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## The Desmid Flora of Kathmandu, Nepal

By

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**Abstract** The desmid flora from ten liquid samples were collected from rivers, ponds, lakes and ditches in Kathmandu, Nepal, includes 49 species, 5 varieties and 3 forms belonging to 10 genera. Among them, the following species were most frequently observed: *Closterium acerosum*, *C. leibleinii* var. *recurvatum*, *Cosmarium javanicum*, *C. obtusatum* and *C. subcostatum*.

### Introduction

On the desmid flora of the southern and southeastern part of Asia, considerable reports were presented by many authors such as ARCHER (1865), JOSHUA (1886), TURNER (1892), WEST & WEST (1897, 1902, 1907), GUTWINSKI (1902), BERNARD (1908), KRIEGER (1932), SKUJA (1937, 1949), SCOTT & PRESCOTT (1961), HIRANO (1963, 1984), WATANABE *et al.* (1979) and BANDO *et al.* (1982). Among the desmid flora reported by them many endemic species are contained. It is no doubt that this region is one of the most important areas as to the distribution and the origin of the desmids, and that the accumulation of accurate information on each desmid species is very useful. In the present study ten samples were collected from various areas of Kathmandu in Nepal, and fifty-seven taxa of desmids were identified. They are listed and illustrated with some taxonomical notes.

### Materials and Methods

The liquid samples examined in this study were collected around Kathmandu, Nepal, by the third author in 1968 and 1986. Some data on the samples are shown in

Table 1. Some data on the samples studied

Sample No.	Date	Sampling locality & habitat
52174	Apr. 16, 1968	A river of Pashupatinath
52184	Apr. 18, 1968	The Lotus Pond at Godawari Bot. Gard.
52210	Apr. 22, 1968	The Bishnumati River, near the Balaju Wat. Gard.
52276	May 18, 1968	A small pool, near Swayambhunath
52280	May 19, 1968	A small pool (A), near Boudhanath
52282	May 19, 1968	A small pool (B), near Boudhanath
53334	Sep. 4, 1986	The Lake Tau Daha
53335	Sep. 4, 1986	The same site of No. 53334
53368	Sep. 18, 1986	A ditch by the side of a ring road, 2 km north of Cabahil
53374	Sep. 18, 1986	The same site of No. 53368

Table 1. The specimens are deposited in the herbarium of Tsukuba Botanical Garden, National Science Museum (TNS).

At least 5 time observations of each liquid sample were done under a light microscope. The preparations examined were preserved by enclosing with Canada Balsam after the exchange of water for GFW solution (1 part glycerin, 1 part commercial formalin and 1 part water).

### Result and Discussion

The desmid flora known from the above-mentioned 10 liquid samples includes 49 species, 5 varieties and 3 formae belonging to 10 genera. Among them, the dominant genera were *Closterium* and *Cosmarium*. Furthermore, the following 5 species were rather abundantly observed: *Closterium acerosum*, *C. leibleinii* var. *recurvatum*, *Cosmarium javanicum*, *C. obtusatum* and *C. subcostatum*.

#### ENUMERATION OF SPECIES

##### Mesotaeniaceae

1. *Netrium digitus* (EHRENBERG ex RALFS) ITZIGSON et ROTHE var. *lamellosum* (BRÉBISSON) GRÖNBLAD (Fig. 1 a)

Cells cylindrical, gradually attenuated near somewhat truncated apices, about 5 times longer than broad. Long. 227  $\mu\text{m}$ ; lat. 47  $\mu\text{m}$ ; lat. apic. 20  $\mu\text{m}$ .

Specim. exam. 53374.

Only a single cell was observed. This is one of the most cosmopolitan varieties of *Netrium digitus*.

## Peniaceae

2. *Penium margaritaceum* (EHRENBERG) ex BRÉBISSON in RALFS (Fig. 1 b, c)

Cells straight, cylindrical or slightly tapering to somewhat truncately rounded apices, often slightly constricted in the middle, sometimes with girdle bands or pseudo-girdle bands, about 5 times longer than broad; cell wall yellowish- or reddish-brown and with granules more or less regularly arranged in longitudinal rows. Long. 114–140  $\mu\text{m}$ ; lat. 22–25  $\mu\text{m}$ .

Specim. exam. 52174.

## Closteriaceae

3. *Closterium acerosum* (SCHRANK) EHRENBERG ex RALFS var. *acerosum* (Fig. 3 a, b)

Cells large, 8–13 times longer than broad, slightly curved or almost straight, ventral margin almost straight, gradually tapering to somewhat recurved apices; cell wall colorless or brownish, almost smooth or delicately striate, sometimes rather finely striate, girdle bands or pseudo-girdle bands rarely present; chloroplast with 10–30 axial pyrenoids. Long. 350–540  $\mu\text{m}$ ; lat. 37–45  $\mu\text{m}$ ; lat. apic 5–6  $\mu\text{m}$ .

Specim. exam. 52174, 52184, 52280, 53368.

This species was most abundantly observed in the above four specimens examined. The color and striation of the wall, and cell size were considerably variable. Reddish-brown and very finely striated walls of some algae in present study were simulative *Closterium pritchardianum* (ARCHER, 1862).

4. *Closterium acerosum* (SCHRANK) EHRENBERG ex RALFS var. *borgei* KRIEGER (Fig. 3 c)

Cells large, about 9 times longer than broad, stouter than the typical, slightly curved or almost straight, gradually tapering to apical regions which are abruptly narrowed, conical and slightly concave on the dorsal margin; chloroplast with 7–11 pyrenoids. Long. 364  $\mu\text{m}$ ; lat. 39  $\mu\text{m}$ ; lat. apic. 7  $\mu\text{m}$ .

Specim. exam. 52174.

5. *Closterium acerosum* (SCHRANK) EHRENBERG ex RALFS var. *elongatum* BRÉBISSON (Fig. 3 d)

Cells 15–17 times longer than broad, rather longer than the typical, slightly curved, gradually tapering to somewhat conical and rounded-truncate apices, ventral margin slightly concave; cell wall colorless or brownish, almost smooth, sometimes obscurely striate, with girdle bands or pseudo-girdle bands; chloroplast with 20–30 pyrenoids. Long. 660–810  $\mu\text{m}$ ; lat. 45–48  $\mu\text{m}$ ; lat. apic. 6  $\mu\text{m}$ .

Specim. exam. 53374.

6. *Closterium diana* EHRENBERG ex RALFS var. *brevius* (PETKOFF) KRIEGER (Fig. 1 d)

Cells about 6 times longer than broad, stouter than the typical, moderately curved,

gradually attenuated to obtusely rounded apices; cell wall smooth, colorless, small inner thickening usually present at each apex; chloroplast with about 5 pyrenoids. Long. 115  $\mu\text{m}$ ; lat. 17.5  $\mu\text{m}$ ; lat. apic. 4  $\mu\text{m}$ .

Specim. exam. 52174.

7. *Closterium ehrenbergii* MENEGHINI ex RALFS (Fig. 2 b, c)

Cells very large, 5–7 times longer than broad, moderately curved, gradually attenuated to rounded and sometimes slightly recurved apices; wall almost smooth or delicately and intermittently striate, colorless or yellowish-brown in some older semi-cells; chloroplast with numerous scattered pyrenoids. Long. 267–440  $\mu\text{m}$ ; lat. 42–67  $\mu\text{m}$ ; lat. apic. 7–12  $\mu\text{m}$ .

Specim. exam. 53374.

A considerable variation in cell size was observed in the same liquid sample. Cell sizes of some smaller algae were included in the cell size range of *Closterium moniliferum* var. *submoniliferum* (KRIEGER, 1937, p. 292), but the pyrenoids of our specimens were not so few as in KRIEGER'S.

8. *Closterium incurvum* BRÉBISSON (Fig. 2 f, g)

Cells small, 5–6 times longer than broad, strongly curved, strongly tapering to acutely pointed apices, ventral margin not tumid; wall smooth and colorless; chloroplast with 2–4 axial pyrenoids. Long. 52–65  $\mu\text{m}$ ; lat. 9.5–11  $\mu\text{m}$ ; lat. apic. 1–1.5  $\mu\text{m}$ .

Specim. exam. 53334, 53374.

9. *Closterium intermedium* RALFS (Fig. 1 i)

Cells about 12 times longer than broad, slightly curved, almost straight in the midregion, gradually attenuated to somewhat swollen apices which are broadly truncate with rounded angles; wall yellowish-brown, striated, with 5–6 striae in 10  $\mu\text{m}$ , with girdle bands; chloroplast with 7–9 axial pyrenoids. Long. 280  $\mu\text{m}$ ; lat. 24  $\mu\text{m}$ ; lat. apic. 10  $\mu\text{m}$ .

Specim. exam. 52174.

Only one cell was observed.

10. *Closterium lanceolatum* KÜTZING ex RALFS (Fig. 3 e)

Cells about 7 times longer than broad, almost straight or somewhat curved, ventral margin straight or slightly convex, gradually tapered to rounded apices; cell wall smooth and colorless, small inner thickening often present at each pole; chloroplast with 6–13 axial pyrenoids. Long. 283–295  $\mu\text{m}$ ; lat. 37.5–42  $\mu\text{m}$ ; lat. apic. 5–6  $\mu\text{m}$ .

Specim. exam. 52281.

11. *Closterium leibleinii* KÜTZING ex RALFS var. *recurvatum* W. WEST et G. S. WEST (Fig. 1 g)

Cells about 7 times longer than broad, ventral margin strongly concave but almost

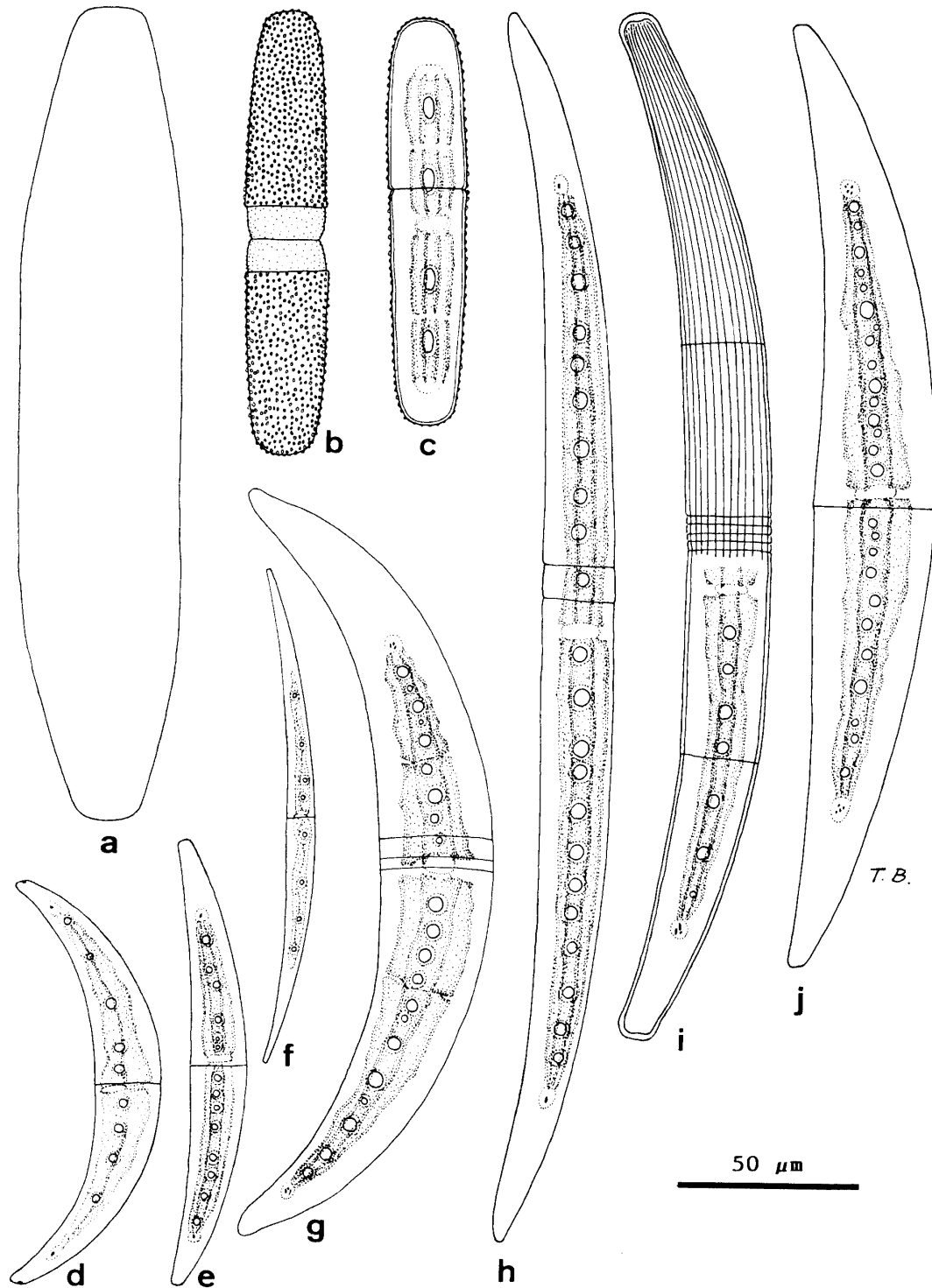


Fig. 1. a. *Netrium digitus* var. *lamellosum*. b, c. *Penium margaritaceum*. d. *Closterium diana* var. *brevius*. e. *Closterium tumidum* var. *tumidum*. f. *Closterium tumidum* var. *nylandicum*. g. *Closterium leibleinii* var. *recurvatum*. h. *Closterium praelongum* var. *brevius*. i. *Closterium intermedium*. j. *Closterium* cf. *sublaterale*.

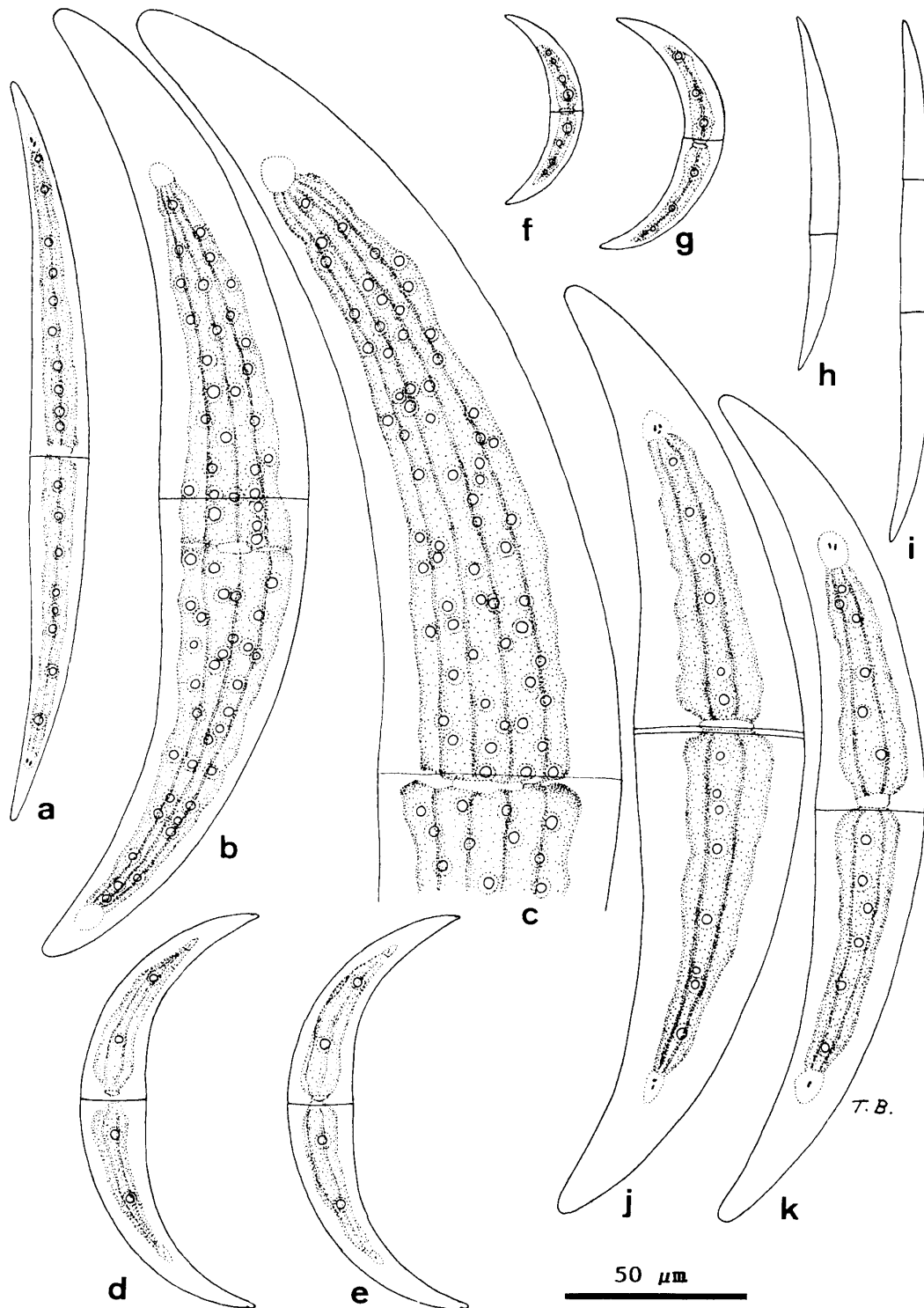


Fig. 2. a. *Closterium strigosum*. b, c. *Closterium ehrenbergii*. d, e. *Closterium tumidulum*. f, g. *Closterium incurvum*. h, i. *Closterium limneticum* var. *fallax*. j. *Closterium moniliferum* fo. *moniliferum*. k. *Closterium moniliferum* fo. *gracile*.

straight in the midregion, gradually attenuated to acutely rounded apices which are recurved; chloroplast with 4–12 axial pyrenoids. Long. 194–214  $\mu\text{m}$ ; lat. 29–31  $\mu\text{m}$ ; lat. apic. 4.5–6  $\mu\text{m}$ .

Specim. exam. 53374.

Many cells were observed. Our algae are somewhat more slender and slightly or not inflated in the midregion in comparison with the iconotype (W. WEST & G. S. WEST, 1907, pl. 13, f. 6). BORGE (1925) reported the four pyrenoids of this species. Our algae, however, have 4–12 pyrenoids in each semicell. FÖRSTER (1982) treated this taxa as a synonym of *C. moniliferum*.

12. *Closterium limneticum* LEMMERMANN var. *fallax* RŮŽIČKA (Fig. 2 h, i)

Cells 12–21 times longer than broad, almost straight in the midregion, slightly incurved, gradually narrowed to apices which are somewhat acute or acutely rounded; cell wall smooth, colorless or rarely yellowish-brown, sometimes with pseudo-girdle band. Long. 97–170  $\mu\text{m}$ ; lat. 7–9  $\mu\text{m}$ ; lat. apic. 1.5–2.0  $\mu\text{m}$ .

Specim. exam. 53374.

The pseudo-girdle band (RŮŽIČKA, 1962) was often observed in the typical variety (RŮŽIČKA, 1962; FÖRSTER, 1982). To the best of our knowledges, however, the pseudo-girdle band of var. *fallax* has never been reported.

13. *Closterium moniliferum* (BORY) EHRENBERG ex RALFS f. *moniliferum* (Fig. 2 j)

Cells medium-sized, rather stout, 5–6 times longer than broad, moderately curved, dorsal margin regularly curved and strongly convex, ventral margin distinctly inflated in the midregion, gradually attenuated to broadly rounded apices; wall smooth and colorless; chloroplast with 5–8 axial pyrenoids. Long. 260  $\mu\text{m}$ ; lat. 47  $\mu\text{m}$ ; lat. apic. 8–9  $\mu\text{m}$ .

Specim. exam. 52174.

In arrangement of pyrenoids, some intermediate forms between this and var. *submoniliferum* were observed. They had somewhat irregularly arranged pyrenoids.

14. *Closterium moniliferum* (BORY) EHRENBERG ex RALFS f. *gracile* FÖRSTER (Fig. 2 k)

Cells 7–8 times longer than broad, somewhat less curved and more slender than the typical. Long. 262–275  $\mu\text{m}$ ; lat. 29–36  $\mu\text{m}$ ; lat. apic. 6.5–7  $\mu\text{m}$ .

Specim. exam. 52276.

Many cells were observed in a sample (no. 52276). FÖRSTER (1982) treated this taxon as a synonym of the typical form (f. *moniliferum*).

15. *Closterium praelongum* BRÉBISSON var. *brevius* (NORDSTEDT) KRIEGER (Fig. 1 h)

Cells about 17 times longer than broad, slightly curved, almost straight in the midregion, gradually attenuated to the somewhat recurved apical region, apices rounded-truncate; wall colorless and smooth; chloroplast with 12–13 axial pyrenoids. Long. 310–350  $\mu\text{m}$ ; lat. 18–21  $\mu\text{m}$ ; lat. apic. 3–3.5  $\mu\text{m}$ .

Specim. exam. 53374.

16. *Closterium strigosum* BRÉBISSON (Fig. 2 a)

Cells 11–14 times longer than broad, slightly curved, almost straight in the mid-region, gradually attenuated to the incurved apical region, apices acutely rounded; wall smooth and colorless; chloroplast with 7–10 axial pyrenoids. Long. 170–206  $\mu\text{m}$ ; lat. 15  $\mu\text{m}$ ; lat. apic. 2–3  $\mu\text{m}$ .

Specim. exam. 52281.

17. *Closterium cf. sublaterale* RŮŽIČKA (Fig. 1 j)

Cells medium-sized, 6–9 times longer than broad, slightly or moderately bowed, dorsal margin evenly curved, ventral margin slightly inflated in the midregion, the apices obliquely truncately rounded; wall colorless or sometimes slightly yellowish in older semicell; chloroplast with 5–15 axial pyrenoids. Long. 242–295  $\mu\text{m}$ ; lat. 32–36  $\mu\text{m}$ ; lat. apic. 5–6  $\mu\text{m}$ .

Specim. exam. 52281.

Several cells were found in a sample (no. 52281). The number (5–15) of pyrenoids of them were much more numerous than that (4–8) of the original description (RŮŽIČKA, 1958). Furthermore, in this taxon, it seems that the existence of striation on the cell wall is one of the most important characters. However, any striation was not observed in our algae.

18. *Closterium tumidulum* GAY (Fig. 2 d, e)

Cells about 6 times longer than broad, strongly curved, ventral margin slightly tumid or nearly straight in the midregion, strongly attenuated to apices which are acute and on each outer side with a minute endopore; wall smooth and colorless; chloroplast with 2 pyrenoids. Long. 107–110  $\mu\text{m}$ ; lat. 17.5  $\mu\text{m}$ ; lat. apic. 1.5  $\mu\text{m}$ .

Specim. exam. 53334, 53335.

19. *Closterium tumidum* JOHNSON var. *tumidum* (Fig. 1 e)

Cells rather small, about 8 times longer than broad, slightly curved, dorsal margin evenly curved, ventral margin slightly tumid or nearly straight in the midregion, gradually attenuated the truncate apices; wall smooth and colorless; chloroplast with 4–7 axial pyrenoids. Long. 125  $\mu\text{m}$ ; lat. 15  $\mu\text{m}$ ; lat. apic. 4  $\mu\text{m}$ .

Specim. exam. 53374.

20. *Closterium tumidum* JOHNSON var. *nylandicum* GRÖNBLAD (Fig. 1 f)

Cells 15–18 times longer than broad, more slender than the typical, the apices truncately rounded; wall smooth and colorless; chloroplast with 3–5 pyrenoids. Long. 107–130  $\mu\text{m}$ ; lat. 7–7.5  $\mu\text{m}$ ; lat. apic. 1.5–2  $\mu\text{m}$ .

Specim. exam. 52276.

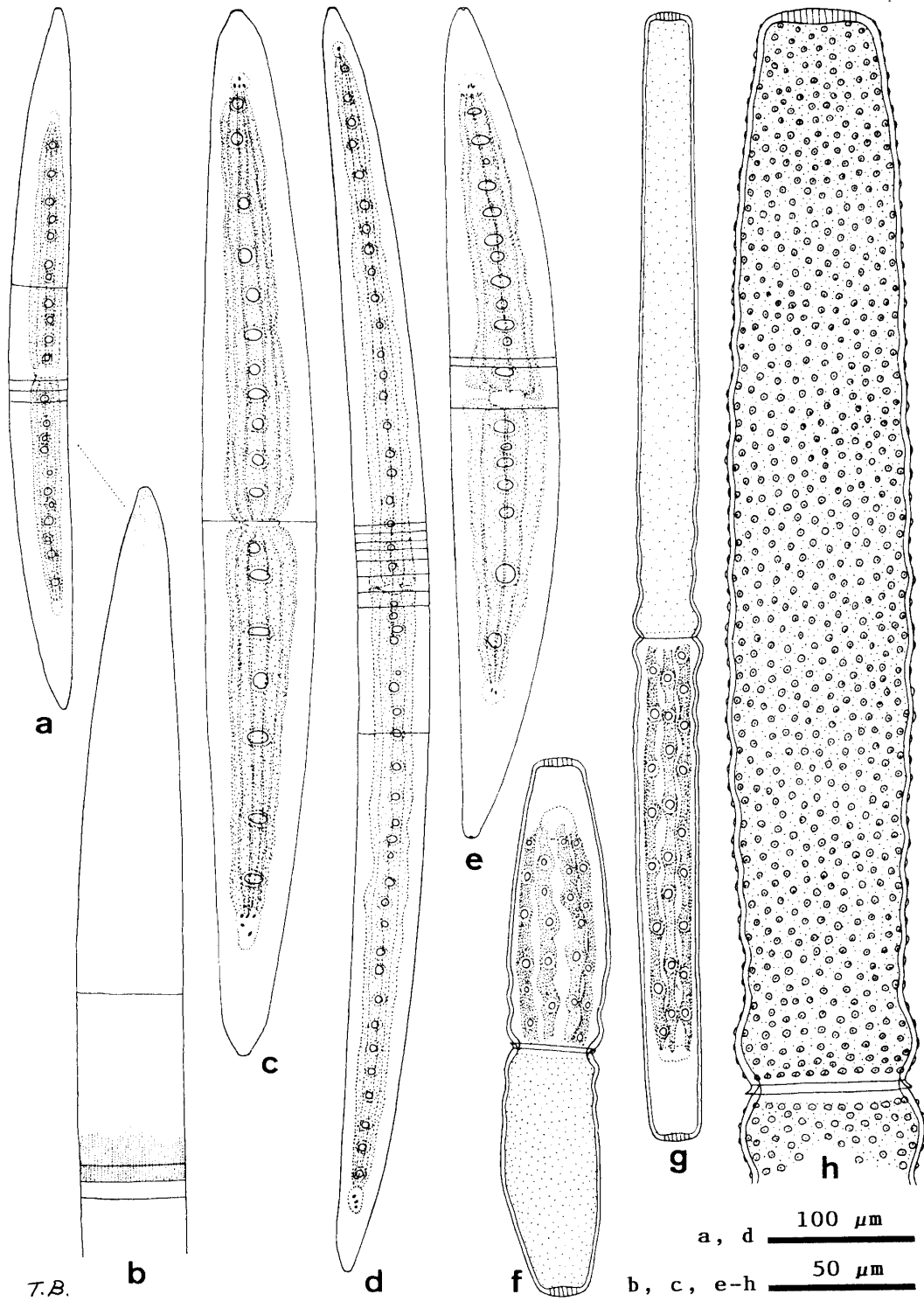


Fig. 3. a, b. *Closterium acerosum* var. *acerosum*. c. *Closterium acerosum* var. *borgei*. d. *Closterium acerosum* var. *elongatum*. e. *Closterium lanceolatum*. f. *Pleurotaenium trabecula* var. *crassum*. g. *Pleurotaenium baculoides*. h. *Pleurotaenium granuliferum*.

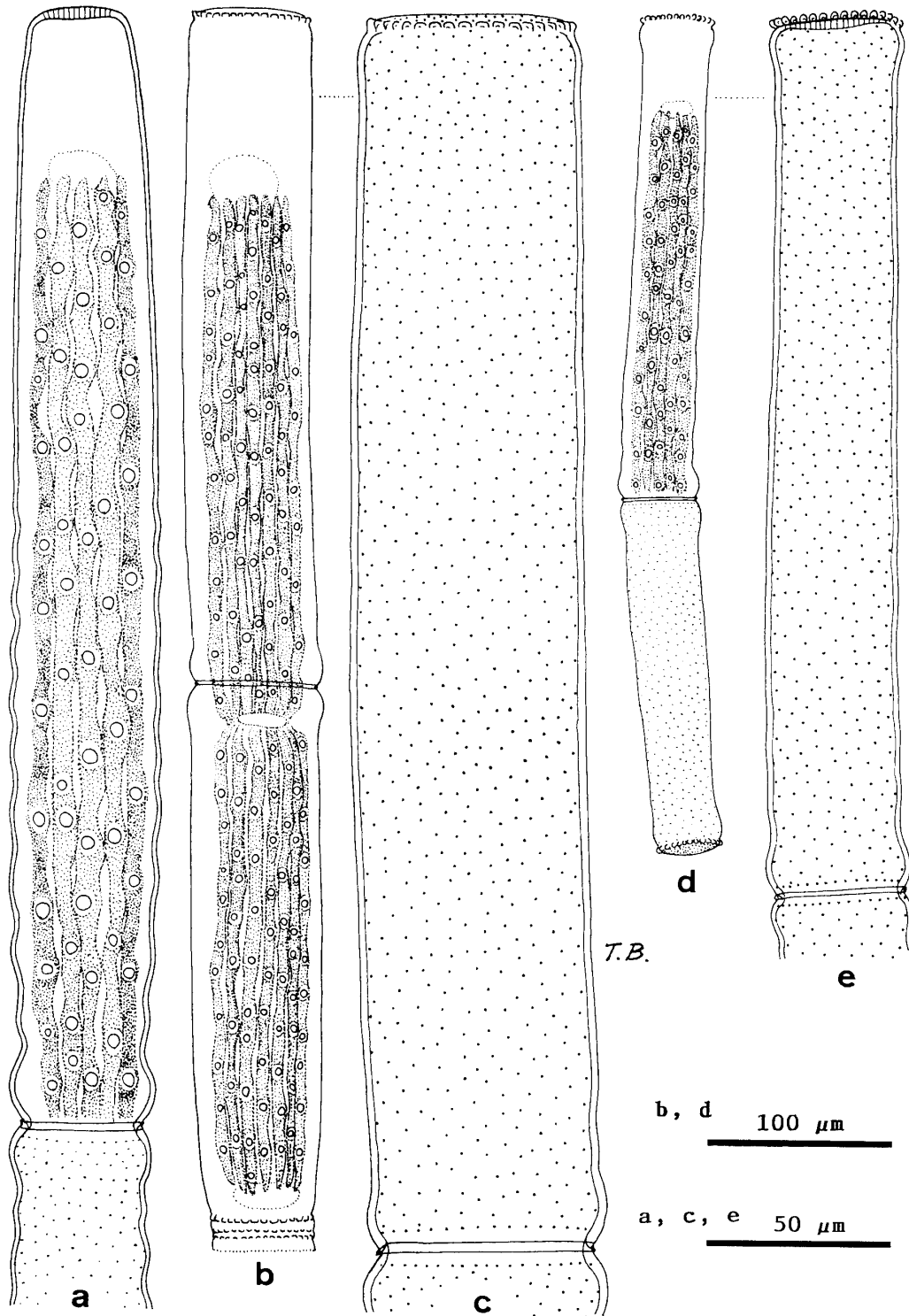


Fig. 4. a. *Pleurotaenium archeri*. b, c. *Pleurotaenium wallichianum*. d, e. *Pleurotaenium subcoronulatum*.

## Desmidiaceae

21. *Pleurotaenium archeri* DELPONTE (Fig. 4 a)

Cells rather large, 16–20 times longer than broad; semicells with a prominent basal inflation and with several accessory swellings above it, which are gradually diminishing in size to the midregion, without apical tubercles; chloroplasts 6–8 parietal bands. Long. 587–880  $\mu\text{m}$ ; lat. 40–45  $\mu\text{m}$ ; lat. apic. 27–28  $\mu\text{m}$ .

Specim. exam. 53368.

22. *Pleurotaenium baculoides* (ROY et BISSET) PLAYFAIR (Fig. 3 g)

Cells slender, 17–21 times longer than broad; semicells with a prominent basal inflation and with 1–4 small accessory swellings above it, without apical tubercles; chloroplasts 4 parietal bands. Long. 398–520  $\mu\text{m}$ ; lat. apic. 15  $\mu\text{m}$ .

Specim. exam. 53334, 53335.

23. *Pleurotaenium granuliferum* (JOSHUA) HIRANO (Fig. 3 h)

Cells large, stout, about 11 times longer than broad; semicells with a prominent basal inflation and 10 to 14 accessory swellings which are gradually diminishing to the apex, slightly tumid in the midregion, without apical tubercles; wall covered densely and evenly with pored granules. Long. 670  $\mu\text{m}$ ; lat. 62  $\mu\text{m}$ ; lat. itshm. 50  $\mu\text{m}$ ; lat. apic. 40  $\mu\text{m}$ .

Specim. exam. 53374.

Only one cell was observed in this study. It is somewhat smaller in cell size and has more numerous undulations than Japanese specimens of the same species (BANDO, 1988).

24. *Pleurotaenium subcoronulatum* (TURNER) W. WEST et G. S. WEST (Fig. 4 d, e)

Cells rather large, cylindrical, about 11 times longer than broad; semicells with basal inflation and somewhat swollen apex, with almost straight or very faintly undulated margins, with 16–18 rounded bud-like apical tubercles; chloroplasts 8 parietal bands. Long. 430  $\mu\text{m}$ ; lat. 40  $\mu\text{m}$ ; lat. apic. 35  $\mu\text{m}$ .

Specim. exam. 53374.

25. *Pleurotaenium trabecula* (EHRENBERG) ex NÄGELI var. *crassum* WITTROCK (Fig. 3 f)

Cells rather short, about 5 times longer than broad; semicells with a small basal inflation and with only one faint accessory swelling about it, somewhat swollen in the midregion, without apical tubercles; wall punctate, chloroplasts 4–6 parietal bands. Long. 187  $\mu\text{m}$ ; lat. 34  $\mu\text{m}$ ; lat. apic. 17  $\mu\text{m}$ .

Specim. exam. 53374.

26. *Pleurotaenium wallichianum* (TURNER) KRIEGER (Fig. 4 b, c)

Cells very large and stout, about 10 times longer than broad; semicells entirely parallel exclusive of a prominent basal inflation; apex truncate, with a peripheral

ring of 14–18 teeth-like tubercles visible; chloroplasts 12–14 parietal bands. Long. 630  $\mu\text{m}$ ; lat. 66  $\mu\text{m}$ ; lat. apic. 63  $\mu\text{m}$ .

Specim. exam. 53374.

27. *Euastrum crameri* RACIBORSKI (Fig. 5 c)

Cells rather small, elliptical in outline, about 1.4 times longer than broad, deeply constricted, sinus narrowly linear; polar lobe with a deep median notch, the angles bearing a spine, lateral margin rather tumid and with a short spine; lateral lobes bilobulate, upper lobule small and furnished with 1 or 2 short spines, lower lobule larger and furnished with 2 or 3 short spines; semicells with 2 median mucilage pores transversely disposed, with a wart below them, and with a wart within each half of the polar lobe. Long. 46  $\mu\text{m}$ ; lat. 33  $\mu\text{m}$ ; isthm. 7  $\mu\text{m}$ ; crass. 17.5  $\mu\text{m}$ .

Specim. exam. 53335.

28. *Euastrum spinulosum* DELPONTE var. *javanicum* (NORDSTEDT) WILDEMAN (Fig. 5 d)

Cells medium-sized, subquadrangular or nearly elliptical in outline, 1.2 times longer than broad; polar lobe cuneate and rather short, the apical margin slightly retuse in the midregion; each cuneate lateral lobe divided into two equal-sized subquadrangular lobules; margins and faces of all lobules with short, spine-like granules; semicells in center with a large granulate protuberance. Long. 62  $\mu\text{m}$ ; lat. 53  $\mu\text{m}$ ; isthm. 14  $\mu\text{m}$ .

Specim. exam. 53374.

In outline of this variety closely resembles var. *vaasii* (SCOTT & PRESCOTT, 1961), but it is easily distinguished from the latter by the semicell without six large emarginate verrucae.

KRIEGER (1937) treated var. *javanicum* as a synonym of var. *innermius*, but we believe that these two varieties must be separated in two different taxa. NORDSTEDT (1880) newly reported var. *javanicum* (as a variety of *E. quadratum*) and var. *innermius* (as a subspecies of *E. spinulosum*) in the same paper. According to his figures (iconotypes) of these two taxa, each lateral lobule of var. *javanicum* is evidently more angular than that of var. *innermius*.

29. *Euastrum turgidum* WALLICH var. *simplex* BORGE (Fig. 5 a, b)

Cells large, subquadrangular, about 1.3 times longer than broad; polar lobe rather short and broadly cuneate, apical margin straight or slightly retuse, without a median incision; lateral lobes broadly rounded, undivided; semicells in center with a large scrobiculate tumor, margins and faces of all lobes with rather large rounded or conical granules; wall coarsely scrobiculate. Long. 103  $\mu\text{m}$ ; lat. 80  $\mu\text{m}$ ; isthm. 36  $\mu\text{m}$ ; crass. 55  $\mu\text{m}$ .

Specim. exam. 53374.

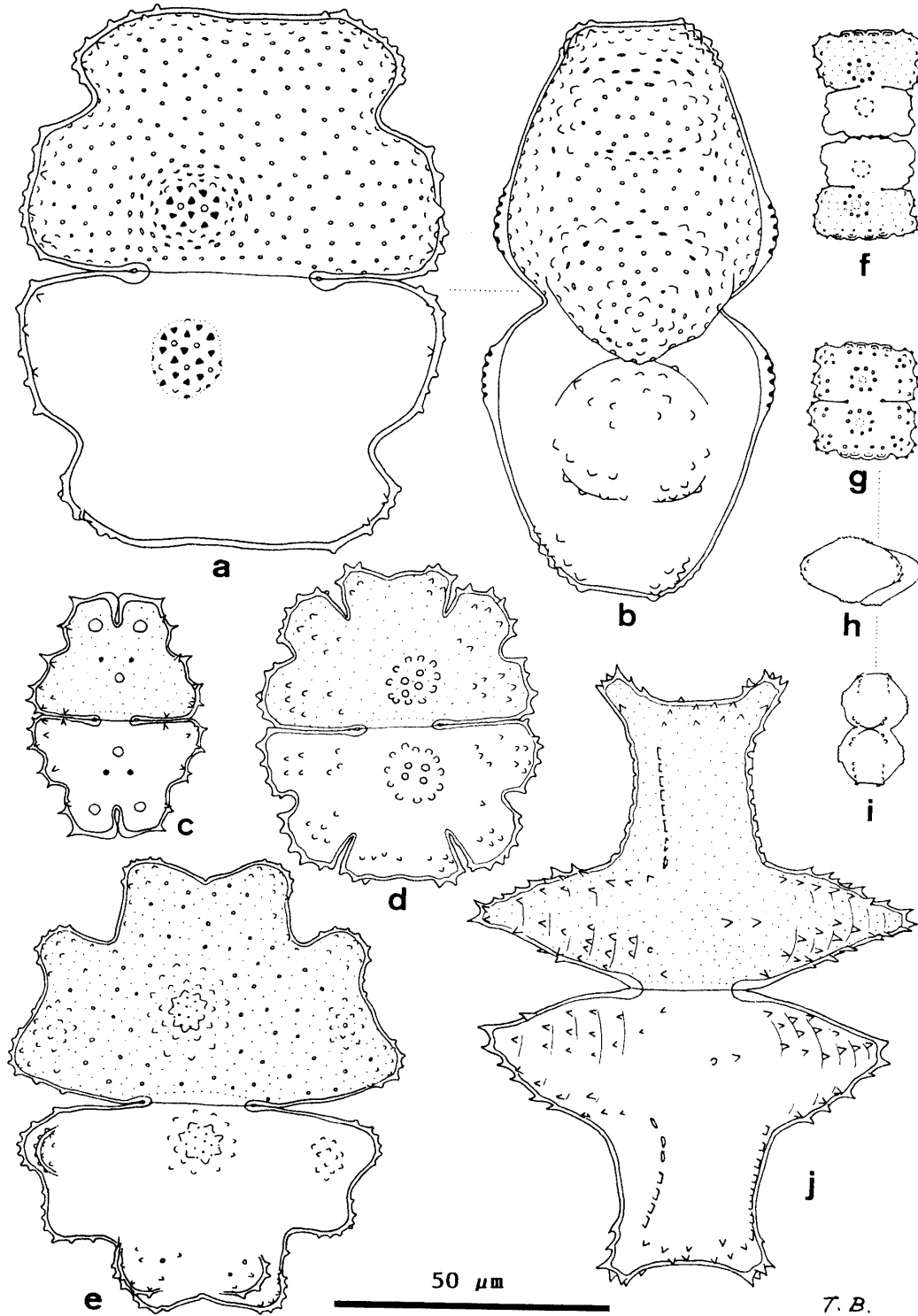


Fig. 5. a, b. *Euastrum turgidum* var. *simplex*. c. *Euastrum crameri*. d. *Euastrum spinulosum* var. *javanicum*. e. *Euastrum verrucosum*. f-i. *Cosmarium nobile*. j. *Micrasterias tropica* var. *crassa*.

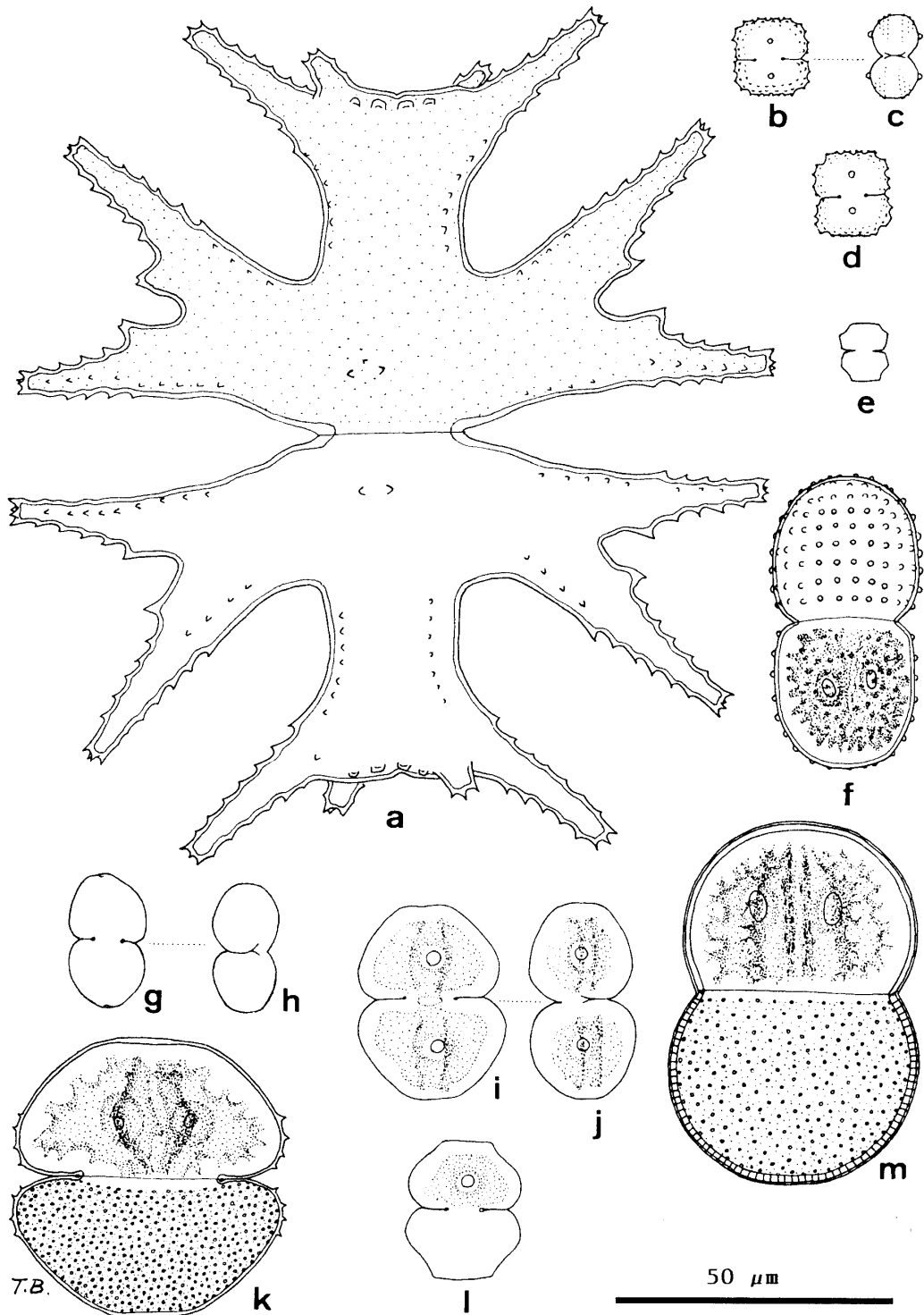


Fig. 6. *Micrasterias mahabuleshwarensis*. b-d. *Cosmarium blytii*. e. *Cosmarium regnellii*. f. *Cosmarium mansangense*. g, h. *Cosmarium laeve* fo. *laeve*. i, j. *Cosmarium laeve* fo. *majus*. k. *Cosmarium auriculatum*. l. *Cosmarium retusiforme*. m. *Cosmarium pseudoconnatum* var. *ellipsoideum*.

30. *Euastrum verrucosum* EHRENBERG ex RALFS (Fig. 5 e)

Cells rather large, about 1.1 times longer than broad; polar lobe broad, with rounded and somewhat protruded angles, the apical margin clearly retuse; lateral lobes directed obliquely upward, with upper and basal lobules, each lobule rounded and protruded; semicells with 3 large tumors across the broadest part, the central one is largest, each tumor decorated with rather large granules arranged in concentric circles; wall coarsely granular. Long. 85  $\mu\text{m}$ ; lat. 73  $\mu\text{m}$ ; isthm. 21  $\mu\text{m}$ .

Specim. exam. 52174.

31. *Micrasterias mababuleshwarensis* HOBSON (Fig. 6 a)

Cells very large, slightly longer than broad, deeply constricted, sinus sharp-angled, opened widely; polar lobe with angles protruded obliquely upward into elongated diverging processes, with rather small accessory processes disposed asymmetrically, the front accessory process situated at the base of the left lateral process and the back one at the base of the right lateral process in the upper semicell, apical margin somewhat retuse and with 4 intramarginal granules; lateral lobes deeply divided into 2 lobules attenuated into long processes; each process and accessory process with serrate margins, the teeth rather stouter at the base of the lateral lobules on their inner side, and some of them subdivided into small accessory process. Long. 158  $\mu\text{m}$ ; lat. 138  $\mu\text{m}$ ; isthm. 25  $\mu\text{m}$ .

Specim. exam. 53335.

32. *Micrasterias tropica* NORDSTEDT var. *crassa* W. WEST et G. S. WEST (Fig. 5 j)

Cells rather large, about 1.4 times longer than broad, deeply constricted, sinus opened widely with sharp-angled extremity; polar lobe stout and subquadrangular, with angles protruded into short diverging processes, each lateral margin ornamented with a row of teeth-like intramarginal verrucae; lateral lobes undivided, horizontally extended, strongly tapered; wall with sparsely arranged, small and stout spines in somewhat concentric series over the lateral lobes and polar processes; semicells with a pair of spines in the middle above the isthmus. Long. 117  $\mu\text{m}$ ; lat. 84  $\mu\text{m}$ ; isthm. 21  $\mu\text{m}$ ; lat. apic. 35  $\mu\text{m}$ .

Specim. exam. 53374.

The present alga is somewhat smaller, and each process is rather shorter and stouter, than in the iconotype (W. WEST & G. S. WEST, 1897).

33. *Cosmarium auriculatum* REINSCH var. *bogoriense* BERNARD (Fig. 6 k)

Cells medium-sized, subcircular, about as long as broad, moderately constricted, sinus narrowly linear but opening outward; semicells pyramidal-semicircular or truncate-pyramidal, basal angles rounded and with 4 small conical spines, lateral margins slightly convex, apex truncately rounded; wall sparsely scrobiculate, and more finely punctate between the scrobiculations. Long. 52  $\mu\text{m}$ ; lat. 50  $\mu\text{m}$ ; isthm. 24  $\mu\text{m}$ .

Specim. exam. 53368.

A few cells were observed. They are somewhat smaller than shown in the original description (BERNARD, 1908).

34. *Cosmarium blytii* WILLE (Fig. 6 b–d)

Cells very small, subquadrangular, about as long as broad or slightly longer than broad, deeply constricted, sinus narrowly linear; each lateral margin of the semicells with 3-crenate, the upper crenation more developed and often emarginate; apex truncate and 4-crenate, sometimes with emarginate crenations; face of semicell with one or two series of small intramarginal granules, and with a subpapillate granule at the center; in lateral view semicells subcircular, with a slightly truncate apex, and with a well-marked prominent granule in the middle on each side; chloroplasts axial, with one central pyrenoid. Long. 14–17  $\mu\text{m}$ ; lat. 12–15  $\mu\text{m}$ ; isthm. 4–4.5  $\mu\text{m}$ ; crass. 8–12  $\mu\text{m}$ .

Specim. exam. 53335.

35. *Cosmarium galeritum* NORDSTEDT (Fig. 8 c)

Cells medium-sized, 1.2–1.3 times longer than broad, deeply constricted, sinus narrowly linear; semicells pyramide-trapeziform to subsemicircular, each angle rounded, sides slightly convex, apex narrowly truncate, generally convex and sometimes slightly retuse in the middle; wall finely punctate; each semicell with 2 pyrenoids. Long. 50–53  $\mu\text{m}$ ; lat. 40–42.5  $\mu\text{m}$ ; isthm. 16–17  $\mu\text{m}$ .

Specim. exam. 53335.

36. *Cosmarium javanicum* NORDSTEDT (Fig. 7 f)

Cells very large, about 2 times longer than broad, rather shallowly constricted, sinus narrowly linear; semicells subpyramidal, basal angles rounded, sides slightly convex, apex narrowly and truncately rounded or gracefully and uniformly rounded; wall scrobiculate-punctate; chloroplasts in parallel bands, 4 visible across face of semicell, each with a row of 3–5 pyrenoids.

Long. 153–165  $\mu\text{m}$ ; lat. 76–85  $\mu\text{m}$ ; isthm. 42–45  $\mu\text{m}$ .

Specim. exam. 53334, 53335.

37. *Cosmarium laeve* RABENHORST f. *laeve* (Fig. 6 g, h)

Cells very small, subelliptical in outline, about 1.6 times longer than broad, deeply constricted, sinus narrowly linear; semicells subpyramidal or slightly pentagonal, lower angles rounded, sides slightly or rather convex, upper angles broadly rounded, apex narrowly truncate or convex, apex with a pronounced small internal thickening of the wall in the middle. Long. 24  $\mu\text{m}$ ; lat. 15  $\mu\text{m}$ ; isthm. 7  $\mu\text{m}$ ; crass. 12  $\mu\text{m}$ .

Specim. exam. 53374.

38. *Cosmarium laeve* RABENHORST f. *majus* BERGE (Fig. 6 i, j)

Cells rather small, about 1.3 times longer than broad, very deeply constricted, sinus narrowly linear; semicells subpyramidal, each angle rounded, the apex narrowly truncate and generally slightly retuse or notched; semicells in lateral view ovate-

elliptic; wall delicately punctate; chloroplast axial, with a central pyrenoid. Long.  $36\ \mu\text{m}$ ; lat.  $27\ \mu\text{m}$ ; isthm.  $7.5\ \mu\text{m}$ ; crass.  $19\ \mu\text{m}$ .

Specim. exam. 52184.

The basal angles of the present alga are more rounded than those of the iconotype (Borge, 1901). The cell size of our alga agrees completely with the average size reported by RŮŽIČKA (1966).

39. *Cosmarium mansangense* W. WEST et G. S. WEST (Fig. 6 f)

Cells rather small, about 2 times longer than broad, shallowly constricted in the middle, sinus opened widely; semicells ovate or subcircular from a flattened base, with the lateral margins slightly convex; wall uniformly granulate, granules disposed in about 9 horizontal series and about 12 vertical series in visible across face of semicell; each semicell with 2 pyrenoids. Long.  $55\ \mu\text{m}$ ; lat.  $27\ \mu\text{m}$ ; isthm.  $19\ \mu\text{m}$ .

Specim. exam. 53335.

This species was described by W. WEST & G. S. WEST (1907) from Burma. The granules of each series of this Nepalese specimen were somewhat fewer than those of the iconotype. However, the result of our observations agree with some other reports of this species from southeastern Asia (KRIEGER, 1932; SCOTT & PRESCOTT, 1961).

40. *Cosmarium nobile* (TURNER) KRIEGER var. (Fig. 5 f-i)

Cells small, slightly longer than broad, deeply constricted, sinus narrowly linear; semicells subquadrangular, sometimes slightly wider at the apex than at the base, the lateral margins 2- or 3-undulate, each undulation furnished with 1-3 small conical granules, the upper angles broadly rounded, prominent and with 3-5 small conical granules, the apex broadly truncate, 4-undulate to the exclusion of the upper angles; wall furnished with 2 or 3 series of granules within the margin, the granules of 2 horizontal series at the apex rather larger than those at the lateral sides, with a ring of 8 larger granules in the center of the semicells situated on a very slight central tumor. Long.  $20\text{--}22.5\ \mu\text{m}$ ;  $17\text{--}20\ \mu\text{m}$ ; isthm.  $4\text{--}7\ \mu\text{m}$ ; crass.  $12\ \mu\text{m}$ .

Specim. exam. 53335.

Each marginal undulation of the present specimens is somewhat less developed than that of the iconotype reported from East India (TURNER, 1892). In vertical view, the poles are not so protruded as North American materials (PRESCOTT *et al.*, 1981). Furthermore, each semicell of our algae does not furnish at the center with a large conical granule, but a slight tumor encircled by 8 granules.

41. *Cosmarium obtusatum* (SCHMIDLE) SCHMIDLE (Fig. 7 g-i)

Cells medium-sized, 1.2-1.3 times longer than broad, deeply constricted, sinus narrowly linear; semicells truncate-pyramidal, basal angles rather rounded, sides convex with 8 to 10, also 2 or 3 similar series of granulate undulations somewhat radially and concentrically arranged within each marginal undulation, gradually diminishing in size towards the central area; each semicell with 2 pyrenoids. Long.  $55\text{--}62\ \mu\text{m}$ ; lat.  $46\text{--}48\ \mu\text{m}$ ; isthm.  $15\text{--}17\ \mu\text{m}$ ; crass.  $30\ \mu\text{m}$ .

Specim. exam. 52174, 52210.

42. *Cosmarium pachydermum* LUNDELL var. (Fig. 7 a, b)

Cells medium-sized, elliptical, about 1.3 times longer than broad, deeply constricted, sinus narrowly linear and the outer half widely open; semicells subsemicircular with strongly rounded basal angles; wall moderate in thickness, densely punctate; each semicell with 2 pyrenoids. Long. 74–80  $\mu\text{m}$ ; lat. 55–60  $\mu\text{m}$ ; isthm. 25–26  $\mu\text{m}$ .

Specim. exam. 52210, 53335.

The thick wall is one of the most important taxonomic characters of this species. The present specimens, however, have the comparatively thin wall (about half in thickness).

43. *Cosmarium pachydermum* LUNDELL var. *aethiopicum* W. WEST et G. S. WEST forma (Fig. 7 c, d)

Cells medium-sized, subcircular, slightly longer than broad; isthmus broad; sinus narrowly linear at inner half or one-third and opening outward, sometimes entirely open; wall fairly thick and thicker at the apex, somewhat sparsely scrobiculate and densely punctate; each semicell with 2 pyrenoids. Long. 57–61  $\mu\text{m}$ ; lat. 50–53  $\mu\text{m}$ ; isthm. 30–32  $\mu\text{m}$ ; crass. 35  $\mu\text{m}$ .

Specim. exam. 53374.

Var. *aethiopicum* originally has the thinner wall. In the present study, however, the form with fairly thick wall was identified with var. *aethiopicum*. CROASDALE (1956) reported the same form as this Nepalese algae from Alaska, as *C. pachydermum* var. *aethiopicum*.

44. *Cosmarium pseudoconnatum* NORDSTEDT var. *ellipsoideum* W. WEST et G. S. WEST (Fig. 6 m)

Cells-medium sized, gourd-shaped, about 1.5 times longer than broad, moderately constricted, sinus shallow and broadly open; semicells subcircular with a broad base; walls finely scrobiculate and punctate; vertical view broadly elliptic; each semicell with 4 pyrenoids. Long. 67  $\mu\text{m}$ ; lat. 45  $\mu\text{m}$ ; isthm. 38  $\mu\text{m}$ ; crass. 37  $\mu\text{m}$ .

Specim. exam. 53374.

45. *Cosmarium quadrum* LUNDELL var. *minus* NORDSTEDT (Fig. 8 b)

Cells medium-sized, subquadrate in outline, about as long as broad, deeply constricted, sinus narrowly linear, with a slight dilated extremity; semicells subrectangular, lower angles rounded, upper angles broadly rounded, lateral and apical margins slightly convex or sometimes almost straight; wall densely granulate, granules rather large, arranged in decussating oblique series and in vertical series, and slightly reduced in size in the middle of the apex, 17 or 18 vertical rows in visible across face of semicell, each vertical row with 7 or 8 granules. Long. 46–50  $\mu\text{m}$ ; lat. 45–47  $\mu\text{m}$ ; isthm. 17–17.5  $\mu\text{m}$ .

Specim. exam. 53335, 53374.

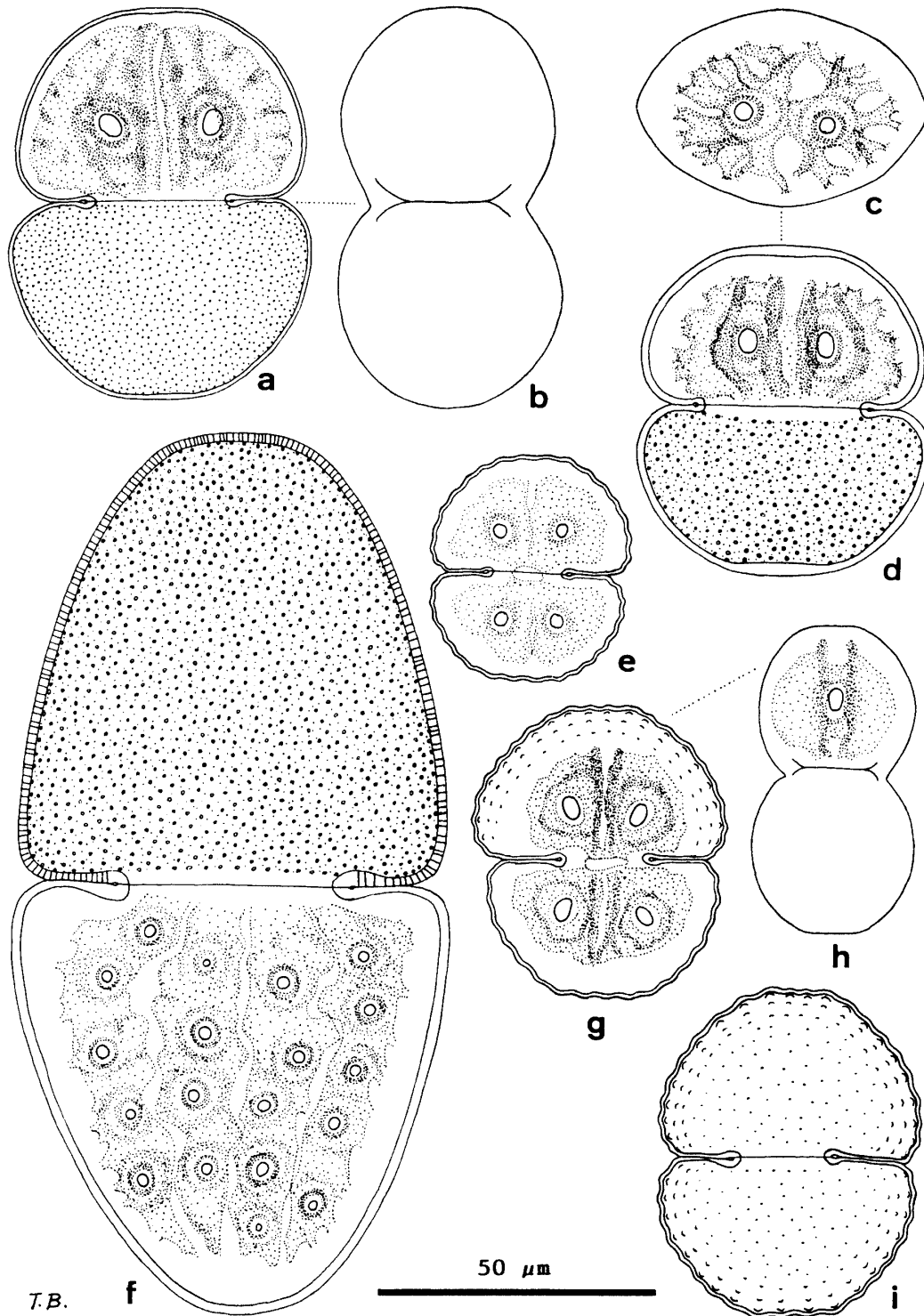


Fig. 7. a, b. *Cosmarium pachydermum* var. c, d. *Cosmarium pachydermum* var. *aethiopicum* fo. e. *Cosmarium sublateriundatum*. f. *Cosmarium javanicum*. g-i. *Cosmarium obtusatum*.

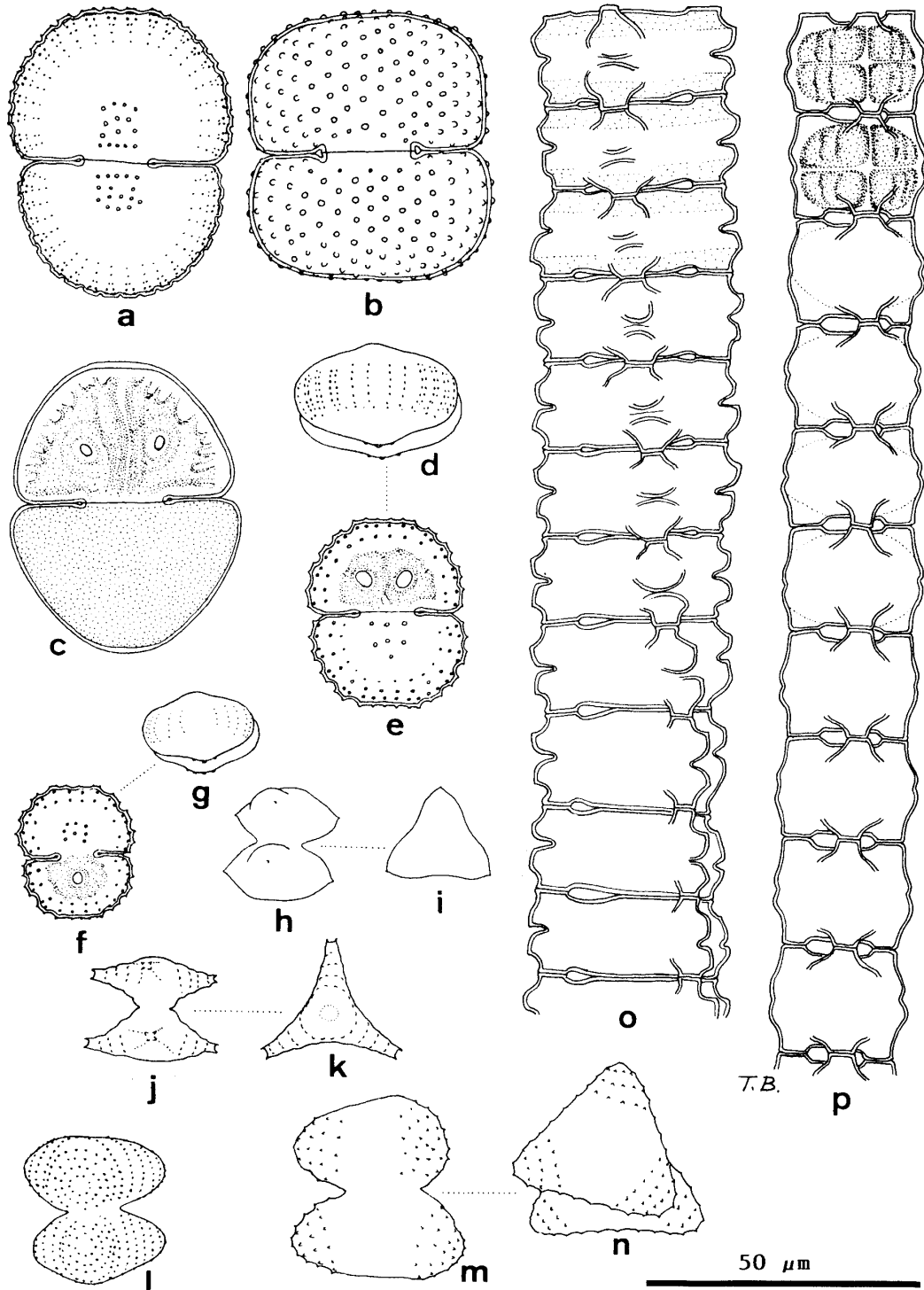


Fig. 8. a. *Cosmarium subspeciosum*. b. *Cosmarium quadrum* var. *minus*. c. *Cosmarium galeritum*. d, e. *Cosmarium subcostatum* fo. *subcostatum*. f, g. *Cosmarium subcostatum* fo. *minor*. h, i. *Staurodesmus brevispinus* fo. *minimus*. j, k. *Staurastrum polymorphum*. l. *Staurastrum punctulatum* var. *punctulatum*. m, n. *Staurastrum punctulatum* var. *pygmaeum*. o. *Desmidium swartzii*. p. *Desmidium baileyi*.

46. *Cosmarium regnellii* WILLE var. (Fig. 6 e)

Cells very small, about 1.2 times longer than broad, deeply constricted, sinus narrow and not so completely closed; semicells trapezoid-hexagonal, lateral angles projecting and slightly upward divergent, lower lateral margins about as long as the upper lateral margins and almost straight, upper lateral margins markedly retuse, apex broadly truncate and almost straight. Long. 10  $\mu\text{m}$ ; lat. 8  $\mu\text{m}$ ; isthm. 2.5  $\mu\text{m}$ .

Specim. exam. 53335.

This Nepalese specimen is considerably small. It is only about half the size of the iconotype (WILLE, 1884).

47. *Cosmarium retusifforme* (WILLE) GUTWINSKI (Fig. 6 l)

Cells small, 1.2–1.3 times longer than broad, deeply constricted, sinus narrowly linear; semicells truncate-subpyramidal, the lower half of sides rounded, the upper half markedly retuse, the upper angles subrectangular, apex widely truncate and almost straight; chloroplast axile with one pyrenoid. Long. 25–28  $\mu\text{m}$ ; lat. 20–23  $\mu\text{m}$ ; isthm. 7–7.5  $\mu\text{m}$ .

Specim. exam. 53335.

48. *Cosmarium subcostatum* NORDSTEDT f. *subcostatum* (Fig. 8 d, e)

Cells rather small, about 1.2 times longer than broad, deeply constricted, sinus narrowly linear; semicells subtrapeziform, the basal angles rounded, sides convex and crenate, with 2 entire crenations nearest the base and 3 larger emarginate crenations, apex almost flat and truncate, with about 6 delicate crenations along the apical margin; face of semicell with 2 or 3 radially and concentric intramarginal series of granules, the series nearest the margin showing a paired arrangement, in the center above the isthmus with a granulate faint tumor, granules in 3–5 subvertical series and 2–4 in each series. Long. 35  $\mu\text{m}$ ; lat. 30  $\mu\text{m}$ ; isthm. 10  $\mu\text{m}$ ; crass. 18  $\mu\text{m}$ .

Specim. exam. 52174, 53368, 53374.

49. *Cosmarium subcostatum* Nordstedt f. *minor* W. WEST et G. S. WEST (Fig. 8 f, g)

Cells rather smaller than in the type, with 2 or 3 entire crenations nearest the base and with only 2 emarginate lateral crenations; chloroplasts with one pyrenoid. Long. 25  $\mu\text{m}$ ; lat. 21  $\mu\text{m}$ ; isthm. 7.5  $\mu\text{m}$ .

Specim. exam. 53374.

50. *Cosmarium sublateriundatum* W. WEST et G. S. WEST (Fig. 7 e)

Cells medium-sized, slightly longer than broad, deeply constricted, sinus narrowly linear; semicells subtrapeziform or subsemicircular, the basal angles rounded, the lateral margins evenly convex, with 6 or 7 delicate undulations, the apex truncate, with very slight 2 undulations; each semicell with 2 pyrenoids. Long. 42  $\mu\text{m}$ ; lat. 37  $\mu\text{m}$ ; isthm. 13  $\mu\text{m}$ .

Specim. exam. 52174.

51. *Cosmarium subspeciosum* NORDSTEDT (Fig. 8 a)

Cells medium-sized, about 1.3 times longer than broad, deeply constricted, sinus narrowly linear; semicells truncate-pyramidal to pyramidal-subsemicircular, the basal angles abruptly rounded, margin 20–22 crenate, 4 apical crenations and 8 or 9 on each convex side, crenations bigranulate and more or less emarginate; in face of semicell about 4 or 5 series of granules radially and concentrically arranged within each marginal crenation, granules of 3 outer concentric series in pairs and 1 or 2 inner series single; in the center above the isthmus with a granulate faint tumor, granules irregularly disposed or in 3–5 indistinct subvertical or in subhorizontal series, 5 granules nearest to the isthmus arranged in a entirely horizontal series. Long. 55  $\mu\text{m}$ ; lat. 41.5  $\mu\text{m}$ ; isthm. 15  $\mu\text{m}$ .

Specim. exam. 53374.

52. *Staurodesmus brevispinus* ((BRÉBISSON) ex RALFS) CROASDALE f. *minimus* (LÜTKEMÜLLER) CROASDALE (Fig. 8 h, i)

Cells small, slightly longer than broad, deeply constricted, sinus widely open and acute-angled; semicells transversely and subhexagonally elliptic, the dorsal margin subtruncate, convex as strong as the ventral margin, lateral angles subacute and furnished with a small mucro; in vertical view cell triangular, the margins concave, the angles acutely rounded and furnished with a mucro. Long. 22  $\mu\text{m}$ ; lat. 20  $\mu\text{m}$ ; isthm. 6.5  $\mu\text{m}$ .

Specim. exam. 52184.

53. *Staurastrum polymorphum* BRÉBISSON ex RALFS (Fig. 8 j, k)

Cells small, about 1.2 times broader than long; deeply constricted, sinus widely open and minutely acuminate at the apex; semicells transversely subfusiform, the ventral margin more strongly convex than the dorsal margin, the angles produced horizontally to form a short stout process tipped with 2 minute spines and provided with 3 or 4 series of granules or small mucrones; in vertical view cell triangular, the margins concave, the angles produced to form shot and truncate processes tipped with 2 minute spines, many granules or small mucrones arranged in about 4 concentric series. Long. 20  $\mu\text{m}$ ; lat. 25  $\mu\text{m}$ ; isthm. 5  $\mu\text{m}$ .

Specim. exam. 53335.

54. *Staurastrum punctulatum* BRÉBISSON ex RALFS var. *punctulatum* (Fig. 8 l)

Cells small, slightly longer than broad, deeply constricted, sinus open and acute-angled; semicells subrhomboid-elliptic or transversely ovate, dorsal and ventral margins about equally convex, angles rounded; cell wall with concentric series of granules over the lobes; in vertical view cell triangular, the angles narrowly rounded, the margins almost straight or slightly retuse in the middle, the wall with concentric series of granules. Long. 27.5  $\mu\text{m}$ ; lat. 25  $\mu\text{m}$ ; isthm. 10  $\mu\text{m}$ .

Specim. exam. 53374.

55. *Staurastrum punctulatum* BRÉBISSON ex RALFS var. *pygmaeum* (BRÉBISSON ex RALFS) W. WEST et G. S. WEST (Fig. 8 m, n)

Cells somewhat larger than in the type, slightly twisted at the isthmus, with subtruncate apices, the lateral lobes somewhat acutely rounded; cell wall with minute and acute granules. Long. 34  $\mu\text{m}$ ; lat. 33  $\mu\text{m}$ ; isthm. 15  $\mu\text{m}$ .

Specim. exam. 52174.

This variety differs from the typical by the sharp granules rather than the flattened or rounded granules of the typical.

56. *Desmidium baileyi* (RALFS) NORDSTEDT var. (Fig. 8 p)

Cells united to form untwisted filaments, rather small and subquadrate, 1.3–1.4 times broader than long, faintly constricted, the sides with 2 undulations and somewhat swollen in the middle, the apices broadly truncate and slightly concave in the middle, with a short connecting process at each angle of the cell; spaces between the cells transversely elongated hexagonal or elliptic; in vertical view (by optical section) cell triangular. Long. 20  $\mu\text{m}$ ; lat. 25–27  $\mu\text{m}$ .

Specim. exam. 53374.

According to the original description (RALFS, 1848), the cells of this species have the entirely straight (not crenate) sides. However, this Nepalese alga has the rather tumid and biundulate sides. The specimens with have the more delicately undulate sides than ours were reported by some authors (TURNER, 1982; HINODE, 1959; SCOTT & PRESCOTT, 1961; CROASDALE *et al.*, 1983).

57. *Desmidium swartzii* (AGARDH) AGARDH ex RALFS (Fig. 8 o)

Cells united to form twisting filaments, medium-sized, subquadrate, about 1.5 times broader than long, moderately constricted, sinus open and linear towards its apex, opening more widely outward; semicells transversely narrowly oblong, lateral margins rather variable in outline, generally somewhat obliquely truncate, with the upper angle of the truncate margin conspicuously protruded towards the apex of the semicell, the lower angle more rounded; the apices broadly truncate and broadly convex in the middle, with a short connecting process at each angle of the cell; spaces between the cells not visible in the middle, but recognized only within the connecting processes; in vertical view (by optical section) cell triangular. Long. 15  $\mu\text{m}$ ; lat. 38  $\mu\text{m}$ .

Specim. exam. 53374.

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