

Contribution to the Desmid Flora of Sikkim Himalayas, India

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Abstract The present paper is an exclusive contribution of the desmid flora of Sikkim Himalayas, India. Thirty-one species of genus *Cosmarium* Corda, two species of *Penium* and seven species of *Euastrum* (Desmidiaceae, Chlorophyceae) were identified from the samples collected during 2000 and 2001 from Sikkim Himalayas. Taxonomic description and some morphological variations of desmid species are discussed in this paper. All the taxa have been reported for the first time from the study area.

Key words: Desmids, Himalayas, India, Sikkim.

The main contributions to our knowledge about Desmidiaceae around the world made by Vyverman (1991), Coesel (1993), Flint and Williamson (1998), Gontcharov *et al.* (2001), Habib *et al.* (1989a), Habib and Pandey (1990), Srivastava (1993), Tarar *et al.* (1998). An illustrated account of desmid flora from different parts of the Indian sub-continent was done by Habib (2003). Apparently no investigations have been done on the desmid flora of Sikkim Himalayas, India. The tiny Himalayan state of India, Sikkim is located between 27°46'00" and 28°07'48"N and between 88°00'05" and 88°55'25"E in the Eastern Himalayas, bounded with three international borders of China, Bhutan and Nepal on the north, east and west sides, respectively, and southern boundary by Darjeeling district of West Bengal, India. The entire state is a young mountainous terrain spreading over 7,298 sq. km. in the Eastern Himalayas and it measures about 112 km in length from east to west, 64 km in breadth in south. With highly folded and faulted rock strata at many places, snow capped mountain peaks, glaciers, transverse river valleys, cascading streams, rivers, lakes make richness of fresh water algal flora of this area.

The topography of this pretty Himalayan state varies with the elevation ranging from 244 m to

8598 m. The land descends to 240 m a. s. l., which is well known for the rich wealth of floral and faunal aggregation. Climatically, Sikkim experiences varied temperature such as the maximum temperature is recorded 20–25°C and minimum 0–5°C. Rainfall occurs throughout the year and state as a whole gets 80–90% of the annual rainfall during monsoon (May to September).

In the present investigation, 40 taxa of desmids are reported from various altitudinal ranges, i.e., subtropical to temperate region of southern and eastern parts of Sikkim.

Materials and Methods

Samples examined here were collected from various localities of Sikkim. The sample numbers, date of collection are shown below along with the description of the locality and the altitude (Table 1). The samples were collected from different altitudinal limits 1500–2000 m a. s. l. from fresh water pools, ditches, splashed rocks, slow running streams and water falls during 2000–2001.

These samples were preserved in 10% formaline and deposited at the Herbarium of National Botanical Research Institute, Lucknow, India. Samples were observed in Leica ATC 2000 research microscope and photographs were taken

Table 1. List of samples examined in this study.

Sample number	Date	Habitat	Elevation (m)
SH 20001	2 Aug. 2000	a slow stream near Forest Department in Gangtok	1600
SH 200014	2 Aug. 2000	squeezed out the submerged vegetation of running water in the road side at Gangtok	1700
SH 200016	2 Aug. 2000	a small ditch at Gandhi Market in Gangtok	1650
SH 200017	2 Aug. 2000	a small water tank near forest department at Gangtok	1600
SH 200031	3 Aug. 2000	a small stream on the road side towards the Hanuman Tok	1875
SH 200033	3 Aug. 2000	on rocks splashed by water at Hanuman Tok	2000
SH 200042	4 Aug. 2000	a road side ditch towards the Rumtek Monastery	1650
SH 200044	23 Apr. 2000	a small stream of glaciers inside the road at Changu lake	1800
SH 200049	4 Aug. 2000	in a small temporary pool below the water fall on the way of the Rumtek Monastery	1600
SH 200064	5 Sep. 2000.	a small ditch at Gangtok taxi stand, Sikkim	1650
SH 200066	5 Sep. 2000	a small ditch inside the road before 5 km of Pakyong, Sikkim	1600
SH 200071	5 Sep. 2000	from ditch inside the road at Pakyong, Sikkim	1600
SH 200073	5 Sep. 2000	a small stream towards Pakyong, Sikkim	1600
SH 200076	5 Sep. 2000	a small ditch inside the road at Pakyong, Sikkim	1600
SH 200099	7 Sep. 2000	on moist soil at the Tashi view point	1800
SH 2000106	7 Sep. 2000	a water tank at the Tashi view point	1800
SH 2000112	7 Sep. 2000	a small ditch near the water tank at Tashi view point	1800
SH 2000114	7 Sep. 2000	on the road side small stream at Gangtok	1700
SH 2000125	8 Sep. 2000	a ditch near taxi stand at Gangtok	1700
SH 2001131	29 March 2001	on the rocks splashed by water at Rumtek Monastery	1600
SH 2001135	29 March 2001	water fall near the Rumtek Monastery	1700
SH 2001142	29 March 2001	a small stream at Gangtok towards Bhusuk forest	1750
SH 2001188	2 Apr. 2001	a Small stream at Namchi towards Jorethang, Sikkim	1500
SH 2001192	3 Apr. 2001	on moist soil splashed by water at Namchi.	1500

with attached digital camera Nikon Coolpix 4500. For the taxonomic description of taxa dimensions are given in micrometer (μm) and the following abbreviations are used: L=length of cell; W=width of cell; I=breadth of isthmus; No.=Sample number; SH=Sikkim Himalaya.

The relevant publications of Turner (1892), West and West (1905), Tiffany and Britton (1952) were consulted for identification of taxa. Where as the confirmation of some taxa and variation of diameter in length, width and isthmus taken from publications of Prasad and Mehrotra (1977a), Therezien (1985), Hegde (1986), Yamagishi (1990), Prasad and Misra (1992), Lenzenweger (1994), Kant and Gupta (1998), Gontcharov *et al.* (1999).

Enumeration

Order Desmidiaceae

Family Desmidiaceae Ralfs

Cosmarium Corda ex Ralfs

C. alatum Kirch. [Pl. I, f. 23]

L: 35 μm , W: 24.2 μm , I: 9.2 μm ; Nos. SH 200099, SH 2000112.

Cells sub-hexagonal deeply constricted, sinus linear, narrow with slightly dilated apex and opening towards, semi cells truncate, pyramidate with axile chloroplast having single pyrenoid in each cell.

This species is slightly longer and broader than the Turner (1892) from east India having length 22 μm and 20 μm in diameter broad.

C. angulosum Breb. var. *concinnum* (Rao.) W. West et G. S. West [Pl. I, f. 1]

L: 25 μm , W: 15 μm , I: 3–4 μm ; No. SH 200033.

Cells very small, broad, deeply constricted, sinus narrow and linear, semi cells hexagonal with sharp angle in parallel sides, apex narrow and slightly retuse, cell wall smooth.

C. bipunctatum Borg. var. *spinuliferum* Hegder

[Pl. I, f. 24; Pl. II, f. 10]
L: 43.8 μm , W: 37.5 μm , I: 12.24 μm ; No. SH 2000112.

Cell pyramidal, margin crenate with spine, sinus linear with deep constriction, cell wall thin and punctate.

C. candianum Delp var. *depressum* Croas.

[Pl. II, f. 11]

L: 42.5 μm , W: 50 μm , I: 18.2 μm ; No. SH 2001192.

Cells broadly rounded, oval in shape, sinus linear, chloroplast axile, two pyrenoid in each semi cell.

C. circulare Reinsch. [Pl. I, f. 17]

L: 60 μm , W: 42.2 μm , I: 12.28 μm ; No. SH 2000106.

Semi cells semi circular to oval, deeply constricted, sinus linear with rounded basal angles, apex rounded not truncate, pyrenoid two in each semi cell.

C. circulare Reinsch. var. *messikomeri* Krieger et Gerloff [Pl. I, f. 17]

L: 60.82 μm , W: 45.52 μm , I: 20–42 μm ; No. SH 2000112.

Cells long, broadly elliptic, deeply constricted, basal angles broadly rounded, lateral view of semi cells sub-circular, cell wall thin and smooth, minutely punctate.

C. cyclicum Lund var. *nordstedtianum* (Reinsch.) West [Pl. II, f. 3]

L: 45 μm , W: 42.3 μm , I: 12 μm ; No. SH 2000106.

Semi cells oval, circular, deeply constricted, margin 2–4 crenate, cell wall thick and smooth.

C. decedense (Rein.) Racib. var. *borgii*

[Pl. I, f. 25]

L: 37–38.2 μm , W: 18–19 μm , I: 14.5 μm ; No. SH 200044.

Cells long as broad, truncate to quadrate with relatively broad apices, margin entire.

C. depressum (Nag.) Lund. [Pl. II f. 6]

L: 38.5 μm , W: 34.5 μm , I: 11.8 μm ; Nos. SH 200033, SH 2000106.

Cells broadly rounded, oval to semi circular in shape, sinus linear, chloroplast axile, two pyrenoids in each semi cell, cell wall thin and smooth.

C. dorsitruncatum (Nordst.) West var. *dorsitruncatum* [Pl. I, f.15]

L: 22–24 μm , W: 24–25 μm , I: 5–7 μm ; No. SH 200076.

Semi cells semi circular, cell wall thick and smooth.

C. furcatospermum W. West et G. S. West var. *maius* [Pl. I, f. 6]

L: 28.5 μm , W: 24.25 μm , I: 8.2 μm ; No. SH 2001135

Cells oval to ovate with crenate margin, sinus linear, cell wall thin and punctate.

C. humile (Gay.) Nordst var. *lucknowense* Prasad et Mehrotra [Pl. I, f. 4]

L: 18.5 μm , W: 12.5 μm , I: 4.2 μm ; Nos. SH 200017, SH 200049

Cells small, slightly larger than broad, deeply constricted, sinus linear, side view elliptic with two deep protuberances on each semi cell, single pyrenoid in each semi cell.

This specimen is smaller in length i.e., 20–22 μm , but broader with isthmus 5 μm than those reported by Prasad and Mehrotra (1977e) from north Indian paddy fields. It is morphologically similar to the *Euastrum montanum*.

C. laeve Rab. [Pl. I, f. 18]

L: 21.24 μm , W: 13.82 μm , I: 4.2 μm ; No. SH 200033.

Cells spherical with rounded apices, number of pyrenoids scattered in the each semi cell.

C. laponicum Bory [Pl. II, f. 7]

L: 32–34 μm , W: 18–20 μm , I: 5 μm ; No. SH 200073.

Cells oval to circular, deeply constricted with

entire margin, sinus linear, cell wall thick and smooth.

C. lundellii Delp var. *subellipticum* Prasad et Mehrotra [Pl. II, f. 9]

L: 41.5 μm , W: 32.2 μm , I: 11.8 μm ; Nos. SH 200017, SH 200042.

Semi cells sub elliptic with rounded apices, cell wall thick and smooth.

C. moniliforme (Turp.) Ralfs. var. *lamenticum* W. West et G. S. West [Pl. I, f. 12]

L: 25–26.8 μm , W: 18.5–20 μm , I: 5.5 μm ; No. SH 2001142.

Cells semi-circular, deep constriction, margin entire, sinus obtuse with broad isthmus.

C. nitidulum De Not. [Pl. II, f. 8]

L: 44.5 μm , W: 30.5 μm , I: 15.2 μm ; No. SH 20001.

Cells broad, deeply constricted, sinus linear, lateral view of semi-cells sub-semicircular with broadly rounded apices, cell wall thin and smooth.

C. perfissum West [Pl. I, f. 5]

L: 24 μm , W: 22 μm , I: 4.2 μm ; No. SH 200049.

Cells small as long as broad, semi cells oblong to semi circular having single pyrenoid in each semi cell, sinus open, cell wall punctate and smooth.

C. pseudoconnatum Nordst. var. *subconstrictum* Jao [Pl. I, f. 22]

L: 58–60 μm , W: 32–35 μm , I: 25 μm ; No. SH 200016.

Cells long, cylindrical to semi-elliptic with parietal.

C. pseudopyramidatum Lund [Pl. I, f. 28]

L: 45 μm , W: 28.5 μm , I: 10.5 μm ; No. SH 200042.

Semi cells small as long as broad, sinus linear with deep constriction, each cell having two pyrenoids.

C. pseudopyramidatum Lund var. *carnicol-icum* Lutken. [Pl. I, f. 16]

L: 40 μm , W: 25 μm , I: 8 μm ; No. SH 2000106.

Semi cells elongate to trapeziform with linear apices, deep constriction, each cell having single pyrenoid situated in the center of semi cell.

C. punctulatum Breb. [Pl. II, f. 4]

L: 25 μm , W: 20 μm , I: 5.8 μm ; Nos. SH 2000106, SH 2000131.

Semi cells truncate to sub semi circular, axile chloroplast with single small pyrenoid, deep constriction, lateral margin crenate with broadly truncate apex.

C. quadratum Ralfs. [Pl. II, f. 5]

L: 58.5 μm , W: 28 μm , I: 14.2 μm ; No. SH 2000125.

Cells elongate with deep constriction, sinus linear, chloroplast axile with two pyrenoid in each semi cell.

C. quadrifarium Lund F. *hexastichum* (Lund.) Nordst. [Pl. I, f. 27]

L: 58.89 μm , W: 35.2 μm , I: 14.8 μm ; No. SH 2000192.

Semi cells with rectangular margin with 4 apical, 7 lateral creations, cell wall thin and punctate.

C. raeticum Messik var. *raeticum* [Pl. I, f. 2]

L: 22 μm , W: 15 μm , I: 7 μm ; No. SH 200016.

Semi cells with crenate margin, quadrate, sinus linear with deep constriction.

C. retusiformae (Will.) Gutw var. *elevatum* Insam et Krieg. [Pl. I, f. 10]

L: 24–27 μm , W: 18.5 μm , I: 6.8 μm ; No. SH 200016.

Semi cells elongate to trapeziform with narrow linear apices, sinus linear with deep constriction.

C. scabratum West. [Pl. II, f. 1]

L: 18–20 μm , W: 10 μm , I: 2.5 μm ; Nos. SH 2000125, SH 2000112.

Semi cells ovate to trapeziform with narrow linear apices, cell wall thin and smooth.

C. speciosum Ralfs var. *simplex* f. *intermedi*
[Pl. II, f. 12]

L: 45.8 μm , W: 34.2 μm , I: 15 μm ; Nos. SH 2000125, SH 2000131, SH 2000192.

Semi cells sub rectangular or sub pyramidate, margin with 5 apical 7 lateral crenations, median portion without vertical series of granules.

C. subcrenatum Hantz. [Pl. II, f. 2]

L: 30 μm , W: 24 μm , I: 10.5 μm ; Nos. SH 200042, SH 2000114.

Semi cells trapeziform with narrow linear apices, sinus linear with deep constriction, cell wall thin and smooth.

C. subtumidum Nordst f. *minor* Prasad et Mehrotra [Pl. I, f. 3]

L: 26.52 μm , W: 22.58 μm , I: 7.2 μm ; No. SH 200033.

Semi cells truncate with rounded apices, chloroplast axile, single pyrenoid in each semi cell situated centrally.

C. venustum (Breb.) Arch [Pl. I, f. 11]

L: 32.5 μm , W: 18.25 μm , I: 7.8 μm ; No. SH 200014.

Semi cells longer than broad with deep constriction, cells hexagonal with undulate margin, chloroplast axile with two pyrenoids in each semi cell.

Euastrum Ehr.

E. anglolense (W. West et G. S. West) Krieg. var. *brasiliense* Krieg. [Pl. I, f. 13]

L: 18–20 μm , W: 14–16.2 μm , I: 3–4 μm ; No. SH 200071.

Semi cells bilobed, apical lobe quadrangular with rounded angles, apex with prominent incision, cell wall smooth.

E. binale (Turp.) Ehr. ex Ralfs [Pl. I, f. 7]

L: 17–18.2 μm , W: 10–12.5 μm , I: 2.5–3 μm ; No. SH 200016.

Semicells truncate, quadrate and compressed.

E. gyanum De Toni [Pl. I, f. 14]

L: 15–18 μm , W: 8–10 μm , I: 4–5 μm ; No. SH 2001192.

Semi cells quadrate, apex with deep apical notch, outer margins 4 lobed, cell wall small protuberances at the constriction.

E. insulare (Witt.) Roy [Pl. I, f. 21]

L: 27–28.5 μm , W: 15–16 μm , I: 5 μm ; No. SH 2000106.

Semicells truncate with trapeziform structure, cell wall punctate without protuberances.

E. sinosum Linorm ex Arch. [Pl. I, f. 9]

L: 48–50 μm , W: 24–25 μm , I: 8–10 μm ; No. SH 2000106.

Sinus narrowly linear with 3 lobed semi cells, polar lobes quadrate, oblong with deep median incision.

E. sublobatum Breb. var. *dessimile* (Nordst.)

W. West et G. S. West [Pl. I, f. 20]

L: 30–32 μm , W: 22–24 μm , I: 10–12 μm ; No. SH 200066.

Semi cells truncate with 2 lobed outer margin deeply constricted with linear sinus.

E. sublobatum Breb. var. *sumartranum* Scott et

Prescott [Pl. I, f. 8]

L: 18–20.5 μm , W: 10–12.5 μm , I: 5 μm ; No. SH 200064.

Semi cells bilobed with rounded angular apices having deep apical notch, cell wall smooth without protuberances.

Penium Breb.

P. cucurbitum Biss. [Pl. I, f. 19]

L: 30–32 μm , W: 14–15 μm ; No. SH 2001188.

Semicells long as broad, pyramidate and scrobilate with rounded apices.

P. cucurbitum Biss. var. *subpolymorphum* W.

West et G. S. West [Pl. I, f. 26]

L: 42–44.5 μm , W: 25–26.5 μm ; No. SH

200031.

Cells sub-cylindrical, constricted in the middle, apices broadly rounded, cell wall minutely punctuate.

The following species are first reports from India: *C. crenatum*, *C. retusiformae* var. *elevatum*, *C. venustum*, *C. laeve*, *C. caelatum* var. *caelatum*, *C. furcatospermum* var. *maius*, *C. pseudopyramidatum* var. *carnicolicum*, *C. raeticum* var. *raeticum*, *C. quadratum*, *C. quadrifarium* f. *hexastichum*.

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Plate I

- Fig. 1. *Cosmarium angulosum* Breb. var. *concinnum* (Rao.) W. West et G. S. West.
 2. *C. raeticum* Messik var. *raeticum*.
 3. *C. subtumidum* Nordst f. *minor* Prasad et Mehrotra.
 4. *C. humile* (Gay.) Nordst var. *lucknowense* Prasad et Mehrotra.
 5. *C. perfissum* West.
 6. *C. furcatospermum* W. West et G. S. West var. *maius*.
 7. *Euastrum binale* (Turp.) Ehr. ex Ralfs.
 8. *E. sublobatum* Breb. var. *sumartranum* Scott et Prescottt.
 9. *E. sinosum* Linorm ex Arch.
 10. *Cosmarium retusiformae* (Will.) Gutw. var. *elevatum* Insam et Krieg.
 11. *C. venustum* (Breb.) Arch.
 12. *C. moniliforme* (Turp.) Ralfs. var. *lamenticum* W. West et G. S. West.
 13. *Euastrum angloense* (W. West et G. S. West) Krieg. var. *brasiliense* Krieg.
 14. *E. gyanum* De Toni.
 15. *Cosmarium dorsitruncatum* (Nordst.) West var. *dorsitruncatum*.
 16. *C. pseudopyramidatum* Lund var. *carnolicum* Lutken.
 17. *C. circulare* Reinsch var. *messikomeri* Krie. et Gerloff.
 18. *C. laeve* Rab.
 19. *Penium cucurbitum* Biss.
 20. *Euastrum sublobatum* Breb. var. *dessimile* (Nordst.) W. West et G. S. West.
 21. *E. insulare* (Witt.) Roy.
 22. *Cosmarium pseudoconnatum* Nordst. var. *subconstrictum* Jao.
 23. *C. alatum* Kirch.
 24. *C. bipunctatum* Borg. var. *spinuliferum* Hegde.
 25. *C. decedense* (Rein.) Racib. var. *borgii*.
 26. *Penium cucurbitum* Biss. var. *subpolymorphum* W. West et G. S. West.
 27. *Cosmarium quadrifarium* Lund f. *hexastichum* (Lund.) Nordst.
 28. *C. pseudopyramidatum* Lund.

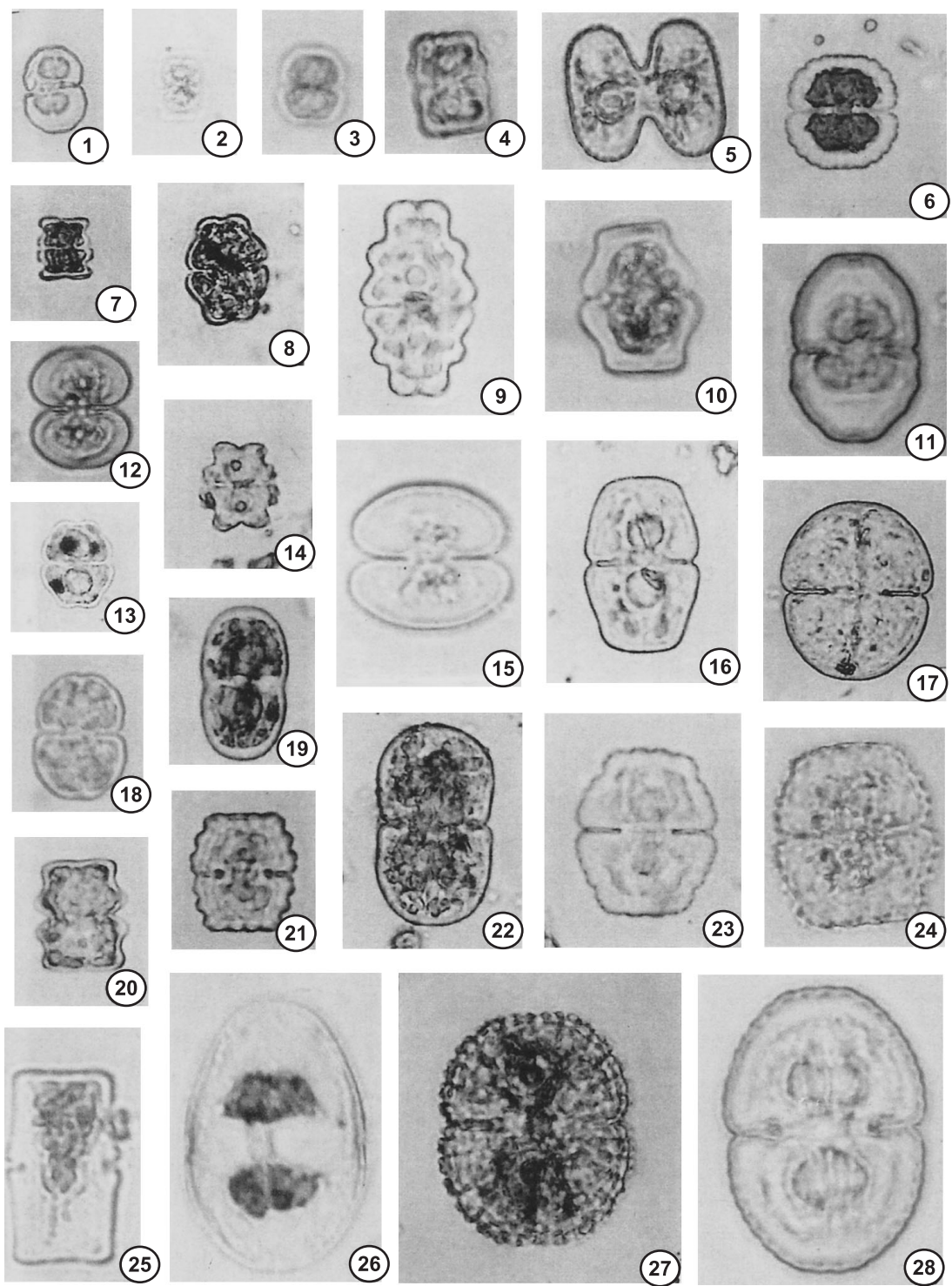


Plate II

- Fig. 1. *Cosmarium scabratum* West.
2. *C. subcrenatum* Hantz.
3. *C. cyclicum* Lund var. *nordstedtianum* (Reinsch.) West.
4. *C. punctulatum* Breb.
5. *C. quadratum* Ralfs.
6. *C. depressum* (Nag.) Lund.
7. *C. laponicum* Bory.
8. *C. nitidulum* De Not.
9. *C. lundellii* Delp var. *subellipticum* Prasad et Mehrotra.
10. *C. bipunctatum* Borges var. *spinuliferum* Hegde.
11. *C. candianum* Delp var. *depressum* Croasd.
12. *C. speciosum* Ralfs var. *simplex* f. *intermedia*.

