J. Protozool., 35(4), 1988, pp. 489–497

Morphology and Infraciliature of *Trochiliopsis australis* N. Sp., *Pelagohalteria viridis* (Fromentel, 1876) N. G., N. Comb., and *Strobilidium lacustris* N. Sp. (Protozoa, Ciliophora)[1]

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ABSTRACT. Three ciliate species from Australia and Norway were examined by silver impregnation, biometry, and scanning electron microscopy. *Trochiliopsis australis* n. sp. (order Nassulida, family Microthoracidae) differs from the single other known species of the genus, *T. opaca,* by its prominent ridges on the left side, the distinctly longer anterior segment of somatic kinety 2, and by the doubled total number of kinetosomes. *Pelagohalteria* n. g. (order Oligotrichida, family Halteriidae) differs from *Halteria* by the structure of the bristle complexes, which are composed of a vertically *and* a horizontally oriented row of kinetosomes. Two *Halteria* species belong to the new genus: *P. viridis* (Fromentel, 1876) n. comb., which is redescribed here, and *P. cirrifera* (Kahl, 1935) n. comb. *Strobilidium lacustris* n. sp. (order Oligotrichida, family Strobilidiidae) differs from its nearest relative, *S. velox,* by the smooth pellicle, the absence of symbiotic green algae, and by its larger size.

THE oligotrichine ciliates play an important part in the planktonic food webs of freshwater and marine environments (23). In spite of this, their taxonomy is poorly explored as evident from some recent guides (23, 24). It was only recently that a few species have been investigated with modern methods like silver impregnation and electron microscopy (4, 5, 8, 15–18, 25). We now add detailed descriptions of two species, one of them used in ecological studies (29). The third species described in this paper belongs to the rare genus *Trochiliopsis* (order Nassulida, family Microthoracidae) and was collected in Australia, the ciliate fauna of which is nearly unexplored (13). Thus, any new reliable record is of importance.

MATERIALS AND METHODS

Trochiliopsis australis occurred in low numbers in activated sludge in February 1987 at the Glenelg waste water treatment plant, Glenelg (part of Adelaide), South Australia. The raw material was used for the investigations.

Pelagohalteria viridis was isolated from the open epilimnion of Lake Røertjern at Nesodden, near Oslo, Norway (August 14, 1984). This is a shallow and small lake (0.01 km^2), eutrophic due to sewage supply and drainage from agricultural areas (28). Stock cultures, which originated from a few individuals, were established in small (10 ml) glass tubes with *Rhodomonas lacustris* as food supply and were used for the investigations. Further details of the culture method are given elsewhere (29).

Strobilidium lacustris was isolated from the mixolimnion of Lake Svinsjøen situated in Asker, near Oslo, Norway. This is a meromictic lake (21) having a eutrophic character (22). The same culture method was used as the method for *P. viridis.*

All species were examined in vivo and in silver-impregnated slides. A protargol (10) and two silver nitrate (3, 9) methods were used to reveal the infraciliature and the silverline system. *Pelagohalteria viridis* and *S. lacustris* were also impregnated with a pyridinated silver carbonate method (1).

For scanning electron microscopy (SEM), cells of *P. viridis* were fixed in 2% (v/v) glutaraldehyde in 0.1 M Na-cacodylate buffer, pH 7.0 and postfixed in 1% OsO_4 in 0.2 M Na-cacodylate buffer, pH 7.0. A slightly better fixation for these ciliates is the Párducz mixture (26) which was used for *S. lacustris.* Since precipitation is produced by mixing Párducz fluid and Na-cacodylate buffer, the ciliates were rinsed in culture medium instead of buffer. To further stabilize these fragile ciliates, they were postfixed in 2% (v/v) glutaraldehyde. After several washes in culture medium, the cells were dehydrated in an ethanol series, critical point-dried using liquid CO_2, sputter-coated with Au + Pd, and observed in a JEOL JSM-35C. The electron microscopy was done at the Electronmicroscopical Unit for Biological Sciences, University of Oslo.

All counts and measurements were performed at a magnification of 1200× on individuals from well fed cultures in the exponential growth phase. Statistical procedures follow methods as described in ref. 30.

The drawings of the impregnated specimens were made with the help of a camera lucida. Electronic flash illumination was used for the photography of freely moving *P. viridis* and *S. lacustris.*

RESULTS AND DISCUSSION

Trochiliopsis australis n. sp.

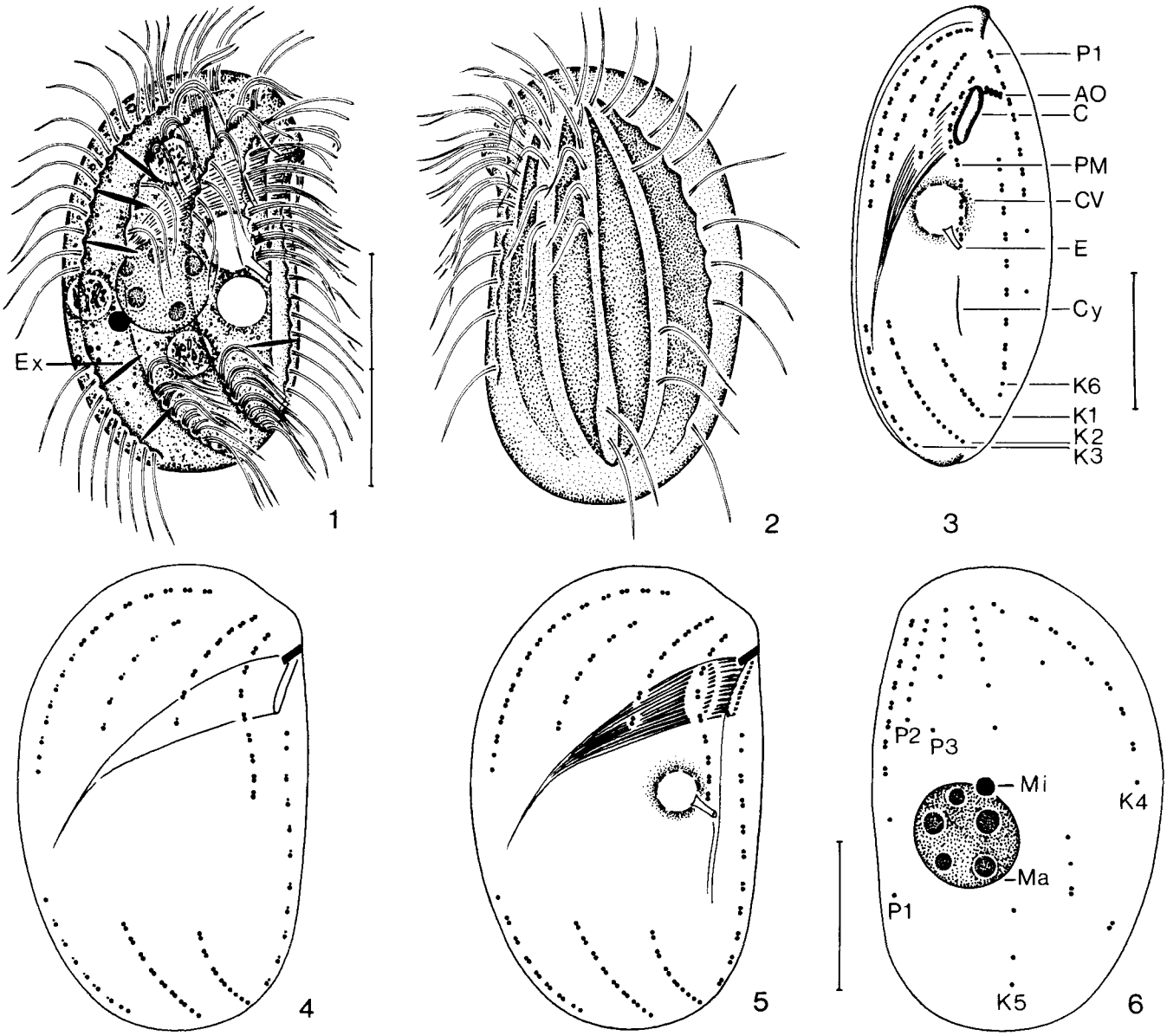
Diagnosis. In vivo ca. 35–45 × 18–30 μm; left side with four prominent ridges; anterior segment of somatic kinety 2 with 13 kinetosomes on the average; total number of kinetosomes ca. 200.

Type location. Activated sludge, Glenelg waste water treatment plant, Glenelg, South Australia.

Type specimens. A holotype and a paratype of *T. australis* as four slides of protargol- and silver nitrate-impregnated cells have been deposited in the collection of microscope slides of the Upper Austrian Museum in Linz.

Description (Figs. 1–8, Table I). Terminology is according to Augustin et al. (1). Body compressed laterally (ca. 2:1), outline oval, anteriorly curved slightly to the ventral side terminating in a pointed beak-like region below, in which the oral apparatus is located. Pellicle rigid, colorless, opaque. Somatic kineties in deep, crenulated furrows, especially on the left side, where four prominent ridges occur that are flattened anteriorly and posteriorly, except for the central furrow, which remains deepened and is slightly widened posteriorly where two cilia emerge. Macronucleus spherical, hyaline, centrally located, with large chromatin bodies (nucleoli?). Micronucleus spherical, next to the macronucleus. Contractile vacuole located centrally left of median; its contents are discharged via a distinct canal whose pore is situated at the end of the paroral membrane. Cytoproct slightly posterior to the contractile vacuole, visible in vivo as a clear vesicle and as black line in silver-impregnated specimens (Figs. 3, 5, 7). Cytoplasm without special inclu-

[1] This study was supported by the Fonds zur Förderung der wissenschaftlichen Forschung, Projekt Nr. P 5889 and by the Australian Biological Resources Study. Our special thanks to Dr. Peter O'Donoghue (Central Veterinary Laboratories, Adelaide, South Australia), who organized an interesting workshop on protozoology in Adelaide during which we were able to perform the investigations on *Trochiliopsis australis.* We gratefully acknowledge Mrs. Karin Bernatzky's assistance with photography. We also wish to thank Anne Lyche who provided plankton samples from Lake Svinsjøen.



Figs. **1–6**. *Trochiliopsis australis* from life (Figs. 1, 2) and from protargol-impregnated specimens (Figs. 3–6). **1**, **4**, **5**. Infraciliature of the right side. Figure 4 shows the same individual as Fig. 5 but with the nonciliated kinetosomes symbolized by smaller dots than the ciliated ones. **2**, **6**. Infraciliature of the left side. **3**. Infraciliature of the ventral side. AO, adoral organelle; C, cyrtos; CV, contractile vacuole; Cy, cytoproct; E, excretion pore of the contractile vacuole; Ex, extrusome; K1–K6, somatic kineties; Ma, macronucleus; Mi, micronucleus; P1–P3, preoral kineties; PM, paroral membrane. Scale bar divisions = 10 μm.

sions. Extrusomes ca. 3 μm long, fusiform, scattered over the whole body in or near the ridges between the furrows (Fig. 1). Feeds on bacteria, which are digested in small, hyaline food vacuoles. Movement slow, often crawling on detritus.

Length of cilia ca. 8 μm. Six arched somatic kineties (K1–K6), between K4 and K5 an additional strongly reduced kinety composed of only ca. five kinetosomes. Most kinetosomes paired, but about half of pairs with only single cilium. Thus, different appearance in vivo (Figs. 1, 2) from that of silver-impregnated specimens (Figs. 3–8). Three preoral kineties (P1–P3); P2 and P3 distinctly marked by lattice-like silverlines (Fig. 8). An x-kinety between K6 and the paroral membrane, present in *T. opaca* (1), not found in *T. australis* (absent or not impregnated).

Adoral membranelle at the oral peak near and above the cyrtos; seems two rows with three to four kinetosomes each. Paroral membrane with 7–11 pairs of cilia. Cyrtos large, visible in vivo (unlike that of *T. opaca* [1]), laterally compressed, made of many fine rods with stronger argyrophilic zone a few micrometers behind their distal ends. Thus, in protargol preparations cyrtos often seemingly begins just right of paroral membrane.

Silverline system granular, except for wide-meshed part between the preoral kineties (Fig. 8).

Occurrence and ecology. No other habitat than that mentioned in the type location is known. The species occurred in the well developed (rapidly settling) activated sludge where polysaprobic conditions dominated. It is of interest that the single other species of the genus, *T. opaca*, also prefers habitats heavily loaded with organic substances and has been found repeatedly in trickling filters and activated sludge chambers (1).

Comparison with other species. The genus *Trochiliopsis* belongs to the Microthoracidae and is closely related to *Stammeridium*, from which it differs mainly by the location of the

TABLE I. *Biometric characterization of* Trochiliopsis australis *n. sp.*[a]

Character	$\bar{x}$	SD	CV	Min	Max
Body, length	31.7	2.4	7.4	29	37
Body, width	19.4	2.6	13.6	16	25
Distance from apex to proximal margin of cyrtos	9.5	0.5	5.5	9	10
Distance from apex to beginning of macronucleus	14.6	1.0	6.6	13	16
Macronucleus, length	7.7	0.8	10.7	7	9
Macronucleus, width	6.9	—	—	6	7
Micronucleus, longer axis	1.6	0.2	12.5	1.4	2
Cyrtos, longer axis	4.2	0.1	3.4	4	5
No. macronuclei	1.0	0.0	0.0	1	1
No. micronuclei	1.0	0.0	0.0	1	1
No. somatic kineties	6.0	0.0	0.0	6	6
No. preoral kineties	3.0	0.0	0.0	3	3
No. kinetosomes of paroral membrane	18.4	2.0	10.9	15	22
No. kinetosomes of somatic kinety 1, AS	17.0	1.8	10.7	13	20
No. kinetosomes of somatic kinety 1, PS	11.6	1.8	15.3	9	14
No. kinetosomes of somatic kinety 2, AS	13.1	1.2	9.1	11	14
No. kinetosomes of somatic kinety 2, PS	17.1	1.5	8.9	15	20
No. kinetosomes of somatic kinety 3, AS	29.1	1.7	5.7	26	32
No. kinetosomes of somatic kinety 3, PS	15.6	1.9	12.2	12	18
No. kinetosomes of somatic kinety 4, AS	15.4	1.8	11.9	13	19
No. kinetosomes of somatic kinety 4, PS	2.4	1.0	40.3	2	5
No. kinetosomes of somatic kinety 5, AS	5.2	1.7	32.4	3	8
No. kinetosomes of somatic kinety 5, PS	3.3	0.5	14.6	3	4
No. kinetosomes of somatic kinety 6	21.8	2.2	10.1	18	26
No. kinetosomes of preoral kinety 1	19.1	2.1	11.3	17	24
No. kinetosomes of preoral kinety 2	7.9	0.7	9.3	7	9
No. kinetosomes of preoral kinety 3	6.0	1.3	22.2	4	8

[a] All data are based on the investigation of 10 randomly selected protargol-impregnated specimens. All measurements in micrometers. Legend: AS, anterior segment; CV, coefficient of variation in %; Max, maximum; Min, minimum; No., number; PS, posterior segment; SD, standard deviation; $\bar{x}$, arithmetic mean.

preoral kineties (1). Until recently, it was monotypic with *T. opaca* Penard, 1922, as type species (1, 27). *Trochiliopsis australis* differs from *T. opaca* in several biometric characters. The total number of kinetosomes is ca. 200 in *T. australis* and ca. 100 in *T. opaca* (1, Table I). The best morphologic characters distinguishing these two species are the prominent ridges on the left side, which is nearly flat in *T. opaca,* and the anterior segment of K2, which in *T. opaca* consists of only two kinetosomes (1).

Pelagohalteria n. g.

Diagnosis. Body globular or obovoid; oral apparatus with eccentrically located buccal cavity and collar and buccal membranelles; somatic bristle complexes each composed of a vertically and a horizontally oriented row of cilia; movement rotating and jumping.

Type species. Pelagohalteria viridis (Fromentel, 1876) n. comb.

Systematic position. Pelagohalteria belongs to the family Halteriidae Claparède & Lachmann, 1858 (2), and is very similar to the genus *Halteria* Dujardin, 1841 (6). The equatorial somatic cilia ("bristles") of *Halteria* are, however, arranged in single, roughly vertically oriented rows (8, 16, 19, 31, 32), whereas *Pelagohalteria* has a second horizontally arranged row of cirri-like cilia close below each vertical bristle complex (Figs. 9, 12, 15, 16). This character is shared at least by one other species of the genus, *Halteria cirrifera* Kahl, 1935 (20), which is thus transferred to the new genus, *Pelagohalteria cirrifera* (Kahl, 1935) n. comb.

Pelagohalteria viridis (Fromentel, 1876) n. comb. (Basionym: *Halteria viridis*)

Type specimens. A neotype of *P. viridis,* as two slides of protargol- and silver nitrate-impregnated cells, has been deposited in the collection of microscope slides of the Upper Austrian Museum in Linz.

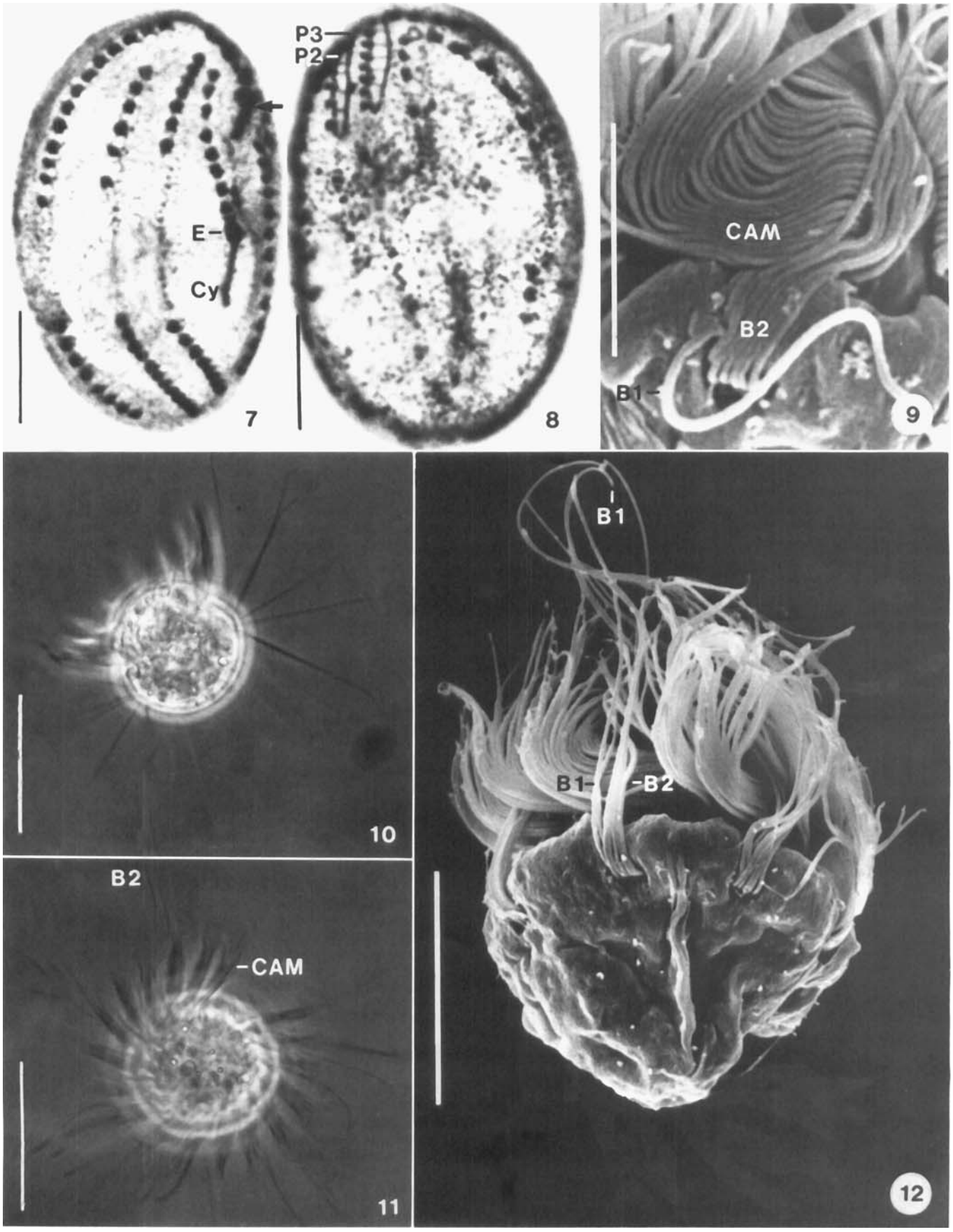
Redescription (Figs. 9–18, Table II). Diameter in vivo 20–30 μm. Body globular to heart-shaped, round in frontal view (Fig. 11), constricted at level of adoral zone of membranelles (Figs. 10, 12), obliquely truncated anteriorly, broadly rounded posteriorly. Pellicle thin, fragile; most individuals burst at contact with the cover glass. Macronucleus centrally located, bean-like, filled with large, globular chromatin bodies. A micronucleus has not been found in the protargol-impregnated cells. Contractile vacuole left of buccal cavity, just anterior to equator. Cytoplasm colorless, filled with many small (1–4 μm) shining globules and ca. 30 symbiotic algae, most grouped in two clumps left and right of the pharynx. Algae 4–6 μm in diameter, with a distinct cell wall, a pyrenoid, and a red stigma, as in those found in *Halteria chlorelligera* (19). Thus, the algae do not belong to the genus *Chlorella* but to another unidentified taxon.

Eight to 11 (mostly nine) bristle complexes, numbered from right (number I) to left in the equator of the cell. Each complex consists of six to 11 ciliated kinetosomes, about half of them in an almost vertically oriented row, the others horizontally oriented; although cilia somewhat like cirri in SEM (Figs. 9, 12), in vivo (Figs. 10, 11) not fused and act independently. Great variability in number and arrangement of kinetosomes in bristle complexes (Fig. 17, Table II). Kinetosomes of horizontal rows always in straight lines; kinetosomes of vertical rows often randomly arranged. Cilia of bristle complexes ca. 25 μm long. Half of individuals with at least one distally bifurcated bristle (Fig. 10).

Cilia of collar adoral membranelles ca. 15 μm long, apparently not fused after preparation for SEM study (Figs. 9, 12). Each collar membranelle three rows of kinetosomes and connected by numerous fibrils with neighboring membranelles. Buccal cavity inconspicuous; short paroral membrane at its right border; at left, seven to nine buccal membranelles, each consisting of two rows of kinetosomes.

Silverline system fine-meshed (mesh diameter ca. 1 μm in nonciliated regions and ca. 0.5 μm near bristle complexes [Fig. 18]).

Occurrence and ecology. Pelagohalteria viridis was common in Lake Rørtjern at the time of sampling. We never found this species in the soil, where *H. grandinella* is rather common (11, 31). Detailed data on the autecology of *P. viridis* have been published earlier (29). From this study it is clear that *P. viridis* can survive and reproduce on algae of the


P3
P2
E
Cy
7
8
CAM
B2
B1
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10
B2
CAM
11
B1
B1
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classes Bacillariophyceae, Dinophyceae, Cryptophyceae, and Chlorophyceae.

Taxonomic remarks. The original description (14) of *P. viridis* is very incomplete.[2] There are, however, a few characters which support our identification. First, Fromentel (14) mentioned that the somatic cilia are thick, which is unusual in members of the genus *Halteria* but typical for the "cirri" of *Pelagohalteria*. Second, Fromentel noticed a green color of his species, which suggests that it possessed symbiotic green algae ("zoochlorellae"). Third, the size (ca. 20 μm) also agrees rather well with our measurements (Table II and ref. 29). Considering the very poor drawing of Fromentel (14, redrawn in ref. 23), any identification is more or less arbitrary. We prefer, however, to redescribe an old species with more precise characteristics rather than create a new one if there are at least a few appropriate features in the old description.

Pelagohalteria viridis differs from *P. cirrifera* by its symbiotic green algae and the less conspicuous horizontal bristle rows ("cirri"). Although neither Kahl (19) nor Dragesco & Dragesco-Kernéïs (5), who found a few individuals of this species in Africa, provided details on the structure of the "cirri," one might suppose from their descriptions and drawings that they were composed of at least two closely associated rows of cilia. *Pelagohalteria viridis* also bears some resemblance to *Halteria chlorelligera* Kahl, 1935 (20), a species with symbiotic green algae, but which is sapropelic and is probably a true *Halteria* species because Kahl (19) did not mention a bipartition of the somatic bristle complexes. The occurrence of bifurcated bristle cilia and symbiotic green algae are described in *Halteria bifurcata* Tamar, 1968 (33). Tamar, however, definitely states that the cilia of the bristle complexes of *H. bifurcata* are arranged in single vertical rows and that the symbiotic algae, which have no stigma, are of the *Chlorella*-type.

We have no explanation why the kinetosomes of the horizontal bristle complexes are more regularly arranged than those of the vertical bristle complexes. This phenomenon needs closer examination in different populations and in clone cultures.

Strobilidium lacustris n. sp.

Diagnosis. In vivo about 70–100 × 50–70 μm (n = 3); body cone-like, posterior region narrowed with a short spine-like projection; 9–10 equally long and equally spaced, right-spiraling somatic kineties; 31–32 adoral membranelles; single, horse-shoe-shaped macronucleus and single, lens-like micronucleus.

Type location. Epilimnion of Lake Svinsjøen near Oslo, Norway.

Type specimens. A holotype and a paratype of *S. lacustris* as four slides of protargol- and silver nitrate-impregnated cells have been deposited in the collection of microscope slides of the Upper Austrian Museum in Linz.

Description (Figs. 19–31, Table III). Body shape as depicted in Figs. 23–26; rarely individuals observed with slightly turned-down collar. Transverse section round with small bulges where somatic kineties located (Fig. 21). Caudal spine inconspicuous but present in all individuals. Pellicle thin, very fragile; most individuals burst at contact with cover glass. Macronucleus beneath the collar, filled with many small and large chromatin bodies (nucleoli?), with centers impregnating with protargol more weakly than peripheries; its "arms" embrace the cytopharynx. Micronucleus conspicuously large, situated in small indentation on dorsal side of macronucleus (Fig. 21, Table III). Contractile vacuole at posterior end of body, just above caudal spine, with two inconspicuous canals (Figs. 22, 23). Cytoplasm colorless, but often appearing green from ingested algae.

Somatic kineties running along small ribs, ending ⅕ body length from posterior pole, composed of short (ca. 2 μm), immobile cilia, parallel to the body surface and close together, with fine projections which may contact pellicle (Figs. 29, 30).

Adoral membranelles very conspicuous, encircle in an angle of about 45° clockwise the frontal collar, which is more distinct in protargol-impregnated (Fig. 19) than in living (Figs. 23–26) cells. Pharynx located eccentrically, large, with long fibers reaching posterior region of cell. Each collar membranelle and first buccal membranelle composed of three long (ca. 17 μm) rows of kinetosomes bearing long (ca. 40 μm) cilia apparently fused except for their distal ends; thus, distal parts of the membranelles appear frayed (Figs. 27, 28). Two shortened buccal membranelles, the innermost ca. 5 μm long and composed of only two rows of kinetosomes (Figs. 20, 31).

Occurrence and ecology. In May 22, 1986, when *S. lacustris* was isolated, the phytoplankton was dominated by *Rhodomonas* sp., several flagellated species of Chrysophyceae, and a small *Cyclotella* species. *Strobilidium lacustris* is kept in culture for further study of its autecology.

Comparison with other species. Superficially, *S. lacustris* looks like *S. caudatum* (=*S. gyrans;* see ref. 12). There are, however, distinct differences: *S. lacustris* never adheres to a substrate and never forms a stalk, which is so typical for *S. caudatum* (18). The somatic kineties are equally long in *S. lacustris,* whereas two of them are shortened in *S. caudatum* (4, 8). As concerns

TABLE II. *Biometric characterization of* Pelagohalteria viridis.[a]

Character	$\bar{x}$	SD	CV	Min	Max
Body, length	23.5	2.0	8.4	21	27
Body, width	23.3	1.7	7.2	21	25
Distance from apex to beginning of bristle complexes	11.2	2.3	20.7	8	14
Macronucleus, length	11.4	1.6	14.3	9	14
Macronucleus, width	7.2	1.1	15.0	6	10
Length of base of the third collar membranelle right of the pharynx	6.0	—	—	5	6
Buccal membranellar field, length	7.3	0.9	12.4	6	9
No. macronuclei	1.0	0.0	0.0	1	1
No. collar membranelles	16.6	0.8	4.9	15	18
No. buccal membranelles	7.5	0.7	9.2	7	9
No. somatic bristle complexes	8.8	0.9	9.9	8	11
No. kinetosomes in the vertical part of bristle complex I	4.8	0.9	18.2	3	6
No. kinetosomes in the horizontal part of bristle complex I	4.4	0.8	18.4	3	5
Total no. of kinetosomes in bristle complex I	9.2	1.4	15.3	6	11

[a] All data are based on the investigation of 11 randomly selected protargol-impregnated specimens. All measurements in micrometers. Legend: CV, coefficient of variation in %; Max, maximum; Min, minimum; No., number; SD, standard deviation; $\bar{x}$, arithmetic mean.

[2] This and other species described by Fromentel are frequently wrongly dated with the year 1874 (e.g. in ref. 23). Fromentel's book appeared during the years 1874–1876. Most of his new species are described in the part which appeared in the year 1876. The exact dates and pages are: 1874 (pp. I–VIII, 1–88), 1875 (pp. 89–192), 1876 (pp. 193–364).

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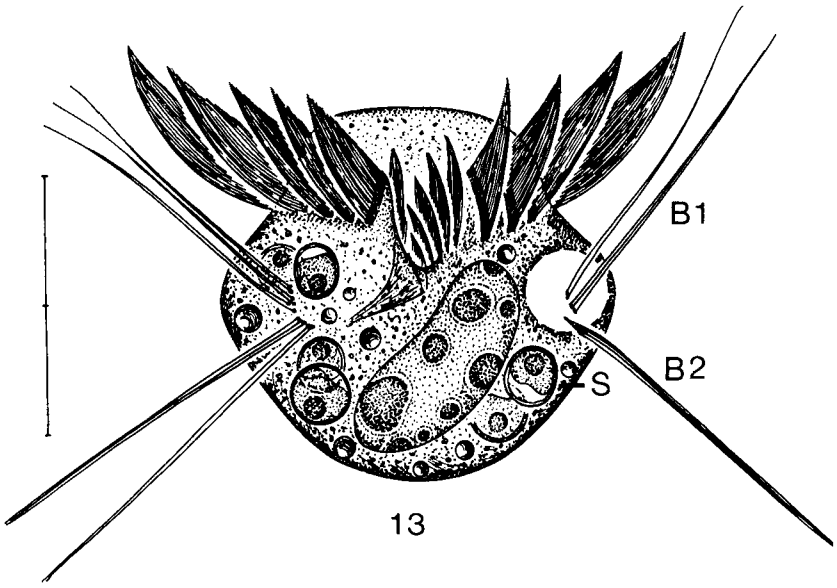
Figs. 7–12. *Trochiliopsis australis* (Figs. 7, 8; dry silver impregnation) and *Pelagohalteria viridis* from life (Figs. 10, 11) and in the SEM (Figs. 9, 12). **7.** Infraciliature and silverline system of the right side. The arrow marks the adoral organelle. E, excretion pore of the contractile vacuole; Cy, cytoproct. Bar = 10 μm. **8.** Infraciliature and silverline system of the left side. P2, P3, preoral kineties. Bar = 10 μm. **9, 12.** Dorsal view and detail of a collar membranelle (CAM) and a somatic bristle complex, which is composed of two ciliary structures (B1, B2). Bars = 5 μm and 10 μm, respectively. **10, 11.** Electronic flash illuminated phase contrast micrographs of freely moving individuals in ventral and frontal view showing collar membranelles (CAM) and the horizontally arranged cilia of a bristle complex (B2). Bars = 25 μm.



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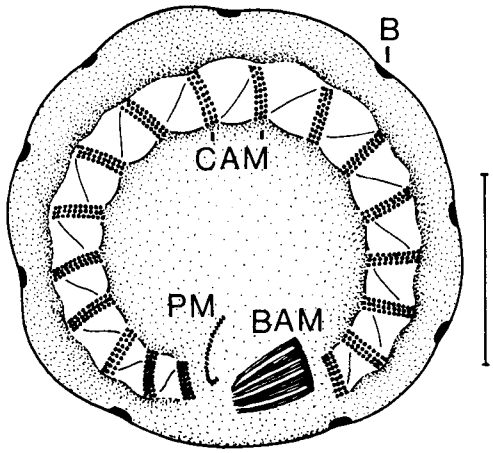

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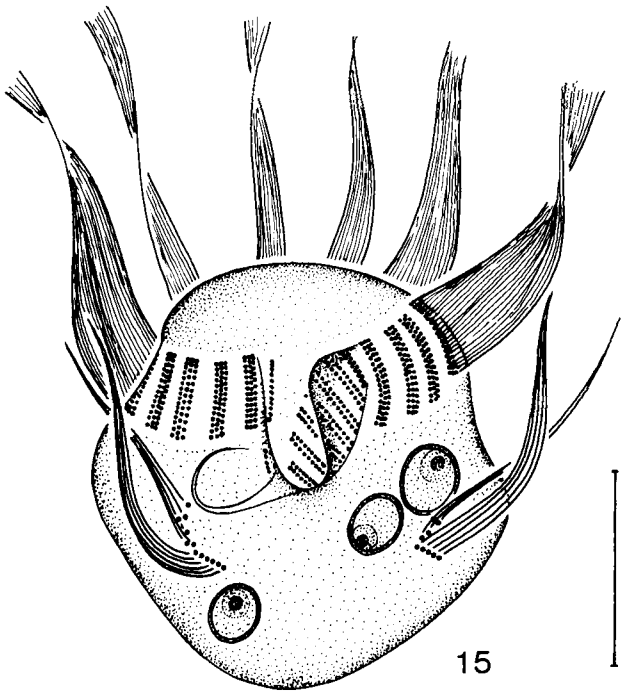

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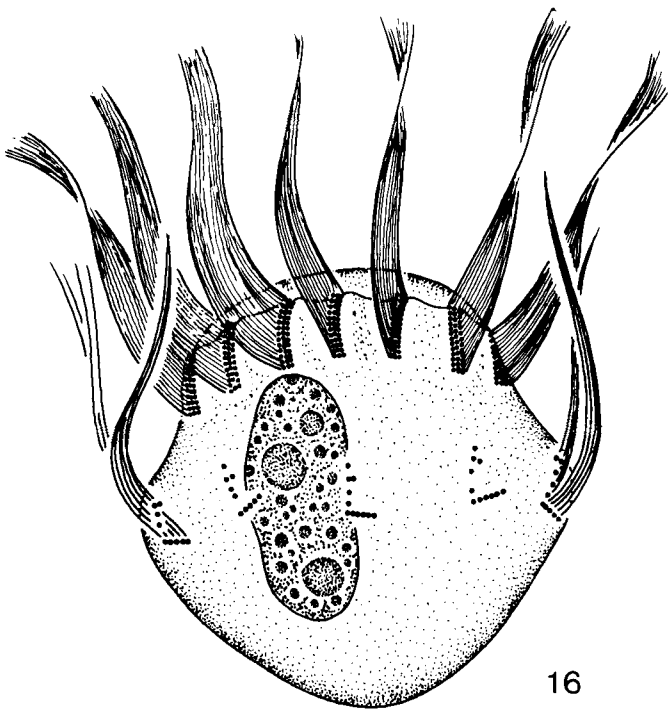

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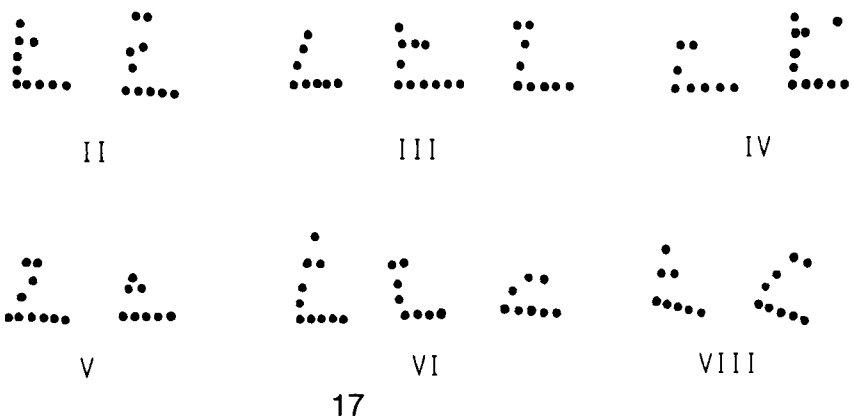

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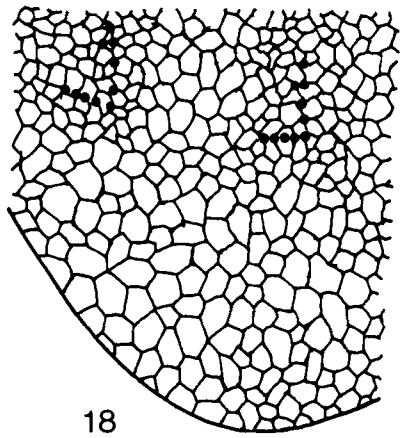

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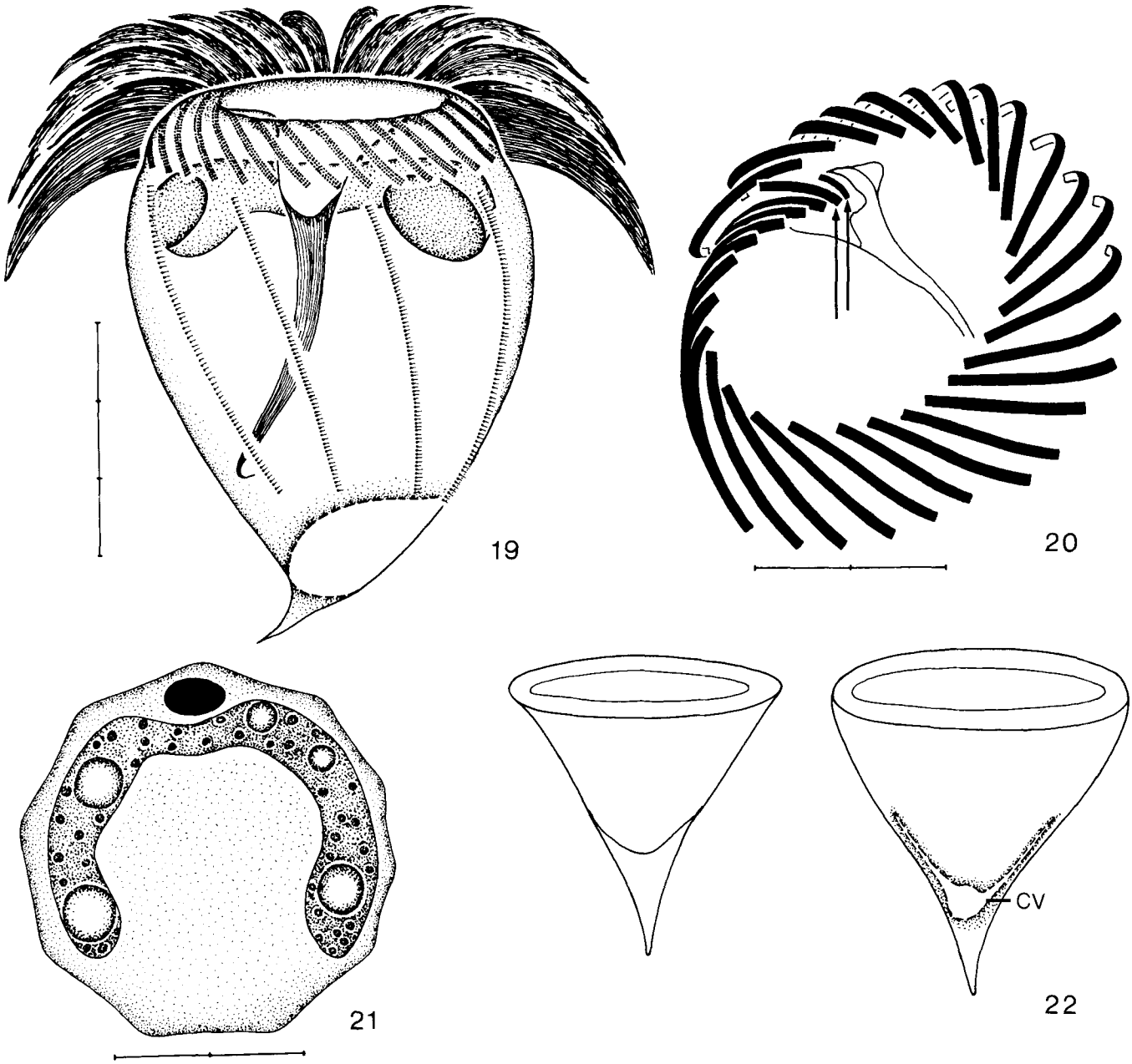

Figs. **19–22.** *Strobilidium lacustris* from protargol-impregnated specimens (Figs. 19–21) and from life (Fig. 22). **19.** Infraciliature of the ventral side. **20.** Oral apparatus in a top view. Arrows mark the shortened buccal membranelles. **21.** Transverse section showing the nuclear apparatus and the slightly ribbed pellicle. **22.** Freely moving individuals with slightly turned down collar. CV, contractile vacuole. Scale bar divisions = 10 μm.

the number of kineties and adoral membranelles, *S. lacustris* is very near to *S. velox* Fauré-Fremiet, 1924 (7). This species, however, measures only 30–70 μm (7, 19), has symbiotic green algae (7), and its pellicle is distinctly ribbed by the somatic kineties (7, 19), which is never the case in *S. lacustris* (Figs. 21, 23–26). The pellicle of *S. velox* of Grim (17) looks rather smooth, suggesting that it might be *S. lacustris.*

The pattern of the adoral membranelles of *S. lacustris* fits exactly that described for *S. velox* (17), with the exception of the shortening of the buccal membranelles, which might have

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Figs. **13–18.** *Pelagohalteria viridis* from life (Fig. 13), from protargol-impregnated specimens (Figs. 14–17), and from a Chatton-Lwoff silvered individual (Fig. 18). **13.** Ventral view. B1, B2, components of a bristle complex; S, symbiotic green alga. **14.** Frontal view showing bristles (B), buccal adoral membranelles (BAM), collar adoral membranelles (CAM), and the paroral membrane (PM). **15, 16.** Infraciliature of the ventral and the dorsal side. **17.** Examples of the structure of bristle complexes II–VIII. **18.** Part of the silverline system in the posterior half of the body. Scale bar divisions = 10 μm.

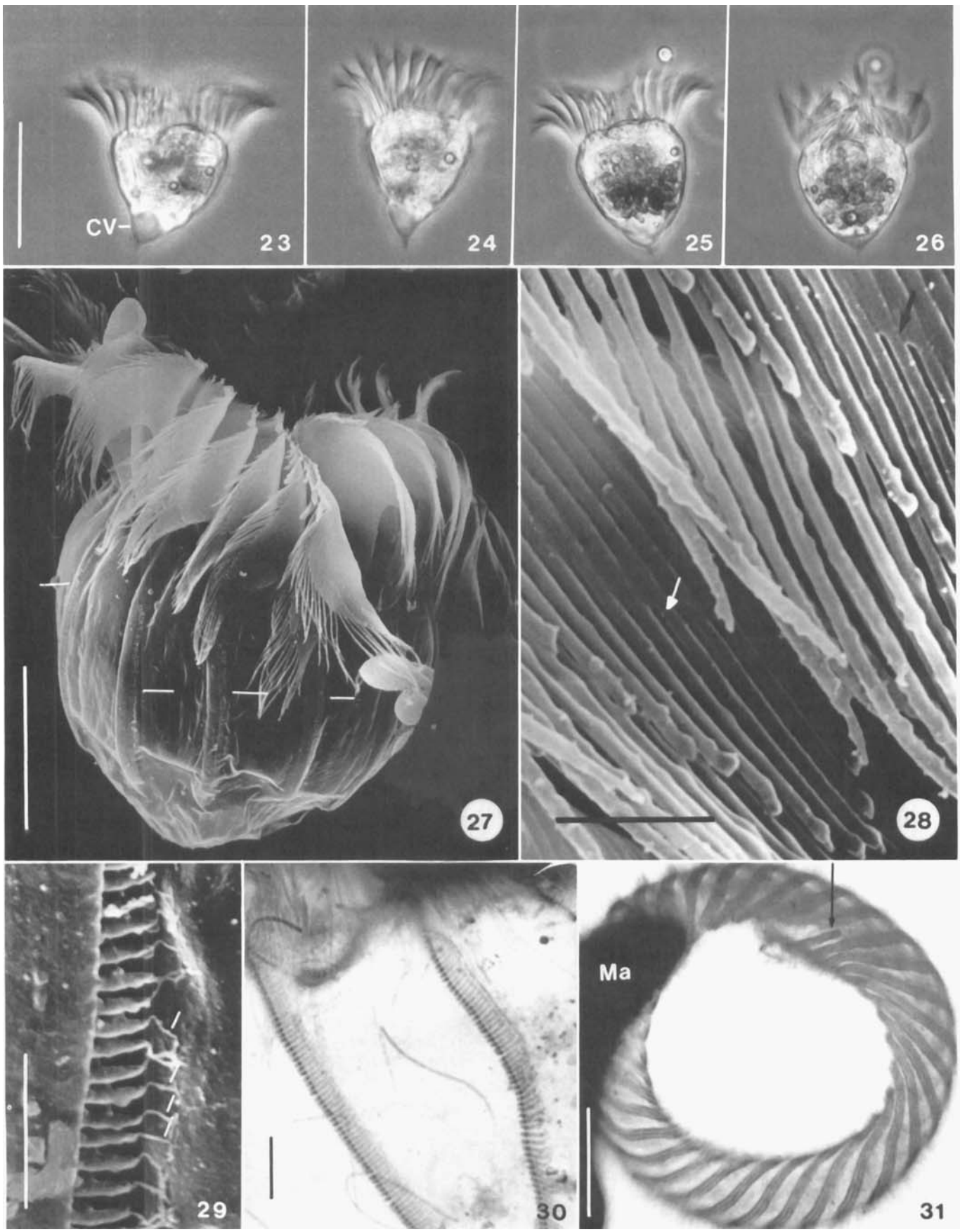
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TABLE III. *Biometric characterization of* Strobilidium lacustris *n. sp.*[a]

Character	$\bar{x}$	SD	CV	Min	Max
Body, length	66.5	8.6	12.9	50	77
Body, width	52.9	5.4	10.1	45	60
Macronuclear figure, diameter	41.0	3.0	7.4	35	46
Macronucleus, width	6.5	0.8	12.5	5	8
Micronucleus, length	6.1	0.7	11.5	5	7
Micronucleus, width	4.0	0.4	11.2	3	5
No. adoral membranelles	31.5	0.5	1.7	31	32
No. somatic kineties	9.7	0.5	4.8	9	10
No. macronuclei	1.0	0.0	0.0	1	1
No. micronuclei	1.0	0.0	0.0	1	1

[a] All data are based on the investigation of 11 randomly selected protargol-impregnated specimens. All measurements in micrometers. Legend: CV, coefficient of variation in %; Max, maximum; Min, minimum; No., number; SD, standard deviation; $\bar{x}$, arithmetic mean.

been overlooked. A paroral membrane, which is present in other strobilids (4, 17), has not been observed in *S. lacustris;* it may not have impregnated or may be inconspicuous.

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Received 8 II 88; accepted 5 VII 88

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Figs. **23–31**. *Strobilidium lacustris* from life (Figs. 23–26), in the SEM (Figs. 27–29), and from silver carbonate-impregnated specimens (Figs. 30, 31). **23–26**. Electronic flash-illuminated phase contrast micrographs of freely moving individuals showing the conspicuous adoral membranelles, the caudal spine, and the contractile vacuole (CV). Bar = 80 μm. **27**. Dorsal view. Note the frayed adoral membranelles. The white lines mark the somatic kineties. Bar = 20 μm. **28**. Detail of the distal end of two adoral membranelles. Note that cilia are fused close behind their distal end (arrows). Bar = 2 μm. **29, 30**. Details of somatic kineties. The very short cilia lie parallel to the body surface and have fine projections which contact the pellicle (white lines in Fig. 29). Bars = 2 μm and 3 μm, respectively. **31**. Frontal view of the adoral zone of membranelles, which are composed of three rows of kinetosomes. The arrow marks the innermost buccal membranelle, which is composed of two rows of kinetosomes. Ma, macronucleus. Bar = 17 μm.