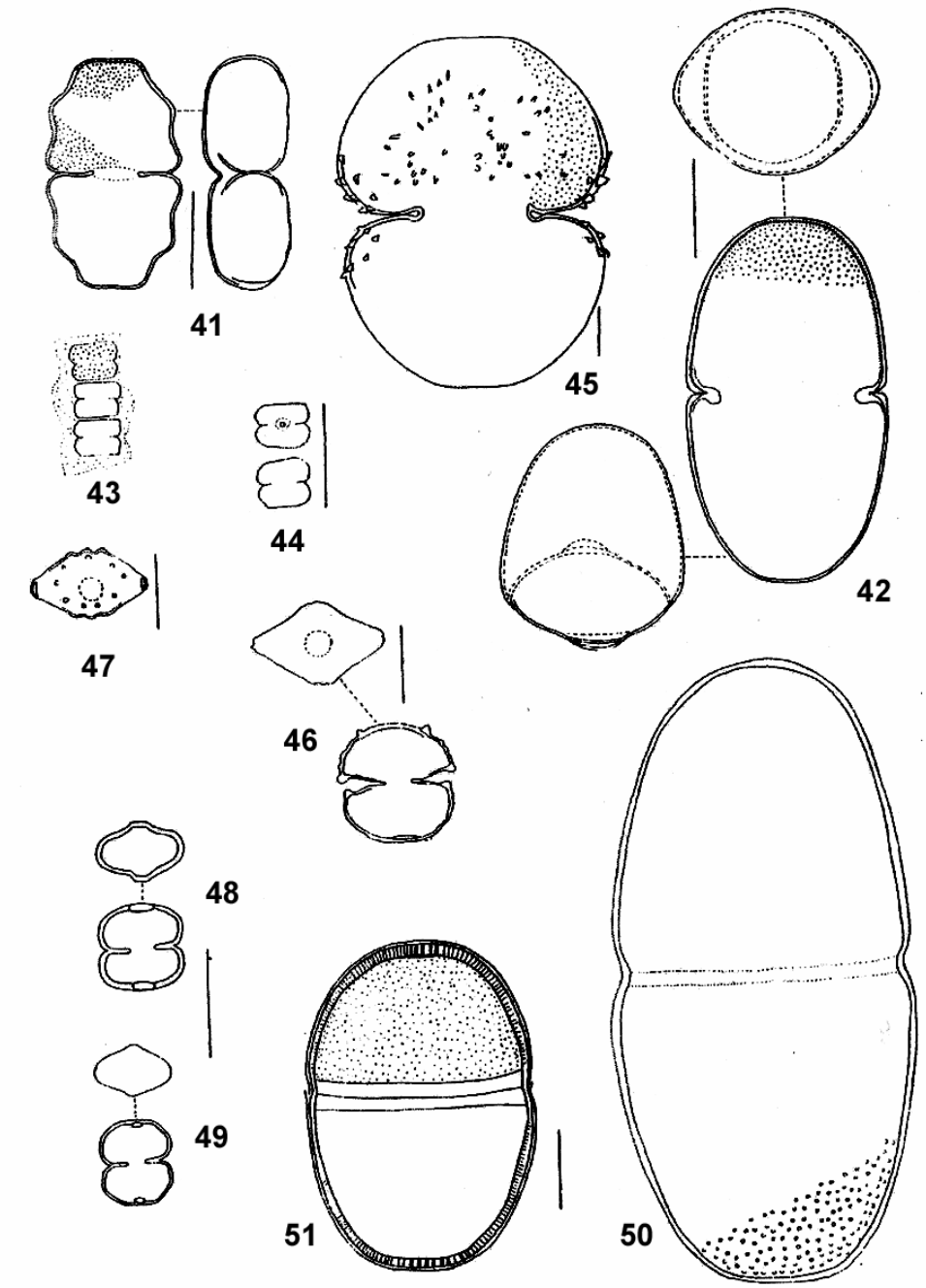


**Plate 6** (Figs. 41-51)

Figs. 41. *C. angulatum* fa. *major*, 42. *C. pakistanicum*, 43-44. *C. phaseolus* var. *minutum*, 45. *C. askenasyi*, 46. *C. taxichondrum* fa., 47. *C. taxichondrum*, 48-49. *C. clepsydra*, 50. *Actinotaenium turgidum* var. *turgidum*, 51. *A. australe* var. *crassius*. [Scales: Figs. 41-42 = 30 µm, rest = 20 µm]

69. **C. portianum** Archer var. **nephroideum** Wittr.
Islam and Irfanullah, 1998, 92, 1:5)
Lake; autumn 1997; rare.

70. **C. pseudamoenum** Wille
Islam and Irfanullah, 1998, 92, 1:4)
Lake (rare) and river (few); spring 1997.

71. **C. pseudoexiguum** Racib. var. **quadratum** Krieger
Islam and Irfanullah, 1998, 92, 1:6)
Lake; winter 1996 and 1997; few.

72. **C. pseudomagnificum** Hinode var. **brasiliense** (Foers. and Eck.) Foers.
Islam and Irfanullah, 1999b, 94, 1:12-13)
Lake (winter 1997) and paddy field (autumn 1997); few.

73. **C. pseudopyramidatum** Lund. var. **letiferum** Taylor
Islam and Irfanullah, 1999b, 94, 1:2-3)
Lake; winter 1996; rare.

74. **C. punctulatum** Bréb. fa. (Pl. **7**, Fig. **63**)
L. 19.2 µm, W. 20.8-23.2 µm, I. 5.2 µm. Lake; winter 1996; few.

75. **C. quadrum** Lund. (Pl. **5**, Fig. **35**)
Hirano 1957, 29:1; Islam and Zaman 1975, 7:95)
L. 56.7 µm, W. 55.3 µm, I. 13.5 µm. It also approaches *C. pardalis* Cohn. as shown by Islam (1970). Lake; autumn 1997 (few) and river; spring 1997 (few).

76. ***C. quinarium** Lundell fa. (Pl. **5**, Fig. **37**)
L. 27.7 µm, W. 26.3 µm, I. 6.7 µm. It is smaller than the typical or it is fa. *irregularis* Nordst (Irene-Marie 1938, p. 190-191) and it differs by its top and side views. Lake; winter 1996; rare.

77. **C. rectangulare** Gurnow var. **cambrense** (Turner) W. & W. (Pl. **7**, Fig. **62**)
Islam and Irfanullah, 1999b, 94, 1:8-9)
Lake; winter 1996; few.

78. **C. regnellii** Wille var. **pseudoregnelii** (Messik.) Krieger & Gerloff
Islam and Irfanullah, 1998, 94, 1:3)
Lake; winter 1996; few.

79. **C. regnesii** Reinsch (Pl. **7**, Fig. **69**)
Scott and Prescott 1961, 32:23)
L. 8.8 µm, W. 10 µm, I. 4.3 µm, cell wall is warted in a symmetric fashion. Lake; autumn 1997; very rare.

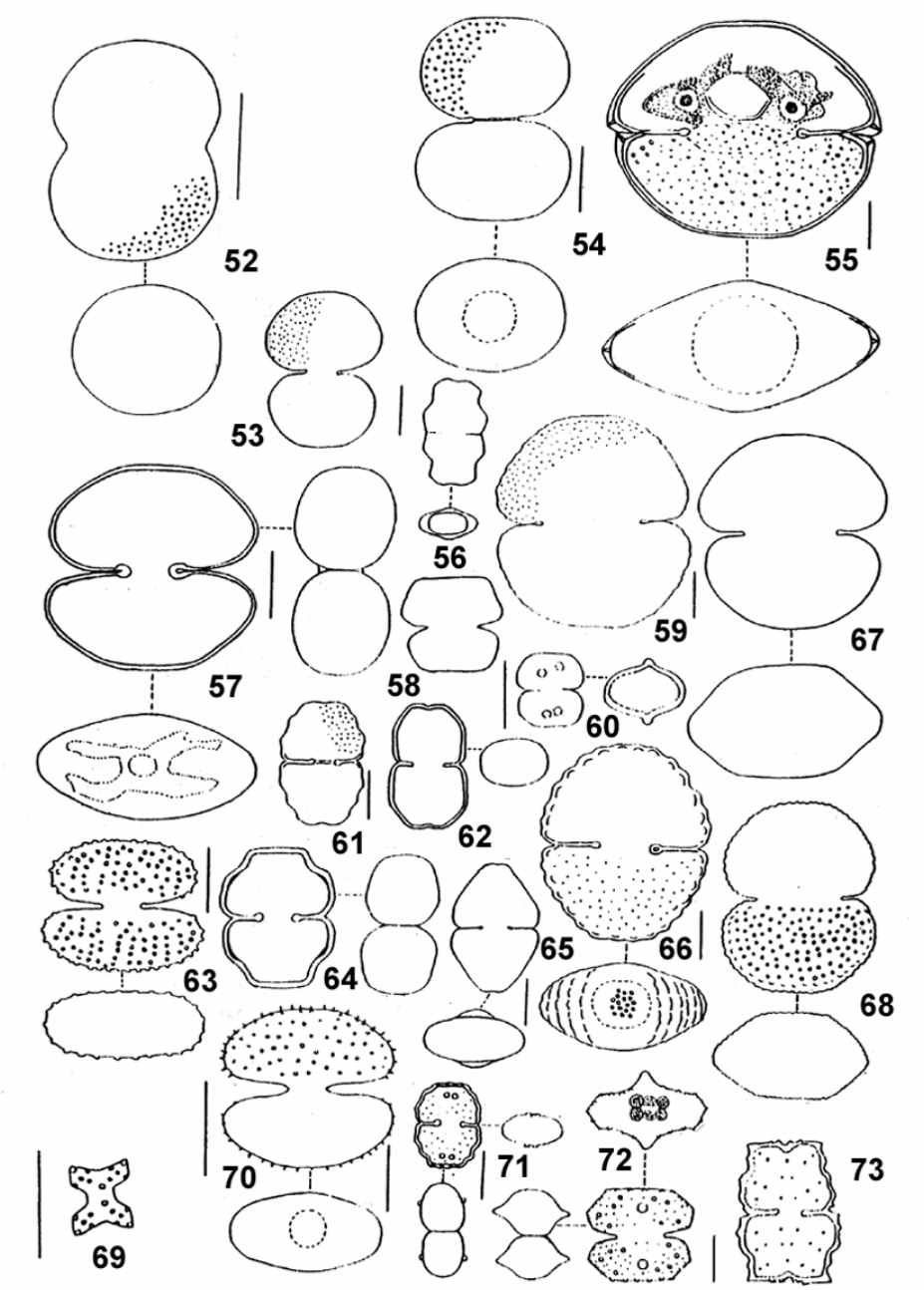


**Plate 7** (Figs. 52-73)

Figs. 52. *Cosmarium connatum*, 53. *C. contractum* var. *ellipsoideum*, 54. *C. tumidum*, 55. *C. obsoletum* var. *sitvense*, 56. *C. subvalidum*, 57. *C. depressum* var. *intermedium*, 58. *C. geometricum* var. *latum*, 59. *C. lundellii*, 60. *C. bireme* var. *barbadense*, 61. *C. venustum* var. *brevius*, 62. *C. rectangulare* var. *cambrense* (after Islam and Irfanullah 1999b), 63. *C. punctulatum* fa., 64. *C. retusiforme*, 65. *C. granatum*, 66. *C. sublatereundatum*, 67-68. *C. stigmosum* var. *hakalukiense*, 69. *C. regnesii*, 70. *C. depressum* var. *apertum* fa. *spinosum* fa. nov., 71. *C. blytii* fa. *australicum*, 72. *C. paucigranulatum*, 73. *Euastrum boldtii*. [Scales: Figs. 52 = 30 μm, rest = 10 μm]

80. **C. retusiforme** (Wille) Gutw. (Pl. **7**, Fig. **64**)
Krieger and Gerloff 1962, 20:11; Islam 1970, 13:13; Ling and Tyler 1986, 14:15)
L. 23.7-24.3 µm, W. 18.2-19 µm, I. 4-4.7 µm, t. 9.4-10 µm. Lake; winter 1996 (rare) and autumn 1997 (common) and river; spring and autumn 1997 (rare to few).

81. **C. scabrum** Turner (Pl. **5**, Fig. **36**)
Turner 1892, 9:32; Scott and Prescott 1961, 29:3)
42 µm, W. 47.2-48.6 µm, I. 13.5 µm. Lake; autumn 1997; rare.

82. ***C. spinuliferum** W. & W. (Pl. **5**, Fig. **34**)
Scott and Prescott 1961, 29:6-7; Ling and Tyler 1986, 18:44)
L. 23 µm, W. ssp. 20-21 µm, I. 5.5. µm. Lake; winter 1997; rare.

83. **C. striolatum** Näg. (Pl. **5**, Fig. **39**)
(Scott and Prescott 1961, 25:2-3; Islam and Haroon 1980, 14:187)
L. 101 µm, W. 59.4 µm, I. 44.5 µm. Lake; winter 1997; rare.

84. **C. stigmosum** (Nordst.) Turner var. **hakalukiense** Islam & Haroon
(Islam and Haroon 1980, 22:361-362)
L. 40.5-42 µm, W. 33.7-40.5 µm, I. 18.2-19 µm. Lake; winter 1996 (rare) and 1997 (few).

85. **C. sublatereundatum** W. & W. (Pl. **7**, Fig. **66**)
(Islam and Haroon 1980, 22:363-364, as a forma)
L. 43.2 µm, W. 35-36.4 µm, I. 12 µm, t. 13.5 µm. Lake; winter 1996, rainy and autumn 1997; rare.

86. ***C. subvalidum** (Pl. **7**, Fig. **56**)
L. 20 µm, W. 11 µm, I. 4.5. µm, t. 8.5 µm. Lake (winter 1997 ) and river (spring 1997); few.

87. **C. taxichondrum** Lund. var. **undulatum** Scott and Prescott
(Islam and Irfanullah, 1999b, 95, 2:22-24)
Paddy field; autumn 1997; few.

88. **C. taxichondrum** Lundell fa. (Pl. **6**, Fig. **46**)
L. 27 µm, W. 26.5 µm, I. 5.3. µm. Compare with Irene-Marie 1938, 27:3-5. Ditch; autumn 1997; few.

89. **C. taxichondrum** Lundell fa. (Pl. **6**, Fig. **47**)
W. 32 µm, I. 5.5. µm. Lake; winter 1996; rare.

90. **C. trachypleurum** Lund. var. **minus** Racib.
(Islam and Irfanullah, 1998, 94, 1:9)
Lake; winter 1996; rare.

91. ***C. tumidum** Lund. (Pl. **7**, Fig. **54**)
(Scott and Prescott 1961, 27:16)
L. 33.7 µm, W. 25.6 µm, I. 7.4 µm. Pitted cell wall. Lake; winter 1996 and 1997 (few) and autumn 1997 (common).

92. ***C. venustum** (Bréb.) Arch. var. **brevius** Bernard (Pl. **7**, Fig. **61**)
(Bernard 1908, 92, Figs. 123-125; Hirano 1957, 137, 20:35)
L. 27-28.3 µm, W. 17.5 µm, I. 4-4.7 µm, t. 8-10.8 µm. It also somewhat resembles *C. impressulum* Elfv. (Hirano 1957). Lake; winter and autumn 1997; rare.

93. **Cosmarium** sp. (Pl. **5**, Fig. **38**)
L. 68.8 µm, W. 60.7 µm, I. 20.2 µm. Lake; winter 1996; rare.

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## References

Bernard, Ch. 1908. Protococcacees et Desmidiees d'eau douce, recotees a Java. Dept. de l'Agri. aux Indes Néerl. pp. 230, Batavia.

Hirano, M. 1956. Flora Desmidiarum Japonicarum. II. Contr. Biol. Lab. Kyoto Univ. No. 2: 57-106.

Hirano, M. 1957. Flora Desmidiarum Japonicarum. III. Contr. Biol. Lab. Kyoto Univ. No. **4**: 107-165 + pls. 19-25.

Hirano, M. 1972. Desmids from Cambodia, with special reference to phytoplankton of Lake Grands Lacs (Tonle Sap). Contr. Biol. Lab. Kyoto Univ. **23**(3-4): 123-127.

Irene-Marie, F. 1938. Flore Desmidiale de la region de Montreal. Laprairie, Canada, pp. 547.

Islam, A.K.M. Nurul 1970. Contributions to the knowledge of desmids of East Pakistan. Part I. Nova Hedwigia **20**: 903-983.

Islam, A.K.M. Nurul and Haroon, A.K.Y. 1980. Desmids of Bangladesh. Int. Revue ges. Hydrobiol. **65**(4): 551-604.

Islam, A.K.M. Nurul and Hossain, M. 1979. Preliminary studies on the algae flora of Bagerhat, Khulna. J. Asiatic Soc. Bangladesh (Sci.) **5**(1): 37-45.

Islam, A.K.M. Nurul and Irfanullah, H.M., 1998. New records of desmids for Bangladesh. I. Fifteen taxa. Bangladesh J. Bot. **27**(2): 89-96.

Islam, A.K.M. Nurul and Irfanullah, H.M., 1999a. New records of desmids for Bangladesh. II. Thirteen taxa. Bangladesh J. Bot. **28**(2): 117-123.

Islam, A.K.M. Nurul and Irfanullah, H.M., 1999b. New records of desmids for Bangladesh. III. 24 taxa. Bangladesh J. Plant Taxon. **6**(2): 91-104.

Islam, A.K.M. Nurul and Irfanullah, H.M., 2000. Hydrobiological studies within the tea gardens at Srimangal, Bangladesh. I. Aquatic macrophytes. Bangladesh J. Plant Taxon. **7**(1): 29-42.

Islam, A.K.M. Nurul and Irfanullah, H.M., 2005a. Hydrobiological studies within the tea gardens at Srimangal, Bangladesh. II. Algal flora (excluding Chlorophyceae). Bangladesh J. Plant Taxon. **12**(1): 33-52.

Islam, A.K.M. Nurul and Irfanullah, H.M., 2005b. Hydrobiological studies within the tea gardens at Srimangal, Bangladesh. III. Chlorophyceae (excluding desmids). Bangladesh J. Plant Taxon. **12**(2): 19-37.

Islam, A.K.M. Nurul and Irfanullah, H.M., 2005c. Hydrobiological studies within the tea gardens at Srimangal, Bangladesh. IV. Desmids (17 genera). Bangladesh J. Plant Taxon. **12**(2): 49-62.

Islam, A.K.M. Nurul and Zaman, K.M. 1975. Limnological studies of the River Buriganga III. Biological aspect. J. Asiatic Soc. Bangladesh (Sc.) **1**(1): 45-65.

Krieger, W. and Gerloff, J. 1962. Die Gattung *Cosmarium*. Lief. **1**: III-XVIII, 1-112 + pls. 1-19. Ver. von J. Cramer, Weinheim.

Krieger, W. and Gerloff, J. 1965. Die Gattung *Cosmarium*. Lief. **2**: 113-240 + pls. 23-42. Ver. von J. Cramer, Weinheim.

Krieger, W. and Gerloff, J. 1969. Die Gattung *Cosmarium*. Lief. **3**+**4**: 241-410 + pls. 43-71. J. Cramer, Lehre.

Ling, H.U. and Tyler, P.A. 1986. A limnological survey of the Alligator Rivers Region. II. Freshwater algae, exclusive of diatoms. Res. Rep. **3**. Austr. Govt. Publ. Service, Canberra, pp. 173.

Okada, Y. 1934. The desmid-flora of the northern Kurile Islands. J. Imp. Fish. Inst. **30**(3): 1-199 + pls. 17-31.

Prescott, G.W., Croasdale, H.T. and Vinyard, W.C., 1977. A Synopsis of North American Desmids. Part II. Desmidiaceae: Placodermae. Sec. **2**, pp. 413.

Růžička, J. 1981. Die Desmidiaceen Mitteleuropas. 1 : Lief. **2**: 293-736. E. Schw. Verlags., Stuttgart.

Scott, A.M. and Prescott, G.W. 1958. Some freshwater algae from Arnhem Land in the Northern Territory of Australia. 2. Rec. Amer.-Austr. Sci. Expn. to Arnhem Land. **3**: 9-136.

Scott, A.M. and Prescott, G.W. 1961. Indonesian Desmids. Hydrobiologia **17**(1-2): 1-132.

Skuja, von H. 1949. Zur Süsswasseralgen-flora Burmas. Nova Acta Reg. Soc. Sci. Upsaliensis Ser. IV. **14**(5): 1-188 + pls. 39.

Turner, W.B. 1892. Algae aquae dulcis Indiae orientalis. The freshwater algae (principally Desmidieae) of East India. Kongl. Sv. Wet.-Akad. Handl. **25**(5): 1-187.