

# DESMID FLORA OF SIKKIM--I

BRAJ NANDAN PRASAD & RAMA MISRA

*Department of Botany, University of Lucknow, Lucknow 226 007*

## Abstract

The paper describes for the first time 18 taxa of desmids from the Sikkim State. Six taxa belonging to three genera, viz., *Closterium* Nitz., *Cosmarium* Corda and *Staurastrum* Meyen are new additions to the algal flora of India.

## Introduction

Algae of eastern Himalayas have received very little attention (Prasad & Mehrotra, 1977 ; Sarma & Khan, 1980). Only a few taxa have been recorded from Sikkim State (Rao, 1963 ; Srinivasan, 1965).

Collections of algae were made from various places in Sikkim, chiefly in and around Gangtok during May, 1984 (Text-fig. 1). This has yielded a rich variety of algae and it is intended to describe them group-wise in a series of papers. The present communication deals with some of the desmid taxa which have not been recorded from this part of eastern Himalayas. In the present paper, 18 taxa of desmids are being described of which one taxon belongs to the family Mesotaeniaceae and 17 belong to the Desmidiaceae. The genera are (no. of taxa of each indicated within brackets) : *Cylindrocystis* Meneghini (1), *Penium* Brebisson (1), *Closterium* Nitzosch (5), *Cosmarium* Corda (10), and *Staurastrum* Meyen (1). As no work has been done on the algae of the Sikkim State, all these desmids are new records for the area. Six taxa, viz., *Closterium eboracense* (Ehr.) Turner, *Cosmarium bipunctatum* Bory forma *subrectangularis* West & West, *Cosmarium botrytis* Menegh. var. *mediolaeve* West, *Cosmarium majae* Strom., *Cosmarium quadratum* Ralfs var. *willei* (Schmidle) Krieger et Gerloff, *Staurastrum subpygmeaym* West var. *sub-angulatum* W. & G. S. West—are new additions to the algal flora of India.

## Systematic Description

The arrangement of genera is after Scott & Prescott (1961), while taxa under each genus are enumerated alphabetically.

Family—Mesotaeniaceae

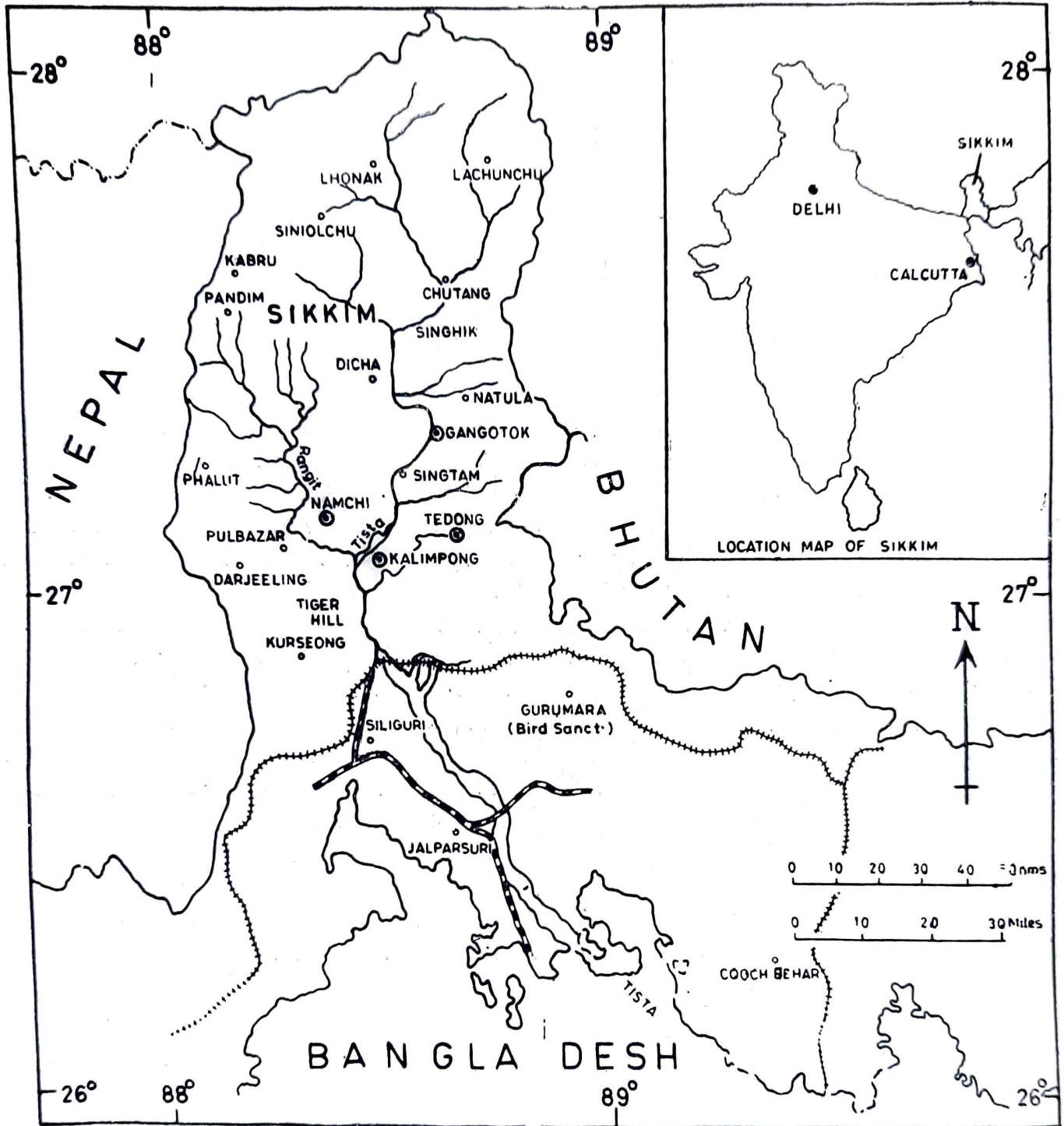
Genus—*CYLINDROCYSTIS* Meneghini, 1838

*Cylindrocystis crassa* De Bary ; Fig. 4

Krieger, W. 1937, p. 211, pl. 6, figs 16-17 ; Croasdale, H. 1965, p. 305, pl. 1, figs. 9-12.

Cell broadly elliptical 1 1/2 to 2 times longer than broad, apices broadly rounded, chloroplast with numerous radiating processes, cell wall smooth. Long. cell 36-38  $\mu\text{m}$  ; lat. cell 21-31  $\mu\text{m}$ .

*Habitat*—Planktonic with other algae in a fresh-water ditch.



Map 1

*Locality*—Collection no. 1264 ; Gangtok (Sikkim).

*Distribution in India*—South India (Bharti & Pai, 1972).

Family—Desmidiaceae

Genus—*PENIUM* Brebisson, 1844

*Penium minutum* (Ralfs) Cleve var. *crassum* W. West ; Fig. 5

West, W. & West G. S. 1904, **I**, p. 105, pl. 10, figs. 11-13.

Cells 6-7 times longer than broad, stout with truncate apices, slightly inflated in the middle, chloroplast with distinct ridges and 4 pyrenoids in a row. Long. cell 135-137  $\mu\text{m}$  ; lat. cell 20  $\mu\text{m}$ .

*Habitat*—Planktonic with other algae in a fresh-water ditch.

*Locality*—Collection no. 1264, Gangtok (Sikkim).

*Distribution in India*—Andaman and Nicobar Islands (Prasad *et al.*, 1982).

Genus—*CLOSTERIUM* Nitzsch, 1817

*Closterium acerosum* (Schrank) Ehr. ; Fig. 13

West, W. and West, G. S. 1904, **1**, p. 146, pl. 15, figs. 2-5.

Cells 12-13 times longer than broad, very slightly curved, with  $10^{\circ}$ - $20^{\circ}$  arc. inner margin almost straight or slightly convex, semi-cells gradually tapering towards the apices, which are narrow and rounded-truncate; chloroplast with 5 ridges and 7 pyrenoids arranged in a row. Long. cell 220  $\mu\text{m}$  ; lat. cell 18  $\mu\text{m}$  ; lat. apex 4  $\mu\text{m}$ .

Present form is slightly narrower and shorter than West and West's British desmid but agrees with the specimen described by Forster (1982, p. 62, pl. 7, figs. 1-2).

*Habitat*—Planktonic with other algae in a fresh water ditch.

*Locality*—Collection no. 1264 ; Gangtok (Sikkim).

*Distribution in India*—Assam (Carter, 1926) ; Maharashtra (Dixit, 1937 ; Gonzalves & Joshi 1943 a, 1943b ; Kamat, 1975 ; Ashtekar & Kamat, 1979) ; Uttar Pradesh (Venkatraman, 1957 ; Lakshminarayana, 1963 ; Suxena 1960 ; Prasad, 1964-65 ; Rai & Kumar, 1976 ; Prasad & Mehrotra, 1977b ; Pandey & Pandey, 1980a) ; Gujarat (Kamat, 1962 ; Patel, 1969 ; Patel & Asokakumar, 1979) ; Delhi (M. Singh, 1966a) ; Punjab (M. Singh, 1966b) ; Andhra Pradesh (Suxena & Venkateswarlu, 1966a ; Venkateswarlu, 1976) ; Himachal Pradesh (Kamat, 1968b) ; Madhya Pradesh (Agarkar, 1969) ; Bihar (Nasar & Munshi, 1976) ; Karnataka (Bongale & Bharti, 1980b ; Bharti & Hegde, 1982 ; Somashekar, 1984).

4. *Closterium eboracense* (Ehr.) Turner ; Fig. 4

Krieger, 1937 pp. 282, pl. 17, fig. 4 ; Ruzicka, J. 1977, p. 137 pl. 14, figs. 1-2.

Cells of medium size, 4-5 times longer than broad sides slightly curved to almost straight, ends broadly rounded, inner end slightly curved ; chloroplast with 5-6 bands and 5 pyrenoids arranged in a row. Long. cell 197  $\mu\text{m}$  ; lat. cell 44.5  $\mu\text{m}$  ; lat. apex 9  $\mu\text{m}$ .

*Habitat*—Planktonic with other algae in a fresh water drain.

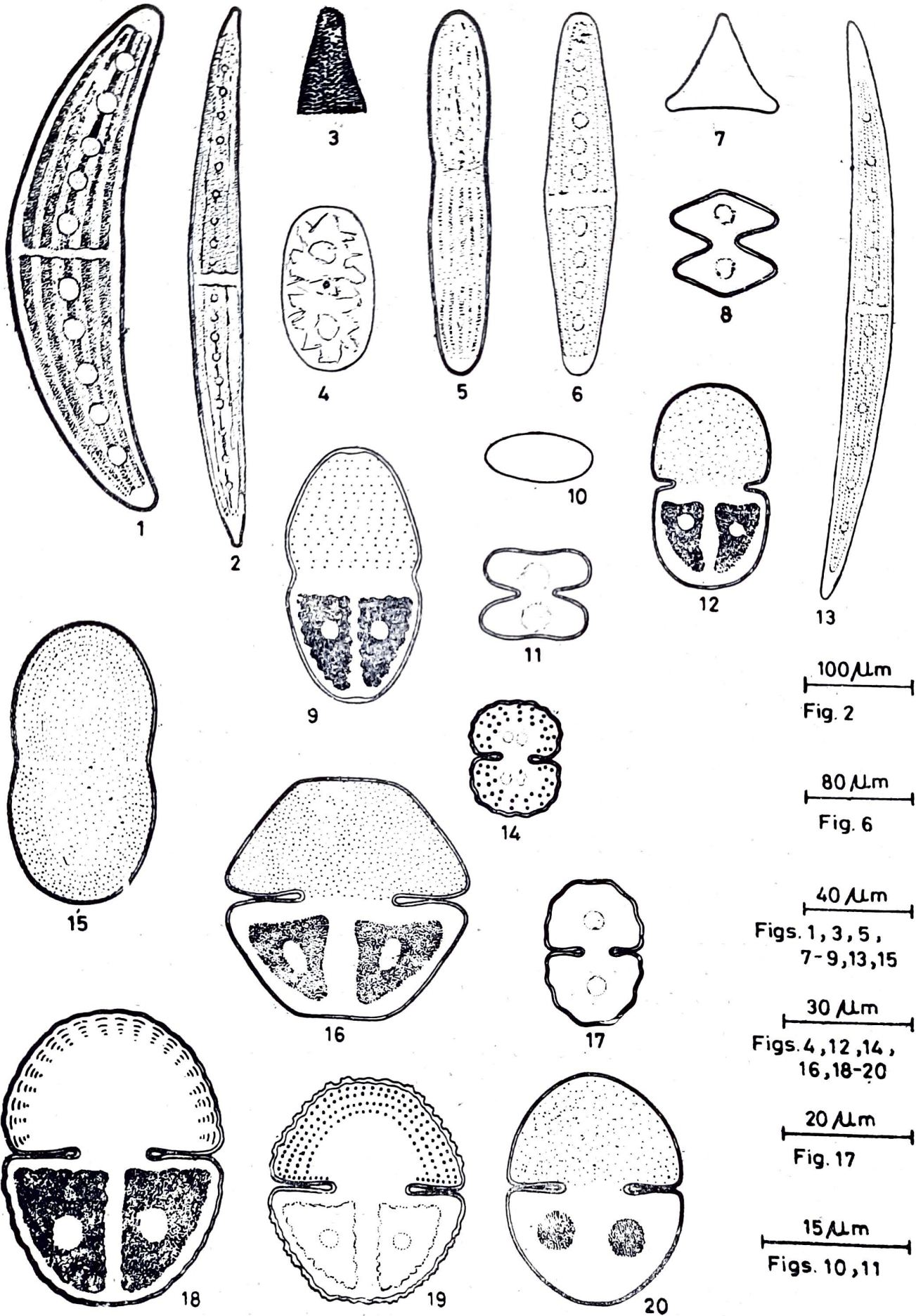
*Locality*—Collection no. 1230 ; Gangtok (Sikkim).

*Distribution in India*—The alga is being reported from India for the first time.

5. *Closterium libellula* Focke var. *intermedium* (Roy *et Biss.*) G. S. West ; Fig. 6

Krieger, 1937, p. 254, pl. 12, figs 3-5 ; Scott, A. M. Grönblad and Croasdale, H. 1965, p. 21, pl. 1, fig. 8.

Cells of medium size, 5 times longer than broad spindle-shaped, more or less straight with both the margins moderately convex ; cell gradually attenuated from middle towards broadly rounded and subtruncate poles ; Cell wall smooth ; chloroplast with 5-6 ridges



100 μm  
Fig. 2

80 μm  
Fig. 6

40 μm  
Figs. 1, 3, 5, 7-9, 13, 15

30 μm  
Figs. 4, 12, 14, 16, 18-20

20 μm  
Fig. 17

15 μm  
Figs. 10, 11

Text-figs. 1-20

and 9-10 pyrenoids arranged in a row. Long. cell 257-278  $\mu\text{m}$  ; lat. cell 51-56  $\mu\text{m}$  ; lat. apex 21-23  $\mu\text{m}$ .

*Habitat*—Planktonic with other algae in a fresh water ditch.

*Locality*—Collection no. 1264 ; Gangtok (Sikkim).

*Distribution in India*—Assam (Carter, 1926) ; Andhra Pradesh (Suxena & Venkateshwarlu, 1966b) ; Madhya Pradesh (Agarkar, 1971 ; Agarkar & Agarker, 1973, 1977) ; Gujarat (Patel & Ashokakumar, 1979) ; Uttar Pradesh (Pandey & D. C. Pandey, 1980b) ; Karnataka and Goa (Bharti & Hegde), 1982).

#### 6. *Closterium moniliferum* (Bory) Ehr.

West, W. and West, G. S. 1904, **1**, p., 143, pl. 16, figs. 15, 16 ; Krieger, W. 1937, **13**(1), p. 289 pl. 18 figs 6, 7.

Cells of medium size, 5-6 times longer than broad, moderately curved, inner margin inflated in the middle, cell uniformly narrowed to obtusely rounded apices with smooth cell wall ; chloroplast with 4-5 ridges and 8-9 pyrenoids arranged in a median series. Long. cell—235-240  $\mu\text{m}$  ; lat. cell 40  $\mu\text{m}$  ; lat. apex 8-9  $\mu\text{m}$ .

*Habitat*—Planktonic with other algae in a fresh-water drain.

*Locality*—Collection no. 1230 ; Gangtok (Sikkim)

*Distribution in India*—Manipur (Bruehl & Biswas, 1296) ; Maharashtra (Gonzalves & Joshi, 1943b ; Kamat 1963a) ; West Bengal (Kachroo, 1959b ; Pal & Santra, 1984) ; Gujarat (Kamat, 1962 ; Patel & Asokakumar, 1979) ; Kashmir (Suxena & Venkateswarlu, 1968c) ; Madhya Pradesh (Agarkar, 1969 as *C. monilifer* (Bory) Ehr. ; Patel & Satyanarayana, 1976) ; Uttar Pradesh (V. P. Singh & P. N. Saxena, 1969 ; V. P. Singh *et al.*, 1970 ; Kamat, 1973 ; Shukla, 1971 ; Prasad & Mehrotra, 1977b Lucknow ; Pandey & Pandey, 1980a ; Sashikala & Sarma, 1985) ; Ladak (Mir & Suri, 1975) ; Rajasthan (Patel & Rao, 1975) ; Western Himalayas (Suxena, 1979) ; Karnataka (Gurdeva *et al.*, 1963 ; Someshkar, 1984).

#### 7. *Closterium pritichardianum* Arch. ; Figs. 2, 3.

West, W. & West, G. S. 1904, **1**, p. 172, pl. 22, figs. 6-14 ; Krieger, W. 1937, **13**(1), p. 321, pl. 25, figs. 1-4.

Cells of medium size or large, faintly curved to more or less straight, 11-12 times longer than broad, outer margin 24-40 degree of arc, inner margin straight or slightly concave, cell gradually attenuated to narrow, truncate and faintly recurved apices ; cell wall striated ; chloroplast with 5-7 ridges and 6-8 pyrenoids arranged in a row. Long. cell 510-514  $\mu\text{m}$  ; lat. cell 43-46  $\mu\text{m}$  ; lat. apex 10  $\mu\text{m}$ .

Figs. 1-20—**1**, *Closterium eboracense* (Ehr) Turner ; **2,3**, *Closterium pritichardianum* Arch ; **4**, *Cylindrocystis crassa* De Bary ; **5**, *Penium minutum* (Ralfs.) Cleve var. *crassum* W. West ; **6**, *Closterium libellula* Focke var. *intermedium* (Roy *et* Biswas) G. W. West ; **7,8**, *Staurastrum subpygmaeum* West var. *subangulatum* W. & G. S. West ; **9**, *Cosmarium cucurbitinum* (Biss.) Lutkem ; **10, 11**, *Cosmarium majae* Strom ; **12**, *Cosmarium quadratum* Ralfs var. *Willei* (Schmidle) Krieger *et* Gerloff ; **13**, *Closterium acerosum* (Schrank) Ehr ; **14**, *Cosmarium bipunctatum* Bory forma *subrectangularis* West & West ; **15**, *Cosmarium subturgidum* (Turn.) Schmidle ; **16**, *Cosmarium lundelli* Delp. ; **17**, *Cosmarium dubium* Borge ; **18**, *Cosmarium botrytis* Menegb. var. *mediolacere* West ; **19**, *Cosmarium diatomprotupsum* West & West ; **20**, *Cosmarium circulare* Reinsch var. *messikommeri* Krieger *et* Gerloff.

*Habitat*—Planktonic with other algae in a fresh water ditch.

*Locality*—Collection no. 1264 ; Gangtok (Sikkim).

*Distribution in India*—Andhra Pradesh (Suxena & Venkateswarlu, 1966a, 1966b) ; Madhya Pradesh (Agarkar, 1971) ; Karnataka and Goa (Bharati & Hegde, 1982).

Genus—*COSMARIUM* Corda, 1834

8. *Cosmarium botrytis* Menegh. var. *mediolaeve* West. ; Fig. 18.

West, W. & West, G. S. 1912, 4, p. 6, pl. 97, fig. 5 ; Irene Marie, F. 1952, 4 (1-2) p. 105, pl. 10, fig. 12.

Cells rather large, about 1 1/3 times longer than broad, deeply constricted, sinus narrowly linear, semi-cell with a smooth and faintly concave apex, granules arranged in radiating and concentric series gradually becoming smaller towards the centre of the semi-cell, central portion smooth, each semicell with two axile chloroplast, each containing one pyrenoid. Long. cell 72-74  $\mu\text{m}$  ; lat. cell 52  $\mu\text{m}$  ; lat isthmus 47  $\mu\text{m}$ .

*Habitat*—On damp rocks.

*Locality*—Collection no. 1328 ; Gangtok (Sikkim).

*Distribution in India*—The alga is being recorded for the first time from India.

9. *Cosmarium bipunctatum* Bory forma *subrectangularis* West & West. ; Fig. 14

West, W. & West, G. S. 1908, 3, p. 214, p. 85, fig. 7.

Cells small somewhat rectangular, almost as long as broad, deeply constricted, sinus narrowly linear with a very slightly dilated extremity ; semicells subrectangular, basal and apical angles round, sides convex, apex widely truncate, margins undulate-crenate showing 12-14 crenations on periphery, each semi-cell with 3 irregular series of small granules within the margin and 2 large granules in the centre. Long. cell 22  $\mu\text{m}$  ; lat. cell 21  $\mu\text{m}$  ; lat. isthmus 6  $\mu\text{m}$ .

*Habitat*—Planktonic with other algae in a fresh water channel.

*Locality*—Collection no. 1230 ; Gangtok (Sikkim).

*Distribution in India*—This constitutes a new record for India.

10. *Cosmarium circulare* Reinsch var. *messikommeri* Krieger et Gerloff ; Fig. 20

Krieger, W. 1923, 11, p. 178, pl. 9, fig. 21 ; Scott, A. M. and Prescott, G. W. 1961, 17 (1-2) p. 60, pl. 25, fig. 7 as *C. lundellii* Delp. var. *circulare* Reinsch.

Cells of medium size, semicells more or less semicircular, sinus narrowly linear and close, cell-wall punctate, chloroplast axile with two pyrenoids in each semi-cell. Long. cell 56-58  $\mu\text{m}$ , lat. cell 43  $\mu\text{m}$  ; lat. isthmus 12-14  $\mu\text{m}$ .

*Habitat*—On damp rocks.

*Locality*—Collection no. 1328 ; Singtam (Sikkim)

*Distribution in India*—Reported from the following places as *C. lundelli* var. *circulare* (Reinsch) Kr.

Manipur (Bruehl & Biswas, 1926 as *C. circulare*), Karnataka (Bharti, 1966 ; Bongale & Bharti, 1980a ; Bharti & Pai, 1982 ; Gurdeva et al., 1983 ; Somashekar, 1984) ; Maharashtra (Kamat, 1975).

11. *Cosmarium cucurbitinum* (Biss.) Lutkem. var. *subpolymorphum* (Nordst.) Lutkem. Fig. 9.

Scot, A. M., Gronblad, R. and Croasdale, H. 1965, **69**, p. 43, pl. 7, fig. 106; Krieger W. and Gerloff, J. 1969, **3**, p. 373, pl. 64, fig. 4.

Cells of medium size, 1.7 times longer than broad, moderately constricted, isthmus broad, semi-cells sub-elliptical with slightly narrowed and rounded apex, cell wall minutely punctate, Chloroplast axile with two pyrenoids in each semi-cell.

Long. cell 96  $\mu\text{m}$  ; lat. cell 52  $\mu\text{m}$ , lat. isthmus 47  $\mu\text{m}$ .

*Habitat*—On damp rocks.

*Locality*—Collection no. 1328 ; Singtam (Sikkim).

*Distribution in India*—Madhya Pradesh (Agarkar, 1971) ; Uttar Pradesh (Pandey & Pandey, 1980b).

12. *Cosmarium didymoprotupsum* W. & G. S. West. ; Fig. 19

West, W. & West, G. S. 1908, **3**, p. 192, pl. 88, fig. 8 ; Forster, K. 1982, p. 198, pl. 36, fig. 11.

Cells of medium size, a little longer than broad, very deeply constricted, sinus narrowly linear with a dilated extremity, semicells broadly truncate pyramdate, basal angles broadly rounded and granulate, apex truncate and straight ; cell wall within the margin densely granulate, granules reduced towards the centre of the semicell ; Chloroplast axile with two pyrenoids in each semicell.

Long. cell 53-59  $\mu\text{m}$  ; lat. cell 48  $\mu\text{m}$  ; lat. isthmus 15  $\mu\text{m}$ .

*Habitat*—On damp rocks.

*Locality*—Collection no. 1287 ; Gangtok (Sikkim).

*Distribution in India*—It is a new record for India.

13. *Cosmarium dubium* Borge ; Fig. 17

Soctt, A. M. & Prescott, G. W. 1961 , p. 58, pl. 32, fig. 3.

Cells small, 1.5 times longer than broad, broadly elliptic, deeply constricted, sinus narrow and linear semi-cells subelliptic, basal angles rounded, apex slightly flattened, margin of each semi-cell with 8-9 undulations ; cell wall smooth with a protuberance in the centre of semi-cell. Long. cell 23.5-26  $\mu\text{m}$  ; lat. cell 16-18  $\mu\text{m}$  ; lat. isthmus 5-6  $\mu\text{m}$ .

*Habitat*—On damp rocks.

*Locality*—Collection no. 1328 ; Singtam (Sikkim).

*Distribution in India*—This report is a new record for India.

14. *Cosmarium lundelli* Delp. ; Fig. 16

West, W. & West, G. S. 1905, **2**, p. 138, pl. 57, figs. 1,2 ; Scott., A. M. & Prescott, G. W. 1961, **17** (1-2), p. 60, pl. 23, fig. 6.

Cells of medium size, a little longer than broad, deeply constricted, sinus linear and open ; semi-cells sub-semicircular to sub-pyramdate, basal angles rounded ; cell wall coarsely punctate ; chloroplast axile with two pyrenoids in each semi-cell. Long. cell 59  $\mu\text{m}$  ; lat. cell 58  $\mu\text{m}$  ; lat. isthmus 19  $\mu\text{m}$ .

*Habitat*—On damp rocks.

*Locality*—Collection no. 1328 ; Singtam (Sikkim).

*Distribution in India*—Bengal (Turner, 1892 as *S. subcirculare* Turner) ; Maharashtra (Gonzalves & Joshi, 1943a ; Kamat, 1963a) ; Andhra Pradesh (Suxena & Venkateshwarlu, 1966a) ; Madhya Pradesh (Patel & Satyanarayan, 1976) ; Kerala (Patel & George, 1977) ; Uttar Pradesh (Pandey & Pandey, 1980a) ; Karnataka (Somashekar, 1984).

15. *Cosmarium majae* Strom. ; Figs. 10, 11

Krieger, W. & Gerloff, J. 1969, p. 312, pl. 49, figs. 9 a-c.

Cells small, somewhat broad, dumb-bell-shaped, slightly broader than long, sinus narrow at apex and widening outwards ; semi-cells with convex sides, apices retuse ; cell wall minutely punctate, each semi-cell with an axile chloroplast containing a large pyrenoid in the centre. Long. cell 9-11  $\mu\text{m}$  ; lat. cell 11-5-13  $\mu\text{m}$  ; lat. isthmus 3.5-4  $\mu\text{m}$ .

*Habitat*—On damp rocks.

*Locality*—Collection no. 1328 ; Singtam (Sikkim).

*Distribution in India*—The alga is being reported from India for the first time.

16. *Cosmarium quadratum* Ralfs. var. *willei* (Schmidle) Krieger et Gerloff ; Fig. 12.

Krieger, W. & Gerloff, J. 1969, p. 280, pl. 46, figs. 5,6 ; West, W. & West, G. S. 1908, p. 59, pl. 87, figs. 21-22.

Cells of medium size, almost two times longer than broad, sinus narrow at the apex but somewhat open towards the exterior ; semi-cells subsquare, slightly narrow upwards, basal angles rounded, sides of semi-cells straight ; chloroplast axile with two pyrenoids in each semi-cell. Long. cell 50  $\mu\text{m}$  ; lat. cell 28-28.5  $\mu\text{m}$  ; lat. isthmus 27-28  $\mu\text{m}$ .

*Habitat*—Planktonic with other algae in fresh water drain.

*Locality*—Collection no. 1230 ; Gangtok (Sikkim).

*Distribution in India*—This constitutes a new addition for Indian flora.

17. *Cosmarium subturgidum* (Turn.) Schmidle , Fig. 15

West, W. & West, G. S. 1908, 3, p. 116, pl. 75, fig. 5.

Cells large, about twice as long as broad, slightly constricted, sinus a shallow depression ; semi-cells widely ovate from a broad base, apex sub-truncately rounded, cell wall somewhat sparsely punctate, vartical view circular.

Long. cell 105  $\mu\text{m}$  ; lat. cell 53  $\mu\text{m}$  ; lat. isthmus 46-47  $\mu\text{m}$ .

*Habitat*—On damp rocks.

*Locality*—Collection no. 1328 ; Singtam (Sikkim).

*Distribution in India*—Maharashtra (Kamat, 1980a).

Genus—*STAURASTRUM* Meyon, 1829

18. *Staurastrum subpygmeum* West var. *subangulatum* W. & G. S. West ; Figs. 7, 8

West, W. & West, G. S. 1912, p. 163, pl. 124, fig. 1

Cells of medium size, about as long as broad, deeply constricted, sinus subrectangular with an acuminate extremity, semi-cells subrhomboid elliptic, angles less produced,



a thicker lateral margin and apex convex, vertical view triangular with convex sides ; cell wall punctuate. Long. cell 40-41  $\mu\text{m}$ , lat. cell. 40.5-43  $\mu\text{m}$ , l at isthmus 9.5  $\mu\text{m}$ .

*Habitat*—Planktonic with other algae in fresh water drain, Collection no. 1230.

*Locality*—Gangtok (Sikkim).

*Distribution in India*—This is a new record for India.

## Acknowledgements

The authors wish to acknowledge financial assistance from Department of Science and Technology, New Delhi, under project no. HCS/DST/997/80 entitled "Algal Flora of North India".

## References

- AGARKAR, D. S. (1969). Contribution to Desmids of Gwalior, Madhya Pradesh. *Phykos*, 8(1-2) : 1-10.
- AGARKAR, D. S. (1971). Contribution to Desmids of Gwalior, Madhya Pradesh (India) II. *Phykos*, 10(1-2) : 54-69.
- AGARKAR, D. S. & AGARKER, M. S. (1973). Contribution to the Desmids of Madhya Pradesh, India (Desmids from Vindhyan region). *Port. Acta Biol.*, 12(1-4) : 159-178 .
- AGARKAR, D. S. & AGARKER, M. S. (1977). Desmids from Pachmarhi, Madhya Pradesh, India. *Hydrobiologia*, 54(1) : 23-32.
- ASTHAKAR, P. V. & KAMAT, N. D. (1979). Additions to the Desmid flora of Marathwada, Maharashtra. *Phykos*, 18(1-2) : 45-50.
- BHARTI, S. G. (1966). A systematic survey of the Desmids of Bombay-Karnatak. Pt. II. *J. Karnatak Univ. Sci.*, 11 : 174-182.
- BHARTI, S. G. & HEGDE, G. R. (1982). Desmids of Karnatak State and Goa, Part I. *Phykos*, 21(1-2) : 143-149.
- BHARTI, S. G. & PAI, K. M. (1972). Some Desmids from Kodai Kanal Lake, S. India. *Phykos*, 2(1-2) : 27-36.
- BONGALE, U. D. & BHARTI, S. G. (1980a). Fresh water algae of Davanagere and Raichur of Karnataka State, India. *J. Bombay nat. Hist. Soc.*, 77 : 6-11.
- BONGALE, U. D. & BHARTI, S. G. (1980b). On the algal flora of cultivated soils of Karnataka State, India. *Phykos*, 19 : 95-109.
- BRUEHL, P. & BISWAS, K. (1926). Algae of the Loktak Lake. *Mem. Asiatic Soc., Bengal*, 8(5) : 257-316.
- CARTER, N. (1926). Fresh water algae from India. *Rec. bot. Surv. India*, 9(4) : 263-302 .
- CROASDALE, H. (1965). Desmids of Devon Island N. W. P. Canada. *Trans. Amer. Microsc. Soc.* 84(3) : 301-335.
- DIXIT, S. C. (1937). The Chlorophyceae of the Bombay Presidency India-I. *Proc. Indian Acad. Sci.*, 5(1) : 16-25.
- FORSTER, K. (1982). Das Phytoplankton des Subwasers systematik and Biologie, E. Schweizerbart. *Sche Vexlagsbuchhandlung Stuttgart*, 8(1) : 1-543.
- GONZALVES, E. A. & JOSHI D. B. (1943a). The algal flora of the temporary waters around Bombay, 1. An ecological study of algae in some rain water pools at Borivili. *J. Univ. Bombay*, 11 : 34-45.
- GONZALVES, E. A. & JOSHI, D. B. (1943b). The algal flora of the temporary waters around Bombay-2. A study of the algae in some rain water puddles near Jogeshwari. *J. Univ. Bombay*, 11 : 120-128.
- GURDEVA, M. R., AREKAL, GOVINDAPPA, D. & SOMASHKAR, R. K. (1983). Desmids flora of Savandurga, Karantaka. *Phykos*, 22(1-2) : 48-56.
- IRENÉE-MARIE, F. (1952). Contribution a la connaissance des Desmidees de la region du lac St. Jean. *Hydrobiologia*, 4(1-2) : 1-208.
- KACHROO, P. (1959a). Aquatic vegetation of Damodar Valley II. Further observations on Association of Aquatic vegetation with Anophelene Breeding within Damodar Eden canal area of West Bengal. *J. Asiatic Soc.* 1(4) : 299-324.
- KACHROO, P. (1959b). Aquatic vegetation of Damodar valley III. The Role and Bearing of Phytoplankton in nutrition of Anopheline larvae. *Proc. Symp. Algology* : 308-334.
- KAMAT, N. D. (1962). Chlorophyceae of Ahmedabad, India. *Hydrobiologia*, 20(3) : 248-279.
- KAMAT, N. D. (1963). The algae of Kolhapur, India. *Hydrobiologia*, 22(3-4) : 209-305.
- KAMAT, N. D. (1968). Algae of Simla. *J. Bombay nat. Hist. Soc.*, 65(1) : 271-277.
- KAMAT, N. D. (1975). Algae of Vidarbha, Maharashtra. *J. Bombay nat. Hist. Soc.*, 72(2) : 450-476.

- KRIEGER, W. (1937-1939). Die Desmidiaceen Europas mit Berücksichtigung der aussereuropäischen Arten RABENHORST'S KRYPTOLOGAMENFLORA, Von Deutschland, Österreich und der Schweiz **13**, Teil 1:1-712, 1937 ; Teil 2:1-117, 1939.
- KRIEGER, W. & GERLOFF, J. (1969). Die Gattung *Cosmarium* Lief 3-4; 241-410, 1969. J. Cramer, Weinheim, Lehre.
- LAKSHMINARAYANA, J. S. S. (1963). Algal Flora of Uttar Pradesh IV. Chlorophyceae : Conjugales, Siphonales and Charales. *Environ. Health*, **5** : 1-5.
- MIR A. M. & SURI, B. L. (1975). Phytoplankton of Ladakh, *Geobios.* **2**(6) : 199-200.
- NASAR, S.A. K. & MUNSHI, J.D. (1976). On the algal flora of some ponds of Bhagalpur, India. *Phykos* **15**(1-2) : 49-52.
- PAL, T. K. & SANTRA, S. C. (1984). New additions to the algal flora of Murshidabad, West Bengal. *Phykos*, **23**(1-2) : 139-141.
- PANDEY, U. C. & PANDEY, D. C. (1980a). Additions to the Algal Flora of Allahabad-III. Desmids. *Phykos*, **19**(1) : 71-81.
- PANDEY, P. E. & PANDEY, D. C. (1980b). Additions to the Algal Flora of Allahabad-V. Desmids. *Phykos*, **19**(2) : 161-170.
- PATEL, R. J. (1969). On Desmids of Gujarat. *J. Bombay nat. Hist. Soc.*, **66**(3) : 414-419.
- PATEL, R. J. & ASOKAKUMAR, C. K. (1979). Desmids of Gujarat, India-I. Genus *Closterium* Nitzsch. *Phykos*, **18**(1-2) : 111-124.
- PATEL, R. J., ISABELLA, P. K. & GEORGE, G. S. (1977). Desmids from Kadaplattom, Kottayam, District Kerala (India). *Cosmarium* Corda, *Staurastrum* Meyen and *Micrasterias* Agarhd. *Vidya J. Gujarat Univ.*, **20**(2) : 99-106.
- PATEL, R. J. AND SATYANARAYAN, K. (1976). Desmids of Pachmarhi (M. P.) India. *Vidya J. Gujarat Univ.* **19**(2) : 55-63.
- PRASAD, B. N. (1964-65). On the Algal-flora of river Varuna in Varanasi District. *J. sci. Res. Banaras Hindu Univ.* **15**(1) : 142-151.
- PRASAD, B. N. & MEHROTRA, R. K. (1977a). Algal floristics in India—A Resume. *Bull. bot. Surv. India.* **19** : 279-292.
- PRASAD, B. N. & MEHROTRA, R. K. (1977b). Desmids Flora of North Indian Paddy fields. *New Botanist*, **4**(1-4) : 49-74.
- PRASAD, B. N., MISRA, P.K. & MEHROTRA, R. K. 1982. Observations on some Desmids from Andaman Islands. *Jap. J. Phycol.* **30** : 297-302.
- RAI, L. C. & KUMAR, H. D. (1976). Systematic and ecological studies on Algae of some habitats polluted with fertilizer factory effluent. *Nova Hedwigia*, **22** : 805-811.
- RAO, R. S. (1963). A botanical tour in the Sikkim State Eastern Himalayas. *Bull bot. Surv. India*, **5** : 165-205.
- RUZICKA, J. (1937). Die Desmidiaceen Mitteleuropas. E. Schweizerbart Verlagsgesellschaft Stuttgart, **1**(1) : 1-291.
- SARMA, Y. S. R. K. & KHAN, M. (1980). 'Algal taxonomy in India. Today and Tomorrow's Printers and Publishers, New Delhi, 153 pp.
- SCOTT, A. M. GRONBLAD, R. & CROASDALE, H. (1965). Desmids from the Amazon Basin, Brazil, collected by Dr. H. Sioli. *Acta. bot. Fenn.*, **69** : 1-94.
- SCOTT, A. M. & PRESCOTT, C. W. (1961). Indonesian Desmids. *Hydrobiologia*, **17**(1-2) : 1-132.
- SHUKLA, A. C. (1971). Systematic description of Algae from Panki rice fields, India. *Rev. Algol n.s.*, **3** : 257-270.
- SINGH, M. (1966a). Planktonic algae from Nazafgarh Lake-II. *Res. Bull. Punjab. Univ.* **17** : 99-103.
- SINGH, M. (1966b). A list of Planktonic Green algae from Amritsar, Punjab. *J. Bombay nat. Hist. Soc.*, **63**(1) : 74-83.
- SINGH, V. P. & SAXENA, P. N. (1969). Preliminary studies on algal succession in raw and stabilized sewage. *Hydrobiologia*, **34**(3-4) : 503-512.
- SINGH, V. P., SAXENA, P. N., TEWARI, A. & KHAN, M. A. (1970). Studies on the seasonal variation of algal flora of sewage. *Phykos*, **9**(2) : 57-62.
- SOMASHEKAR, R. K. (1984). Contribution to the algal flora of river Kapila, Karnataka : Cyanophyceae and Chlorophyceae. *Phykos.*, **23**(1-2) : 116-124.
- SRINIVASAN, K. S. (1965). Algal species ex India : Oruindae. *Bull. bot. Surv. India*, **7** : 188-266.
- SUXENA, M. R. & VENKATESWARLU, V. (1966a). Desmids of Andhra Pradesh-I. From Pakhal Lake, Warangal. *Hydrobiologia*, **28**(1) : 49-69.
- SUXENA, M. R. & VENKATESWARLU, V. (1966b). Desmids of Andhra Pradesh III. *J. Osmania Univ. Sci.*, **3**(1-2) : 41-60.

- SUXENA, M. R. & VENKATESWARLU, V. (1968). Desmids from Kashmir. *Phykos*, **7**(1-2) : 165-185.
- SUXENA, M. R. & VENKATESWARLU, V. (1970). Desmids of Andhra Pradesh V. Mostly from Warangal and its environs. *Phykos*, **9**(1) : 17-28.
- TURNER, W. B. (1892). The fresh water algae of East India. *K. Svensk. VetenskAkad. Handl*, **25**(5) : 1-187.
- VENKATARAMAN, G. S. (1957). The algal flora of the ponds and puddles inside the Banaras Hindu University Grounds, India. *J. Bombay nat. Hist. Soc.* **54**(4) : 908-919.
- VENKATESWARLU, V. (1976). Taxonomy and ecology of Algae in the River Moosi. Hyderabad, India. *Nova Hedw.* **27** : 661-688.
- WEST, W. & WEST, G. S. (1904). A monograph of the British Desmidiaceae. *Ray Society, London*, **1** : 1-224.
- WEST, W. & WEST, G. S. (1908). A monograph of the British Desmidiaceae. *Ray Society, London*, **3** : 1-272.
- WEST, W. & WEST, G. S. (1912). A monograph of the British Desmidiaceae. *Ray Society, London*, **4** : 1-191.